INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
(Approved by AICTE | NAAC Accreditation with 'A' Grade | Accredited by NBA | Affiliated to JNTUH)
Dundigal, Hyderabad - 500 043, Telangana

OUTCOME BASED EDUCATION
WITH
CHOICE BASED CREDIT SYSTEM

BACHELOR OF TECHNOLOGY
CIVIL ENGINEERING

ACADEMIC REGULATIONS, COURSE STRUCTURE AND SYLLABI
UG20

B.Tech Regular Four Year Degree Program
(for the batches admitted from the academic year 2020 - 2021)
&

B.Tech (Lateral Entry Scheme)
(for the batches admitted from the academic year 2021 - 2022)

These rules and regulations may be altered/changed from time to time by the academic council
FAILURE TO READ AND UNDERSTAND THE RULES IS NOT AN EXCUSE

VISION

To bring forth professionally competent and socially sensitive engineers, capable of working across cultures meeting the global standards ethically.

MISSION

To provide students with an extensive and exceptional education that prepares them to excel in their profession, guided by dynamic intellectual community and be able to face the technically complex world with creative leadership qualities.

Further, be instrumental in emanating new knowledge through innovative research that emboldens entrepreneurship and economic development for the benefit of wide spread community.

QUALITY POLICY

Our policy is to nurture and build diligent and dedicated community of engineers providing a professional and unprejudiced environment, thus justifying the purpose of teaching and satisfying the stake holders.

A team of well qualified and experienced professionals ensure quality education with its practical application in all areas of the Institute.

PROGRAM OUTCOMES (PO's)

Engineering Graduates will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-Long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

CONTENTS

"Take up one idea.
Make that one idea your life-think of it, dream of it, live on that idea.
Let the brain muscles, nerves, every part of your body be full of that idea and just leave every other idea alone. This is the way to success"

Swami Vivekananda

PRELIMINARY DEFINITIONS AND NOMENCLATURES

AICTE: Means All India Council for Technical Education, New Delhi.

Autonomous Institute: Means an institute designated as Autonomous by University Grants Commission (UGC), New Delhi in concurrence with affiliating University (Jawaharlal Nehru Technological University, Hyderabad) and State Government.

Academic Autonomy: Means freedom to an institute in all aspects of conducting its academic programs, granted by UGC for Promoting Excellence.

Academic Council: The Academic Council is the highest academic body of the institute and is responsible for the maintenance of standards of instruction, education and examination within the institute. Academic Council is an authority as per UGC regulations and it has the right to take decisions on all academic matters including academic research.

Academic Year: It is the period necessary to complete an actual course of study within a year. It comprises two main semesters i.e., (one odd + one even) and one supplementary semester.

Branch: Means specialization in a program like B.Tech degree program in Aeronautical Engineering, B.Tech degree program in Computer Science and Engineering etc.

Board of Studies (BOS): BOS is an authority as defined in UGC regulations, constituted by Head of the Organization for each of the departments separately. They are responsible for curriculum design and updation in respect of all the programs offered by a department.

Backlog Course: A course is considered to be a backlog course, if the student has obtained a failure grade (F) in that course.

Basic Sciences: The courses offered in the areas of Mathematics, Physics, Chemistry etc., are considered to be foundational in nature.

Betterment: Betterment is a way that contributes towards improvement of the students' grade in any course(s). It can be done by either (a) re-appearing or (b) re-registering for the course.

Commission: Means University Grants Commission (UGC), New Delhi.

Choice Based Credit System: The credit based semester system is one which provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching along with provision of choice for the student in the course selection.

Certificate Course: It is a course that makes a student to have hands-on expertise and skills required for holistic development in a specific area/field.

Compulsory course: Course required to be undertaken for the award of the degree as per the program.

Continuous Internal Examination: It is an examination conducted towards sessional assessment.

Core: The courses that are essential constituents of each engineering discipline are categorized as professional core courses for that discipline.

Course: A course is a subject offered by a department for learning in a particular semester.

Course Outcomes: The essential skills that need to be acquired by every student through a course.

Credit: A credit is a unit that gives weight to the value, level or time requirements of an academic course. The number of 'Contact Hours' in a week of a particular course determines its credit value. One credit is equivalent to one lecture/tutorial hour per week.

Credit point: It is the product of grade point and number of credits for a course.

Cumulative Grade Point Average (CGPA): It is a measure of cumulative performance of a student over all the completed semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

Curriculum: Curriculum incorporates the planned interaction of students with instructional content, materials, resources, and processes for evaluating the attainment of Program Educational Objectives.

Department: An academic entity that conducts relevant curricular and co-curricular activities, involving both teaching and non-teaching staff, and other resources in the process of study for a degree.

Detention in a Course: Student who does not obtain minimum prescribed attendance in a course shall be detained in that particular course.

Dropping from Semester: Student who doesn't want to register for any semester can apply in writing in prescribed format before the commencement of that semester.

Elective Course: A course that can be chosen from a set of courses. An elective can be Professional Elective and / or Open Elective.

Evaluation: Evaluation is the process of judging the academic performance of the student in her/his courses. It is done through a combination of continuous internal assessment and semester end examinations.

Experiential Engineering Education (ExEEd): Engineering entrepreneurship requires strong technical skills in engineering design and computation with key business skills from marketing to business model generation. Our students require sufficient skills to innovate in existing companies or create their own.

Grade: It is an index of the performance of the students in a said course. Grades are indicated by alphabets.

Grade Point: It is a numerical weight allotted to each letter grade on a 10 - point scale.

Honours: An Honours degree typically refers to a higher level of academic achievement at an undergraduate level.

Institute: Means Institute of Aeronautical Engineering, Hyderabad unless indicated otherwise by the context.

Massive Open Online Courses (MOOC): MOOC courses inculcate the habit of self learning. MOOC courses would be additional choices in all the elective group courses.

Minor: Minor are coherent sequences of courses which may be taken in addition to the courses required for the B.Tech degree.

Pre-requisite: A specific course or subject, the knowledge of which is required to complete before student register another course at the next grade level.

Professional Elective: It indicates a course that is discipline centric. An appropriate choice of minimum number of such electives as specified in the program will lead to a degree with specialization.

Program: Means, UG degree program: Bachelor of Technology (B.Tech); PG degree program: Master of Technology (M.Tech) / Master of Business Administration (MBA).

Program Educational Objectives: The broad career, professional and personal goals that every student will achieve through a strategic and sequential action plan.

Project work: It is a design or research based work to be taken up by a student during his/her final year to achieve a particular aim. It is a credit based course and is to be planned carefully by the student.

Re-Appearing: A student can reappear only in the semester end examination for theory component of a course, subject to the regulations contained herein.

Registration: Process of enrolling into a set of courses in a semester of a program.

Regulations: The regulations, common to all B.Tech programs offered by Institute, are designated as "IARE Regulations – R20" and are binding on all the stakeholders.

Semester: It is a period of study consisting of 15 to 18 weeks of academic work equivalent to normally 90 working days. Odd semester commences usually in July and even semester in December of every year.

Semester End Examinations: It is an examination conducted for all courses offered in a semester at the end of the semester.

S/he: Means "she" and "he" both.

Student Outcomes: The essential skill sets that need to be acquired by every student during her/his program of study. These skill sets are in the areas of employability, entrepreneurial, social and behavioral.

University: Means Jawaharlal Nehru Technological University Hyderabad (JNTUH), Hyderabad, is an affiliating University.

Withdraw from a Course: Withdrawing from a course means that a student can drop from a course within the first two weeks of odd or even semester (deadlines are different for summer sessions). However, s/he can choose a substitute course in place of it, by exercising the option within 5 working days from the date of withdrawal.

FOREWORD

The autonomy is conferred to Institute of Aeronautical Engineering (IARE), Hyderabad by University Grants Commission (UGC), New Delhi based on its performance as well as future commitment and competency to impart quality education. It is a mark of its ability to function independently in accordance with the set norms of the monitoring bodies including J N T University Hyderabad (JNTUH), Hyderabad and AICTE, New Delhi. It reflects the confidence of the affiliating University in the autonomous institution to uphold and maintain standards it expects to deliver on its own behalf. Thus, an autonomous institution is given the freedom to have its own **curriculum, examination system** and **monitoring mechanism**, independent of the affiliating University but under its observance.

IARE is proud to win the credence of all the above bodies monitoring the quality in education and has gladly accepted the responsibility of sustaining, if not improving upon the standards and ethics for which it has been striving for more than a decade in reaching its present standing in the arena of contemporary technical education. As a follow up, statutory bodies such as Academic Council and Board of Studies (BOS) are constituted with the guidance of the Governing Body of the institute and recommendations of the JNTUH to frame the regulations, course structure, and syllabi under autonomous status.

The autonomous regulations, course structure, and syllabi have been prepared after prolonged and detailed interaction with several expertise solicited from academics, industry and research, in accordance with the vision and mission of the institute in order to produce a quality engineering graduate to the society.

All the faculty, parents, and students are requested to go through all the rules and regulations carefully. Any clarifications needed are to be sought at appropriate time and from the principal of the institute, without presumptions, to avoid unwanted subsequent inconveniences and embarrassments. The cooperation of all the stake holders is requested for the successful implementation of the autonomous system in the larger interests of the institute and brighter prospects of engineering graduates.

PRINCIPAL

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

ACADEMIC REGULATIONS – UG20

B.Tech. Regular Four Year Degree Program
(for the batches admitted from the academic year 2020 - 2021)
&
B.Tech. (Lateral Entry Scheme)
(for the batches admitted from the academic year 2021 - 2022)

For pursuing four year undergraduate Bachelor of Technology (B.Tech) degree program of study in engineering offered by Institute of Aeronautical Engineering under Autonomous status.

A student shall undergo the prescribed courses as given in the program curriculum to obtain his/her degree in major in which he/she is admitted with 160 credits in the entire program of 4 years. Additional 20 credits can be acquired for the degree of B.Tech with **Honours or additional Minor in Engineering**. These additional 20 credits will have to be acquired with massive open online courses (MOOCs), to tap the zeal and excitement of learning beyond the classrooms. This creates an excellent opportunity for students to acquire the necessary skill set for employability through massive open online courses where the rare expertise of world famous experts from academics and industry are available.

Separate certificate will be issued in addition to major degree program mentioning that the student has cleared Honours / Minor specialization in respective courses.

1. CHOICE BASED CREDIT SYSTEM

The credit based semester system provides flexibility in designing program curriculum and assigning credits based on the course content and hours of teaching. The Choice Based Credit System (CBCS) provides a 'cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning.

A course defines learning objectives and learning outcomes and comprises lectures / tutorials / laboratory work / field work / project work / comprehensive examination / seminars / assignments / MOOCs / alternative assessment tools / presentations / self-study etc., or a combination of some of these. Under the CBCS, the requirement for awarding a degree is prescribed in terms of number of credits to be completed by the students.

2. MEDIUM OF INSTRUCTION

The medium of instruction shall be **English** for all courses, examinations, seminar presentations and project work. The program curriculum will comprise courses of study as given in course structure, in accordance with the prescribed syllabi.

3. PROGRAMS OFFERED

Presently, the institute is offering Bachelor of Technology (B.Tech) degree programs in eleven disciplines. The various programs and their two-letter unique codes are given in Table 1.

Table 1: B.Tech Programs offered

S. No	Name of the Program	Title	Code
1	Aeronautical Engineering	AE	07
2	Computer Science and Engineering	CS	05
3	Computer Science and Engineering (AI & ML)	CA	34
4	Computer Science and Engineering (Data Science)	CD	35
5	Computer Science and Engineering (Cyber Security)	CC	36
6	Computer Science and Information Technology	CI	37
7	Information Technology	IT	06
8	Electronics and Communication Engineering	EC	04
9	Electrical and Electronics Engineering	EE	02
10	Mechanical Engineering	ME	03
11	Civil Engineering	CE	01

4. SEMESTER STRUCTURE

Each academic year is divided into three semesters, TWO being **MAIN SEMESTERS** (one odd + one even) and ONE being a **SUPPLEMENTARY SEMESTER**. Main semesters are for regular class work. Supplementary Semester is primarily for failed students i.e. registration for a course for the first time is generally not permitted in the supplementary semester.

4.1 Each main semester shall be of 21 weeks (Table 1) duration and this period includes time for registration of courses, course work, examination preparation, and conduct of examinations.

4.2 Each main semester shall have a minimum of 90 working days.

4.3 The supplementary semester shall be a fast track semester consisting of eight weeks and this period includes time for registration of courses, course work, and examination preparation, conduct of examinations, assessment, and declaration of final results.

4.4 All subjects may not be offered in the supplementary semester. The student has to pay a stipulated fee prescribed by the institute to register for a course in the supplementary semester. The supplementary semester is provided to help the student in not losing an academic year. It is optional for a student to make use of supplementary semester. **Supplementary semester is a special semester and the student cannot demand it as a matter of right** and will be offered based on availability of faculty and other institute resources.

4.5 The institute may use **supplementary semester** to arrange add-on courses for regular students and / or for deputing them for practical training / FSI model. A student can register for a maximum number of 15 credits during a supplementary semester.

The registration for the supplementary semester (during May – July, every year) provides an opportunity to students to clear their backlogs (‘F’ grade) or who are prevented from appearing for SEE examinations due to shortage of attendance less than 65% in each course (‘SA’ Grade) in the earlier semesters or the courses which he / she could not register (Drop / Withdraw) due to any reason.

Students will not be permitted to register for more than 15 credits (both I and II semester) in the supplementary semester. Students required to register for supplementary semester courses are to pay a nominal fee within the stipulated time. A separate circular shall be issued at the time of supplementary semester.

It will be optional for a student to get registered in the course(s) of supplementary semester; otherwise, he / she can opt to appear directly in supplementary examination. However, if a student gets registered in a course of supplementary semester, then it will be compulsory for a student to fulfill attendance criterion (≥90%) of supplementary semester and he / she will lose option to appear in immediate supplementary examination.

The students who have earlier taken SEE examination and register afresh for the supplementary semester may revoke the CIA marks secured by them in their regular/earlier attempts in the same course. Once revoked, the students shall not seek restoration of the CIA marks.

Supplementary semester will be at an accelerated pace e.g. one credit of a course shall require two hours/week so that the total number of contact hours can be maintained same as in normal semester.

Instructions and guidelines for the supplementary semester course:

- A minimum of 36 to 40 hours will be taught by the faculty for every course.
- Only the students registered and having sufficient percentage of attendance for the course will be permitted to write the examination.
- The assessment procedure in a supplementary semester course will be similar to the procedure for a regular semester course.
- Student shall register for the supplementary semester as per the schedule given in academic calendar.
- Once registered, students will not be allowed to withdraw from supplementary semester.

4.6 The academic calendar shown in Table 2 is declared at the beginning of the academic year.

Table 2: Academic Calendar

<table>
<tr><td rowspan="6">FIRST SEMESTER (21 weeks)</td><td>I Spell Instruction Period</td><td>8 weeks</td><td rowspan="5">19 weeks</td></tr>
<tr><td>I Continuous Internal Assessment Examinations (Mid-term)</td><td>1 week</td></tr>
<tr><td>II Spell Instruction Period</td><td>8 weeks</td></tr>
<tr><td>II Continuous Internal Assessment Examinations (Mid-term)</td><td>1 week</td></tr>
<tr><td>Preparation and Practical Examinations</td><td>1 week</td></tr>
<tr><td colspan="2">Semester End Examinations</td><td>2 weeks</td></tr>
<tr><td colspan="3">Semester Break and Supplementary Exams</td><td>2 weeks</td></tr>
<tr><td rowspan="6">SECOND SEMESTER (21 weeks)</td><td>I Spell Instruction Period</td><td>8 weeks</td><td rowspan="5">19 weeks</td></tr>
<tr><td>I Continuous Internal Assessment Examinations (Mid-term)</td><td>1 week</td></tr>
<tr><td>II Spell Instruction Period</td><td>8 weeks</td></tr>
<tr><td>II Continuous Internal Assessment Examinations (Mid-term)</td><td>1 week</td></tr>
<tr><td>Preparation & Practical Examinations</td><td>1 week</td></tr>
<tr><td colspan="2">Semester End Examinations</td><td>2 weeks</td></tr>
<tr><td colspan="3">Summer Vacation, Supplementary Semester and Remedial Exams</td><td>8 weeks</td></tr>
</table>

4.7 Students admitted on transfer from JNTUH affiliated institutes, Universities and other institutes in the subjects in which they are required to earn credits so as to be on par with regular students as prescribed by concerned ‘Board of Studies’.

5.0 REGISTRATION / DROPPING / WITHDRAWAL

The academic calendar includes important academic activities to assist the students and the faculty. These include, dates assigned for registration of courses, dropping of courses and withdrawal from courses. This enables the students to be well prepared and take full advantage of the flexibility provided by the credit system.

5.1. Each student has to compulsorily register for course work at the beginning of each semester as per the schedule mentioned in the Academic Calendar. It is compulsory for the student to register for courses in time. The registration will be organized departmentally under the supervision of the Head of the Department.

5.2. In ABSENTIA, registration will not be permitted under any circumstances.

5.3. At the time of registration, students should have cleared all the dues of Institute and Hostel for the previous semesters, paid the prescribed fees for the current semester and not been debarred from the institute for a specified period on disciplinary or any other ground.

5.4. In the first two semesters, the prescribed course load per semester is fixed and is mandated to registered all courses. Withdrawal / dropping of courses in the first and second semester is not allowed.

5.5. In higher semesters, the average load is 22 credits / semester, with its minimum and maximum limits being set at 16 and 28 credits. This flexibility enables students (**from IV semester onwards**) to cope-up with the course work considering the academic strength and capability of student.

5.6. **Dropping of Courses:**

Within one week after the last date of first internal assessment test or by the date notified in the academic calendar, the student may in consultation with his / her faculty mentor/adviser, drop one or more courses without prejudice to the minimum number of credits as specified in clause 5.4. The dropped courses are not recorded in the memorandum of grades. Student must complete the dropped subject by registering in the supplementary semester / forthcoming semester in order to earn the required credits. Student must complete the dropped subject by registering in the supplementary semester / forthcoming semester in order to earn the required credits.

5.7. **Withdrawal from Courses:**

A student is permitted to withdraw from a course by the date notified in the academic calendar. Such withdrawals will be permitted without prejudice to the minimum number of credits as specified in clause 5.4. A student cannot withdraw a course more than once and withdrawal of reregistered courses is not permitted.

6.0 CREDIT SYSTEM

The B.Tech Program shall consist of a number of courses and each course shall be assigned with credits. The curriculum shall comprise Theory Courses, Elective Courses, Laboratory Courses, Value Added Courses, Mandatory Courses, Experiential Engineering Education (ExEEd), Internship and Project work.

Depending on the complexity and volume of the course, the number of contact periods per week will be assigned. Each theory and laboratory course carries credits based on the number of hours / week.

- Contact classes (Theory): 1 credit per lecture hour per week, 1 credit per tutorial hour per week.
- Laboratory hours (Practical): 1 credit for 2 practical hours per week.
- Project work: 1 credit for 2 hours of project work per week.
- Mandatory Courses: No credit is awarded.
- Value Added Courses: No credit is awarded.
- Experiential Engineering Education (ExEEd): 1 credit for two per hours.

Credit distribution for courses offered is given in Table 5.

Table 5: Credit distribution

S. No	Course	Hours	Credits
1	Theory Course	2 / 3 / 4	2 / 3 / 4
2	Elective Courses	3	3
3	Laboratory Courses	2 / 3 / 4	1 / 1.5 / 2
4	Mandatory Course / Value Added Course	-	0
5	Project Work	-	10
6	Full Semester Internship (FSI) Project work	-	10

Major benefits of adopting the credit system are listed below:

- Quantification and uniformity in the listing of courses for all programs at College, like core, electives and project work.
- Ease of allocation of courses under different heads by using their credits to meet national /international practices in technical education.
- Convenience to specify the minimum / maximum limits of course load and its average per semester in the form of credits to be earned by a student.
- Flexibility in program duration for students by enabling them to pace their course load within minimum/maximum limits based on their preparation and capabilities.
- Wider choice of courses available from any department of the same College or even from other similar Colleges, either for credit or for audit.
- Improved facility for students to optimize their learning by availing of transfer of credits earned by them from one College to another.

7.0 CURRICULAR COMPONENTS

Courses in a curriculum may be of three kinds: **Foundation / Skill, Core and Elective Courses.**

Foundation / Skill Course:

Foundation courses are the courses based upon the content leads to enhancement of skill and knowledge as well as value based and are aimed at man making education. Skill subjects are those areas in which one needs to develop a set of skills to learn anything at all. They are fundamental to learning any subject.

Professional Core Courses:

There may be a core course in every semester. This is the course which is to be compulsorily studied by a student as a core requirement to complete the requirement of a program in the said discipline of study.

Elective Course:

Electives provide breadth of experience in respective branch and application areas. Elective course is a course which can be chosen from a pool of courses. It may be:

- Supportive to the discipline of study
- Providing an expanded scope
- Enabling an exposure to some other discipline / domain
- Nurturing student’s proficiency / skill.

An elective may be Professional Elective, is a discipline centric focusing on those courses which add generic proficiency to the students or may be Open Elective, chosen from unrelated disciplines.

There are six professional elective tracks; students can choose not more than two courses from each track. Overall, students can opt for six professional elective courses which suit their project work in consultation with the faculty advisor/mentor. Nevertheless, one course from each of the four open electives has to be selected. A student may also opt for more elective courses in his/her area of interest.

Every course of the B.Tech program will be placed in one of the eight categories with minimum credits as listed in the Table 6.

Table 6: Category Wise Distribution of Credits

S. No	Category	Breakup of Credits
1	Humanities and Social Sciences (HSMC), including Management.	6
2	Basic Science Courses (BSC) including Mathematics, Physics and Chemistry.	18.5
3	Engineering Science Courses (ESC), including Workshop, Drawing, ExEEd, Basics of Electrical / Electronics / Mechanical / Computer Engineering.	20.5
4	Professional Core Courses (PCC), relevant to the chosen specialization / branch.	78
5	Professional Electives Courses (PEC), relevant to the chosen specialization / branch.	18
6	Open Elective Courses (OEC), from other technical and/or emerging subject areas.	09
7	Project work (PROJ) / Full Semester Internship (FSI) Project work	10
8	Mandatory Courses (MC) / Value Added Courses (VAC).	Non-Credit
TOTAL		**160**

Semester wise course break-up

Following are the **TWO** models of course structure out of which any student shall choose or will be allotted with one model based on their academic performance.

i. Full Semester Internship (FSI) Model and

ii. Non Full Semester Internship (NFSI) Model

In the FSI Model, out of the selected students - half of students shall undergo Full Semester Internship in VII semester and the remaining students in VIII semester. In the Non-FSI Model, all the selected students shall carry out the course work and Project work as specified in the course structure. A student who secures a minimum CGPA of 7.5 upto IV semester with **no current arrears** and maintains the CGPA of 7.5 till VI Semester shall be eligible to opt for FSI.

8. EVALUATION METHODOLOGY

Each theory course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Student's performance in a course shall be judged by taking into account the results of CIA and SEE together. Table-7 shows the typical distribution of weightage for CIA and SEE.

Table 7: Assessment pattern for Theory Courses

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (End-term)	10	
	Tech talk / Quiz – 1 and Quiz – 2	5	
	Concept video / Alternative Assessment Tool (AAT)	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			**100**

8.1. Semester End Examination (SEE):

The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each modules carries equal weightage in terms of marks distribution. The question paper pattern is as follows.

Two full questions with 'either' 'or' choice will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept
50 %	To test the analytical skill of the concept OR to test the application skill of the concept

8.1. Continuous Internal Assessment (CIA):

For each theory course the CIA shall be conducted by the faculty / teacher handling the course. CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT). **Two CIE Tests are Compulsory** and sum of the two tests, along with the scores obtained in the quizzes (average of Quiz – 1 and Quiz – 2) / AAT shall be considered for computing the final CIA of a student in a given course.

The CIE Tests/quizzes/AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Quiz/AAT is mandatory and the responsibility lies with the concerned course faculty.

8.1.1. Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered. The valuation and verification of answer scripts of CIE exams shall be completed within a week after the conduct of the Examination.

8.1.2. Quiz – Online Examination

Two Quiz exams shall be conducted along with CIE in online mode for 5 marks each, consisting of 10 short answers questions (Definitions and Terminology) and 10 multiple choice questions (having each question to be answered by tick marking the correct answer from the choices (commonly four) given against it. Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Average of two quiz examinations shall be considered.

8.1.3. Alternative Assessment Tool (AAT)

In order to encourage innovative methods while delivering a course, the faculty members are encouraged to use the Alternative Assessment Tool (AAT). This AAT enables faculty to design own assessment patterns during the CIA. The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices. If properly applied, the AAT converts the classroom into an effective learning centre.

The AAT may include tech talk, tutorial hours/classes, seminars, assignments, term paper, open ended experiments, concept videos, partial reproduction of research work, oral presentation of research work, developing a generic tool-box for problem solving, report based on participation in create-a-thon, make-a-thon, code-a-thon, hack-a-thon conducted by reputed organizations / any other. etc.

However, it is mandatory for a faculty to obtain prior permission from the concerned HOD and spell out the teaching/assessment pattern of the AAT prior to commencement of the classes.

8.2 Laboratory Course

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance and 10 marks for the final internal lab assessment. The semester end laboratory examination for 70 marks shall be conducted internally by the respective department with at least two faculty members as examiners, both nominated by the Principal from the panel of experts recommended by the Chairman, BOS.

All the drawing related courses are evaluated in line with laboratory courses. The distribution shall be 30 marks for internal evaluation (20 marks for day–to–day work, and 10 marks for internal tests) and 70 marks for semester end laboratory examination. There shall be ONE internal test of 10 marks in each semester.

8.3 Audit Courses

In Addition, a student can register for courses for audit only with a view to supplement his/her knowledge and/or skills. Here also, the student's grades shall have to be reflected in the Memorandum of Grades. But, these shall not be taken into account in determining the student's academic performance in the semester. In view of this, it shall not be necessary for the institute to issue any separate transcript covering the audit courses to the registrants at these courses. Its result shall be declared as "Satisfactory" or "Not Satisfactory" performance.

8.4 Mandatory Courses (MC)

These courses are among the compulsory courses but will not carry any credits. However, a pass in each such course during the program shall be necessary requirement for the student to qualify for the award of Degree. Its result shall be declared as "Satisfactory" or "Not Satisfactory" performance.

8.5 Additional Mandatory Courses for lateral entry B.Tech students

In addition to the non-credit mandatory courses for regular B.Tech students, the lateral entry students shall take up the following three non-credit mandatory bridge courses (one in III semester, one in IV semester and one in V semester) as listed in Table 8. The student shall pass the following non-credit mandatory courses for the award of the degree and must clear these bridge courses before advancing to the VII semester of the program.

Table-8: Additional Mandatory Courses for lateral entry

S. No	Additional mandatory courses for lateral entry students
1	Dip-Mathematics
2	Dip-Programming for Problem Solving
3	Dip-English Communication Skills

8.6 Value Added Courses

The value added courses are audit courses offered through joint ventures with various organizations providing ample scope for the students as well as faculty to keep pace with the latest technologies pertaining to their chosen fields of study. A plenty of value added programs will be proposed by the departments one week before the commencement of class work. The students are given the option to choose the courses according to their desires and inclinations as they choose the desired items in a cafeteria. The expertise gained through the value added programs should enable them to face the formidable challenges of the future and also assist them in exploring new opportunities. Its result shall be declared with "Satisfactory" or "Not Satisfactory" performance.

8.7 Experiential Engineering Education (ExEED)

Engineering entrepreneurship requires strong technical skills in engineering design and computation with key business skills from marketing to business model generation. Students require sufficient skills to innovate in existing companies or create their own.

This course will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end Examination. Out of 30 marks of internal assessment, The Student has to submit Innovative Idea in a team of four members in the given format. The semester end examination for 70 marks shall be conducted internally, students has to present the Innovative Idea and it will be evaluated by internal ExEEd faculty with at least one faculty member as examiner from the industry, both nominated by the Principal from the panel of experts recommended by the Dean-CLET.

8.8 Project Work / FSI Project Work

This gives students a platform to experience a research driven career in engineering, while developing a device / systems and publishing in reputed SCI / SCOPUS indexed journals and/or filing an **Intellectual Property** (IPR-Patent/Copyright) to aid communities around the world. Students should work individually as per the guidelines issued by head of the department concerned. The benefits to students of this mode of learning include increased engagement, fostering of critical thinking and greater independence.

The topic should be so selected that the students are enabled to complete the work in the stipulated time with the available resources in the respective laboratories. The scope of the work be handling part of the consultancy work, maintenance of the existing equipment, development of new experiment setup or can be a prelude to the main project with a specific outcome.

Project report will be evaluated for 100 marks in total. Assessment will be done for 100 marks out of which, the supervisor / guide will evaluate for 30 marks based on the work and presentation / execution of the work. Subdivision for the remaining 70 marks is based on publication, report, presentation, execution and viva-voce. Evaluation shall be done by a committee comprising the supervisor, Head of the department and an examiner nominated by the Principal from the panel of experts recommended by Chairman, BOS in consultation with Head of the department.

8.8.1 Project work

The student's project activity is spread over in VII semester and in VIII semesters. A student shall carry out the project work under the supervision of a faculty member or in collaboration with an Industry, R&D organization or another academic institution/University where sufficient facilities exist to carry out the project work.

Project work (phase-I) starts in VII semester as it takes a vital role in campus hiring process. Students shall select project titles from their respective logins uploaded by the supervisors at the beginning of VII semester. Three reviews are conducted by department review committee (DRC) for 10 marks each. Student must submit a project report summarizing the work done up to design phase/prototype by the end of VII semester. The semester end examination for project work (phase-I) is evaluated based on the project report submitted and a viva-voce exam for 70 marks by a committee comprising the head of the department, the project supervisor and an external examiner nominated by the Principal.

Project Work (phase-II) stars in VIII semester, shall be evaluated for 100 marks out of which 30 marks towards continuous internal assessment and 70 marks for semester end examination. Three reviews are to be conducted by DRC on the progress of the project for 30 marks. The semester end examination shall be based on the final report submitted and a viva-voce exam for 70 marks by a committee comprising the head of the department, the project supervisor and an external examiner nominated by the Principal.

A minimum of 40% of maximum marks shall be obtained to earn the corresponding credits.

8.8.2 Full Semester Internship (FSI)

FSI is a full semester internship program carry 10 credits. The FSI shall be opted in VII semester or in VIII semester. During the FSI, student has to spend one full semester in an identified industry / firm / R&D organization or another academic institution/University where sufficient facilities exist to carry out the project work.

Following are the evaluation guidelines:

- Quizzes: 2 times
- Quiz #1 - About the industry profile, weightage: 5%
- Quiz #2 - Technical-project related, weightage: 5%
- Seminars - 2 times (once in six weeks), weightage: 7.5% + 7.5%
- Viva-voce: 2 times (once in six weeks), weightage: 7.5% + 7.5%

- Project Report, weightage: 15%
- Internship Diary, weightage: 5 %
- Final Presentation, weightage: 40%

FSI shall be open to all the branches with a ceiling of maximum 10% distributed in both semesters. The selection procedure is:

- Choice of the students.
- CGPA (> 7.5) upto IV semester having no credit arrears.
- Competency Mapping / Allotment.

It is recommended that the FSI Project work leads to a research publication in a reputed Journal/Conference or the filing of patent/design with the patent office, or, the start-up initiative with a sustainable and viable business model accepted by the incubation center of the institute together with the formal registration of the startup.

8.9 Plagiarism index for Project Report:

All project reports shall go through the plagiarism check and the plagiarism index has to be less than 20%. Project reports with plagiarism more than 20% and less than 60% shall be asked for resubmission within a stipulated period of six months. Project reports with plagiarism more than 60% shall be rejected.

9. MAKEUP EXAMINATION

The make-up examination facility shall be available to students who may have missed to attend **CIE/Quiz** of one or more courses in a semester for valid reasons. The CIE make-up examination shall have comprehensive online objective type questions for 20 marks and Quiz for 5 marks. The content for the make-up examination shall be on the whole syllabus. The Makeup examination shall be conducted at the end of the respective semester.

10. SUPPLEMENTARY EXAMINATIONS

In addition to the Regular Semester End Examinations held at the end of each semester, Supplementary Semester End Examinations will be conducted within three weeks of the commencement of the teaching of the next semester. Candidates taking the Regular / Supplementary examinations as Supplementary candidates may have to take more than one Semester End Examination per day. A student can appear for any number of supplementary examinations till he/she clears all courses which he/she could not clear in the first attempt. However the maximum stipulated period for the course shall not be relaxed under any circumstances.

11. ATTENDANCE REQUIREMENTS AND DETENTION POLICY

11.1 It is desirable for a candidate to have 100% attendance in each course. In every course (theory/laboratory), student has to maintain a minimum of 75% attendance including the days of attendance in sports, games, NCC and NSS activities to be eligible for appearing in Semester End Examination of the course.

11.2 In case of medical issues, deficiency of attendance in each course to the extent of 10% may be condoned by the College Academic Committee (CAC) on the recommendation of the Head of the Department if the attendance is between 75% and 65% in every course, subjected to the submission of medical certificates, medical case file, and other needful documents to the concerned departments.

11.3 The basis for the calculation of the attendance shall be the period prescribed by the institute by its calendar of events. For late admission, attendance is reckoned from the date of admission to the program. However, in case of a student having less than 65% attendance in any course, s/he shall be detained in the course and in no case such process will be relaxed.

11.4 A candidate shall put in a minimum required attendance in atleast 60% of (rounded to the next highest integer) theory courses for getting promoted to next higher class / semester. Otherwise, s/he shall be declared detained and has to repeat semester.

11.5 Students whose shortage of attendance is not condoned in any subject are not eligible to write their semester end examination of that courses and their registration shall stand cancelled.

11.6 A prescribed fee shall be payable towards condonation of shortage of attendance.

11.7 A student shall not be promoted to the next semester unless he satisfies the attendance requirement of the present semester, as applicable. They may seek readmission into that semester when offered next. If any candidate fails to fulfill the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

11.8 Any student against whom any disciplinary action by the institute is pending shall not be permitted to attend any SEE in that semester.

12. CONDUCT OF SEMESTER END EXAMINATIONS AND EVALUATION

12.1 Semester end examination shall be conducted by the Controller of Examinations (COE) by inviting Question Papers from the External Examiners.

12.2 Question papers may be moderated for the coverage of syllabus, pattern of questions by a Semester End Examination Committee chaired by Head of the Department one day before the commencement of semester end examinations. Internal Examiner shall prepare a detailed scheme of valuation.

12.3 The answer papers of semester end examination should be evaluated by the internal examiner immediately after the completion of exam and the award sheet should be submitted to COE in a sealed cover.

12.4 COE shall invite 3 - 9 internal/external examiners to evaluate all the semester end examination answer books on a prescribed date(s). Practical laboratory exams are conducted involving external examiners.

12.5 Examinations Control Committee shall consolidate the marks awarded by examiner/s and award grades.

13. SCHEME FOR THE AWARD OF GRADE

13.1 A student shall be deemed to have satisfied the minimum academic requirements and earn the credits for each theory course, if s/he secures

a) Not less than 35% marks for each theory course in the semester end examination, and

b) A minimum of 40% marks for each theory course considering Continuous Internal Assessment (CIA) and Semester End Examination (SEE).

13.2 A student shall be deemed to have satisfied the minimum academic requirements and earn the credits for each Laboratory / Project work / FSI Project work, if s/he secures

a) Not less than 40% marks for each Laboratory / Project work / FSI Project work course in the semester end examination,

b) A minimum of 40% marks for each Laboratory / Project work / FSI Project work course considering both internal and semester end examination.

13.3 If a candidate fails to secure a pass in a particular course, it is mandatory that s/he shall register and reappear for the examination in that course during the next semester when examination is conducted in that course. It is mandatory that s/he should continue to register and reappear for the examination till s/he secures a pass.

13.4 A student shall be declared successful or 'passed' in a semester, if he secures a Grade Point $\geq$ 5 ('C' grade or above) in every course in that semester (i.e. when the student gets an SGPA $\geq$5.0 at the end of that particular semester); and he shall be declared successful or 'passed' in the entire under graduate programme, only when gets a CGPA $\geq$5.0 for the award of the degree as required.

14. LETTER GRADES AND GRADE POINTS

14.1 Performances of students in each course are expressed in terms of marks as well as in Letter Grades based on absolute grading system. The UGC recommends a 10-point grading system with the following letter grades as given in the Table-9.

Table-9: Grade Points Scale (Absolute Grading)

Range of Marks	Grade Point	Letter Grade
100 – 90	10	S (Superior)
89 – 80	9	A+ (Excellent)
79 – 70	8	A (Very Good)
69 – 60	7	B+ (Good)
59 – 50	6	B (Average)
49 – 40	5	C (Pass)
Below 40	0	F (Fail)
Absent	0	AB (Absent)
Authorized Break of Study	0	ABS

14.2 A student is deemed to have passed and acquired to correspondent credits in particular course if s/he obtains any one of the following grades: “S”, “A+”, “A”, “B+”, “B”, “C”.

14.3 A student obtaining Grade F shall be considered Failed and will be required to reappear in the examination.

14.4 For non credit courses, ‘Satisfactory’ or “Not Satisfactory” is indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.

14.5 “SA” denotes shortage of attendance (as per item 11) and hence prevention from writing Semester End Examination.

14.6 “W” denotes **withdrawal** from the exam for the particular course.

14.7 At the end of each semester, the institute issues grade sheet indicating the SGPA and CGPA of the student. However, grade sheet will not be issued to the student if s/he has any outstanding dues.

14.8 **Award of Class:**

Sometimes, it is necessary to provide equivalence of these averages, viz., SGPA and CGPA with the percentages and/or Class awarded as in the conventional system of declaring the results of University examinations. This shall be done by Autonomous Colleges under the University only at one stage by prescribing certain specific thresholds in these averages for First Class with Distinction, First Class and Second Class, at the time of Degree Award. This provision given in Table-10 follows the approach of the Council for this purpose as reproduced from the AICTE Approval Process Handbook:

Table 10: Percentage Equivalence of Grade Points (for a 10 – Point Scale)

Grade Point	Percentage of Marks / Class
5.5	50
6.0	55
6.5	60
7.0	65
7.5	70
8.0	75

Note:

(1) The following Formula for Conversion of CGPA to percentage of marks to be used only after a student has successfully completed the program:
Percentage of Marks = $(CGPA - 0.5) \times 10$

(2) Class designation:
≥75% (First Class with Distinction),
≥ 60% and <75 % (First Class),
≥ 50 % and <60% (Second Class),
≥45% and <50% (Pass Class).

(3) The SGPA will be computed and printed on the Memorandum of Grades only if the candidate passes in all the courses offered and gets minimum B grade in all the courses.

(4) CGPA is calculated only when the candidate passes in all the courses offered in all the semesters.

15. COMPUTATION OF SGPA AND CGPA

The UGC recommends to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA). The credit points earned by a student are used for calculating the Semester Grade Point Average (SGPA) and the Cumulative Grade Point Average (CGPA), both of which are important performance indices of the student. SGPA is equal to the sum of all the total points earned by the student in a given semester divided by the number of credits registered by the student in that semester. CGPA gives the sum of all the total points earned in all the previous semesters and the current semester divided by the number of credits registered in all these semesters. Thus,

$$SGPA = \sum_{i=1}^{n}(C_i G_i) / \sum_{i=1}^{n} C_i$$

Where, C_i is the number of credits of the i^{th} course and G_i is the grade point scored by the student in the i^{th} course and n represent the number of courses in which a student is registered in the concerned semester.

$$CGPA = \sum_{j=1}^{m}(C_j S_j) / \sum_{j=1}^{m} C_j$$

Where, S_j is the SGPA of the j^{th} semester and C_j is the total number of credits upto the semester and m represent the number of semesters completed in which a student registered upto the semester.

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

16. ILLUSTRATION OF COMPUTATION OF SGPA AND CGPA

16.1 Illustration for SGPA

Course Name	Course Credits	Grade letter	Grade point	Credit Point (Credit x Grade)
Course 1	3	A	8	3 x 8 = 24
Course 2	4	B+	7	4 x 7 = 28
Course 3	3	B	6	3 x 6 = 18
Course 4	3	S	10	3 x 10 = 30
Course 5	3	C	5	3 x 5 = 15
Course 6	4	B	6	4 x 6 = 24
	20			**139**

Thus, SGPA = 139 / 20 = 6.95

16.2 Illustration for CGPA

Semester 1	Semester 2	Semester 3	Semester 4
Credit: 20 SGPA: 6.9	Credit: 22 SGPA: 7.8	Credit: 25 SGPA: 5.6	Credit: 26 SGPA: 6.0
Semester 5	**Semester 6**		
Credit: 26 SGPA: 6.3	Credit: 25 SGPA: 8.0		

$$Thus,\ CGPA = \frac{20x6.9\ +\ 22x7.8\ +\ 25x5.6\ +\ 26x6.0\ +\ 26x6.3\ +\ 25x8.0}{144} = 6.73$$

17. REVIEW OF SEE THEORY ANSWER BOOKS

Semester end examination answer books are made available online in CMS portal on the day of publication of results. A student, who is not satisfied with the assessment, is directed to apply for the review of his/her semester end examination answer book(s) in the theory course(s), within 2 working days from the publication of results in the prescribed format to the Controller of Examinations through the Head of the department with prescribed fee.

The Controller of Examinations shall appoint two examiners (chief examiner of original exam and a new examiner) for the review of the semester end examination (theory) answer book. Both examiners shall jointly review and marks awarded in the previous assessment shall be kept open.

The marks obtained by the candidate after the review shall be considered for grading, only if, the change in mark is more than or equal to 10% of total mark of semester end examination (theory). Marks obtained after re-evaluation shall stand final even if it is less than the original marks. Review is not permitted to the courses other than theory courses.

18. PROMOTION POLICIES

The following academic requirements have to be satisfied in addition to the attendance requirements mentioned in item no. 11.

18.1 For students admitted into B.Tech (Regular) program

18.1.1 A student will not be promoted from II semester to III semester unless s/he fulfills the academic requirement of securing 50% of the total credits (rounded to the next lowest integer) from I and II semester examinations, whether the candidate takes the examination(s) or not.

18.1.2 A student will not be promoted from IV semester to V semester unless s/he fulfills the academic requirement of securing 60% of the total credits (rounded to the next lowest integer) upto III semester **or** 60% of the total credits (rounded to the next lowest integer) up to IV semester, from all the examinations, whether the candidate takes the examination(s) or not.

18.1.3 A student shall be promoted from VI semester to VII semester only if s/he fulfills the academic requirements of securing 60% of the total credits (rounded to the next lowest integer) up to V semester **or** 60% of the total credits (rounded to the next lowest integer) up to VI semester from all the examinations, whether the candidate takes the examination(s) or not.

18.1.4 A student shall register for all the 160 credits and earn all the 160 credits. Marks obtained in all the 160 credits shall be considered for the award of the Grade.

18.2 For students admitted into B.Tech (lateral entry students)

18.2.1 A student will not be promoted from IV semester to V semester unless s/he fulfills the academic requirement of securing 60% of the total credits (rounded to the next lowest integer) up to IV semester, from all the examinations, whether the candidate takes the examination(s) or not.

18.2.2 A student shall be promoted from VI semester to VII semester only if s/he fulfills the academic requirements of securing 60% of the total credits (rounded to the next lowest integer) up to V semester **or** 60% of the total credits (rounded to the next lowest integer) up to VI semester from all the examinations, whether the candidate takes the examination(s) or not.

18.2.3 A student shall register for all the 126 credits and earn all the 126 credits. Marks obtained in all the 126 credits shall be considered for the award of the Grade.

19. GRADUATION REQUIREMENTS

The following academic requirements shall be met for the award of the B.Tech degree.

19.1 Student shall register and acquire minimum attendance in all courses and secure 160 credits (with minimum CGPA of 5.0), for regular program and 126 credits (with minimum CGPA of 5.0), for lateral entry program.

19.2 A student of a regular program, who fails to earn 160 credits within eight consecutive academic years from the year of his/her admission with a minimum CGPA of 5.0, shall forfeit his/her degree and his/her admission stands cancelled.

19.3 A student of a lateral entry program who fails to earn 126 credits within six consecutive academic years from the year of his/her admission with a minimum CGPA of 5.0, shall forfeit his/her degree and his/her admission stands cancelled.

20. BETTERMENT OF MARKS IN THE COURSES ALREADY PASSED

Students who clear all the courses in their first attempt and wish to improve their CGPA shall register and appear for betterment of marks for one course of any theory courses within a period of subsequent two semesters. The improved marks shall be considered for classification / distinction but not for ranking. If there is no improvement, there shall not be any change in the original marks already awarded.

21. AWARD OF DEGREE

21.1 Classification of degree will be as follows:

CGPA $\geq$ 8.0	CGPA $\geq$ 6.5 and $<$ 8.0	CGPA $\geq$ 5.5 and $<$ 6.5	CGPA $\geq$ 5.0 and $<$ 5.5	CGPA $<$ 5.0
First Class with Distinction	**First Class**	**Second Class**	**Pass Class**	**Fail**

21.2 A student with final CGPA (at the end of the under graduate programme) $\geq$8.00, and fulfilling the following conditions - shall be placed in '**first class with distinction**'. However,

(a) Should have passed all the courses in '**first appearance'** within the first 4 academic years (or 8 sequential semesters) from the date of commencement of first year first semester.

(b) Should have secured a CGPA $\geq$8.00, at the end of each of the 8 sequential semesters, starting from I year I semester onwards.

(c) Should not have been detained or prevented from writing the semester end examinations in any semester due to shortage of attendance or any other reason.

A student not fulfilling any of the above conditions with final CGPA >8 shall be placed in **'first class'.**

21.3 Students with final CGPA (at the end of the B.Tech program) $\geq$6.50 but <8.00 shall be placed in **'first class'.**

21.4 Students with final CGPA (at the end of the B.Tech program) ≥5.50 but <6.50, shall be placed in '**second class'**.

21.5 All other students who qualify for the award of the degree (as per item 19), with final CGPA (at the end of the B.Tech program) ≥5.0 but <5.50, shall be placed in '**pass class**'.

21.6 A student with final CGPA (at the end of the B.Tech program) < 5.00 will not be eligible for the award of the degree.

21.7 Students fulfilling the conditions listed under item 21.2 alone will be eligible for award of '**Gold Medal**'.

21.8. In order to extend the benefit to the students with one/two backlogs after either VI semester or VIII semester, GRAFTING option is provided to the students enabling their placements and fulfilling graduation requirements. Following are the guidelines for the Grafting:

(a) Grafting will be done among the courses within the semester shall draw a maximum of 7 marks from the any one of the cleared courses in the semester and will be grafted to the failed course in the same semester.

(b) Students shall be given a choice of grafting only once in the 4 years program, either after VI semester (Option #1) or after VIII semester (Option #2).

(c) Option#1: Applicable to students who have maximum of TWO theory courses in V and / or VI semesters.

Option#2: Applicable to students who have maximum of TWO theory courses in VII and / or VIII semesters.

(d) Eligibility for grafting:

i. Prior to the conduct of the supplementary examination after the declaration of VI or VIII semester results.

ii. S/he must appear in all regular or supplementary examinations as per the provisions laid down in regulations for the courses s/he appeals for grafting.

iii. The marks obtained by her/him in latest attempt shall be taken into account for grafting of marks in the failed course(s).

21.9 Student, who clears all the courses upto VII semester, shall have a chance to appear for Quick Supplementary Examination to clear the failed courses of VIII semester.

21.10 By the end of VI semester, all the students (regular and lateral entry students) shall complete one of the Value added course and mandatory course with acceptable performance.

21.11 In case, a student takes more than one attempt in clearing a course, the final marks secured shall be indicated by * mark in the grade sheet.

All the candidates who register for the semester end examination will be issued a memorandum of grades sheet by the institute. Apart from the semester wise memorandum of grades sheet, the institute will issue the provisional certificate and consolidated grades memorandum subject to the fulfillment of all the academic requirements.

22. B.TECH WITH HONOURS OR ADDITIONAL MINORS IN ENGINEERING

Students acquiring 160 credits are eligible to get B.Tech degree in Engineering. A student will be eligible to get B.Tech degree with Honours or additional Minors in Engineering, if s/he completes an additional 20 credits (3/4 credits per course). These could be acquired through MOOCs from SWAYAM / NPTEL / edX / Coursera / Udacity / PurdueNext / Khan Academy / QEEE etc. The list for MOOCs will be a dynamic one, as new courses are added from time to time. Few essential skill sets required for employability are also identified year wise. Students interested in doing MOOC courses shall register the course title at their department office at the start of the semester against the courses that are announced by the department. Any expense incurred for the MOOC course / summer program should be met by the students.

Only students having no credit arrears and a CGPA of 7.5 or above at the end of the fourth semester are eligible to register for B.Tech (Honours / Minor). After registering for the B.Tech (Honours / Minor) program, if a student fails in any course, s/he will not be eligible for B.Tech (Honours / Minor).

Every Department to develop and submit a Honours / Minors – courses list of 5 - 6 theory courses.

Honours Certificate for Vertical in his/her OWN Branch for Research orientation; Minor in any other branch for Improving Employability.

For the MOOCs platforms, where examination or assessment is absent (like SWAYAM) or where certification is costly (like Coursera or edX), faculty members of the institute prepare the examination question papers, for the courses undertaken by the students of respective Institutes, so that examinations Control Office (ECO) can conduct examination for the course. There shall be one Continuous Internal Examination (Quiz exam for 30 marks) after 8 weeks of the commencement of the course and semester end examination (Descriptive exam for 70 marks) shall be done along with the other regular courses.

A student can enroll for both Minor & Honours or for two Minors. The final grade sheet will only show the basic CGPA corresponding to the minimum requirement for the degree. The Minors/Honours will be indicated by a separate CGPA. The additional courses taken will also find separate mention in the grade sheet.

If a student drops (or terminated) from the Minor/Honours program, they cannot convert the earned credits into free or core electives; they will remain extra. These additional courses will find mention in the grade sheet (but not in the degree certificate). In such cases, the student may choose between the actual grade or a "Pass (P)" grade and also choose to omit the mention of the course as for the following:

- All the courses done under the dropped Minor/Honours will be shown in the grade sheet
- None of the courses done under the dropped Minor/Honours will be shown in the grade sheet.

Honours will be reflected in the degree certificate as "B.Tech (Honours) in XYZ Engineering". Similarly, Minor as "B.Tech in XYZ Engineering with Minor in ABC". If a student has done both Honours & Minor, it will be acknowledged as "B.Tech (Honours) in XYZ Engineering with Minor in ABC". And two minors will be reflected as "B.Tech in XYZ Engineering with Minor in ABC and Minor in DEF".

22.1. B.Tech with Honours

The total of 20 credits required to be attained for B.Tech Honours degree are distributed from V semester to VII semester in the following way:

For V semester	:	4 – 8 credits
For VI semester	:	4 – 8 credits
For VII semester	:	4 – 8 credits

Following are the details of such Honours which include some of the most interesting areas in the profession today:

S. No	Department	Honours scheme
1	Aeronautical Engineering	Aerospace Engineering / Space Science etc.
2	Computer Science and Engineering / Information Technology	Big data and Analytics / Cyber Physical Systems, Information Security / Cognitive Science / Artificial Intelligence/ Machine Learning / Data Science / Internet of Things (IoT) etc.
3	Electronics and Communication Engineering	Digital Communication / Signal Processing / Communication Networks / VLSI Design / Embedded Systems etc.
4	Electrical and Electronics Engineering	Renewable Energy systems / Energy and Sustainability / IoT Applications in Green Energy Systems etc.
5	Mechanical Engineering	Industrial Automation and Robotics / Manufacturing Sciences and Computation Techniques etc.
6	Civil Engineering	Structural Engineering / Environmental Engineering etc.

22.2 B.Tech with additional Minor in Engineering

Every department to develop and submit Minor courses list of 5 - 6 Theory courses. Student from any department is eligible to apply for Minor from any other department. The total of 20 credits to complete the B.Tech (Minor) program by registering for MOOC courses each having a minimum of 3/4 credits offered by reputed institutions / organization with the approval of the department. Registration of the student for B.Tech (Minor), is from V Semester to VII Semester of the program in the following way:

For V semester	:	4 – 8 credits
For VI semester	:	4 – 8 credits
For VII semester	:	4 – 8 credits

Only students having no credit arrears and a CGPA of 7.5 or above at the end of the fourth semester are eligible to register for B.Tech (Minor). After registering for the B.Tech (Minor) program, if a student fails in any course, s/he will not be eligible for B.Tech (Minor).

Every student shall also have the option to do a minor in engineering. A major is a primary focus of study and a minor is a secondary focus of study. The minor has to be a subject offered by a department other than the department that offers the major of the student or it can be a different major offered by the same department. For example, a student with the declared major in Computer Science and Engineering (CSE) may opt to do a minor in Physics; in which case, the student shall receive the degree B.Tech, Computer Science and Engineering with a minor in Physics. A student can do Majors in chosen filed as per the career goal, and a minor may be chosen to enhance the major thus adding the diversity, breadth and enhanced skills in the field.

22.3 Advantages of Minor in Engineering:

The minors mentioned above are having lots of advantages and a few are listed below:

1. To apply the inter-disciplinary knowledge gained through a Major (Stream) + Minor.
2. To enable students to pursue allied academic interest in contemporary areas.
3. To provide an academic mechanism for fulfilling multidisciplinary demands of industries.
4. To provide effective yet flexible options for students to achieve basic to intermediate level competence in the Minor area.
5. Provides an opportunity to students to become entrepreneurs and leaders by taking business/ management minor.
6. Combination in the diverse fields of engineering e.g., CSE (Major) + Electronics (Minor) combination increases placement prospects in chip designing companies.
7. Provides an opportunity to Applicants to pursue higher studies in an inter-disciplinary field of study.
8. Provides opportunity to the Applicants to pursue interdisciplinary research.
9. To increase the overall scope of the undergraduate degrees.

22.4 Following are the details of such Minor / Honours which include some of the most interesting areas in the profession today:

1. Aerospace Engineering
2. Space Science
3. Industrial Automation and Robotics
4. Computer Science and Engineering
5. Data Analytics
6. Machine Learning
7. Data Science
8. Artificial Intelligence
9. Information Security
10. Internet of Things
11. Cyber Physical Systems
12. Electronic System Design
13. Renewable Energy Sources
14. Energy and Sustainability

15. Manufacturing Sciences and Computation Techniques
16. Structural Engineering
17. Environmental Engineering
18. Technological Entrepreneurship
19. Materials Engineering
20. Physics (Materials / Nuclear / Optical / Medical)
21. Mathematics (Combinatorics / Logic / Number theory / Dynamical systems and differential equations/ Mathematical physics / Statistics and Probability).

23.0 TEMPORARY BREAK OF STUDY FROM THE PROGRAM

23.1 A candidate is normally not permitted to take a break from the study. However, if a candidate intends to temporarily discontinue the program in the middle for valid reasons (such as accident or hospitalization due to prolonged ill health) and to rejoin the program in a later respective semester, s/he shall seek the approval from the Principal in advance. Such application shall be submitted before the last date for payment of examination fee of the semester in question and forwarded through the Head of the Department stating the reasons for such withdrawal together with supporting documents and endorsement of his / her parent / guardian.

23.2 The institute shall examine such an application and if it finds the case to be genuine, it may permit the student to temporarily withdraw from the program. Such permission is accorded only to those who do not have any outstanding dues / demand at the College / University level including tuition fees, any other fees, library materials etc.

23.3 The candidate has to rejoin the program after the break from the commencement of the respective semester as and when it is offered.

23.4 The total period for completion of the program reckoned from the commencement of the semester to which the candidate was first admitted shall not exceed the maximum period specified in clause 19. The maximum period includes the break period.

23.5 If any candidate is detained for any reason, the period of detention shall not be considered as 'Break of Study'.

24. TERMINATION FROM THE PROGRAM

The admission of a student to the program may be terminated and the student is asked to leave the institute in the following circumstances:

a. The student fails to satisfy the requirements of the program within the maximum period stipulated for that program.

b. A student shall not be permitted to study any semester more than three times during the entire program of study.

c. The student fails to satisfy the norms of discipline specified by the institute from time to time.

25. TRANSCRIPT

The Transcript will be issued to the student as and when required and will contain a consolidated record of all the courses undergone by him/her, grades obtained and CGPA upto the date of issue of transcript. Only last letter grade obtained in a course by the student upto the date of issue of transcript will be shown in the Transcript.

26. WITH-HOLDING OF RESULTS

If the candidate has not paid any dues to the institute / if any case of indiscipline / malpractice is pending against him, the results and the degree of the candidate will be withheld.

27. GRADUATION DAY

The institute shall have its own annual Graduation Day for the award of degrees to the students completing the prescribed academic requirements in each case, in consultation with the University and by following the provisions in the Statute. The college shall institute prizes and medals to meritorious students and award them annually at the Graduation Day. This will greatly encourage the students to strive for excellence in their academic work.

28. DISCIPLINE

Every student is required to observe discipline and decorum both inside and outside the institute and are expected not to indulge in any activity which will tend to bring down the honour of the institute. If a student indulges in malpractice in any of the theory / practical examination, continuous assessment examinations, he/she shall be liable for punitive action as prescribed by the institute from time to time.

29. GRIEVANCE REDRESSAL COMMITTEE

The institute shall form a Grievance Redressal Committee for each course in each department with the Course Teacher and the HOD as the members. This Committee shall solve all grievances related to the course under consideration.

30. TRANSITORY REGULATIONS

A candidate, who is detained or has discontinued a semester, on readmission shall be required to do all the courses in the curriculum prescribed for the batch of students in which the student joins subsequently. However, exemption will be given to those candidates who have already passed such courses in the earlier semester(s) he was originally admitted into and substitute subjects are offered in place of them as decided by the Board of Studies. However, the decision of the Board of Studies will be final.

a) Four Year B.Tech Regular course:

A student who is following Jawaharlal Nehru Technological University (JNTUH) curriculum and detained due to the shortage of attendance at the end of the first semester shall join the autonomous batch of first semester. Such students shall study all the courses prescribed for the batch in which the student joins and considered on par with regular candidates of Autonomous stream and will be governed by the autonomous regulations.

A student who is following JNTUH curriculum, detained due to lack of credits or shortage of attendance at the end of the second semester or at the subsequent semesters shall join with the autonomous batch in the appropriate semester. Such candidates shall be required to pass in all the courses in the program prescribed by the Board of Studies concerned for that batch of students from that semester onwards to be eligible for the award of degree. However, exemption will be given in the courses of the semester(s) of the batch which he had passed earlier and substitute courses will be offered in place of them as decided by the Board of Studies. The student has to clear all his backlog courses up to previous semester by appearing for the supplementary examinations conducted by JNTUH for the award of degree. The total number of credits to be secured for the award of the degree will be sum of the credits up to previous semester under JNTUH regulations and the credits prescribed for the semester in which a candidate seeks readmission and subsequent semesters under the autonomous stream. The class will be awarded based on the academic performance of a student in the autonomous pattern.

b) Three Year B.Tech program under Lateral Entry Scheme:

A student who is following JNTUH curriculum and detained due to the shortage of attendance at the end of the first semester of second year shall join the autonomous batch of third semester. Such students shall study all the courses prescribed for the batch in which the student joins and considered on par with Lateral Entry regular candidates of Autonomous stream and will be governed by the autonomous regulations.

A student who is following JNTUH curriculum, if detained due to lack of credits or shortage of attendance at the end of the second semester of second year or at the subsequent semesters shall join with the autonomous batch in the appropriate semester. Such candidates shall be required to pass in all the courses in the program prescribed by the Board of Studies concerned for that batch of students from that semester onwards to be eligible for the award of degree. However, exemption will be given in the courses of the semester(s) of the batch which he had passed earlier and substitute courses are offered in place of them as decided by the Board of Studies. The student has to clear all his backlog courses up to previous semester by appearing for the supplementary examinations conducted by JNTUH for the award of degree. The total number of credits to be secured for the award of the degree will be sum of the credits up to previous semester under JNTUH regulations and the credits prescribed for the semester in which a candidate seeks readmission and subsequent semesters under the autonomous status. The class will be awarded based on the academic performance of a student in the autonomous pattern.

c) Transfer candidates (from non-autonomous college affiliated to JNTUH):

A student who is following JNTUH curriculum, transferred from other college to this institute in third semester or subsequent semesters shall join with the autonomous batch in the appropriate semester. Such candidates shall be required to pass in all the courses in the program prescribed by the Board of Studies concerned for that batch of students from that semester onwards to be eligible for the award of degree. However, exemption will be given in the courses of the semester(s) of the batch which he had passed earlier and substitute courses are offered in their place as decided by the Board of Studies. The student has to clear all his backlog courses up to previous semester by appearing for the supplementary examinations conducted by JNTUH for the award of degree. The total number of credits to be secured for the award of the degree will be the sum of the credits up to the previous semester under JNTUH regulations and the credits prescribed for the semester in which a candidate joined after transfer and subsequent semesters under the autonomous status. The class will be awarded based on the academic performance of a student in the autonomous pattern.

d) Transfer candidates (from an autonomous college affiliated to JNTUH):

A student who has secured the required credits up to previous semesters as per the regulations of other autonomous institutions shall also be permitted to be transferred to this institute. A student who is transferred from the other autonomous colleges to this institute in third semester or subsequent semesters shall join with the autonomous batch in the appropriate semester. Such candidates shall be required to pass in all the courses in the program prescribed by the Board of Studies concerned for that batch of students from that semester onwards to be eligible for the award of degree. However, exemption will be given in the courses of the semester(s) of the batch which he had passed earlier and substitute subjects are offered in their place as decided by the Board of Studies. The total number of credits to be secured for the award of the degree will be the sum of the credits up to previous semester as per the regulations of the college from which he is transferred and the credits prescribed for the semester in which a candidate joined after transfer and subsequent semesters under the autonomous status. The class will be awarded based on the academic performance of a student in the autonomous pattern.

e) Readmission from IARE-R16/R18 to IARE-UG.20 regulations

A student took admission in IARE-R18 Regulations, detained due to lack of required number of credits or percentage of attendance at the end of any semester is permitted to take re-admission at appropriate level under any regulations prevailing in the institute subject to the following rules and regulations.

1. Student shall pass all the courses in the earlier scheme of regulations (IARE - R18). However, in case of having backlog courses, they shall be cleared by appearing for supplementary examinations conducted under IARE - R18 regulations from time to time.
2. After rejoining, the student is required to study the courses as prescribed in the new regulations for the re-admitted program at that level and thereafter.
3. If the student has already passed any course(s) of readmitted program in the earlier regulation / semester of study, such courses are exempted in the new scheme to appear for the course(s).

4. The courses that are not done in the earlier regulations / semester as compared with readmitted program need to be cleared after readmission by appearing for the examinations conducted time to time under the new regulations.
5. In general, after transition, course composition and number of credits / semester shall be balanced between earlier and new regulations on case to case basis.
6. In case, the students who do not have option of acquiring required credits with the existing courses offered as per the new curriculum, credit balance can be achieved by clearing the additional courses offered by the respective departments (approved in Academic Council meeting). The additional courses that are offered can be of theory or laboratory courses and shall be offered during semester.
7. Students re-joined in III semester shall be treated on par with "Lateral Entry" students for credits and graduation requirements. However, the student shall clear all the courses in B.Tech I Semester and B.Tech II Semester as per IARE-R18 regulations.

31. REVISION OF REGULATIONS AND CURRICULUM

The Institute from time to time may revise, amend or change the regulations, scheme of examinations and syllabi if found necessary and on approval by the Academic Council and the Governing Body and shall be binding on the students, faculty, staff, all authorities of the Institute and others concerned.

FREQUENTLY ASKED QUESTIONS AND ANSWERS ABOUT AUTONOMY

1. **Who grants Autonomy? UGC, Govt., AICTE or University**
   In case of Colleges affiliated to a university and where statutes for grant of autonomy are ready, it is the respective University that finally grants autonomy but only after concurrence from the respective state Government as well as UGC. The State Government has its own powers to grant autonomy directly to Govt. and Govt. aided Colleges.

2 **Shall IARE award its own Degrees?**
   No. Degree will be awarded by Jawaharlal Nehru Technological University, Hyderabad with a mention of the name IARE on the Degree Certificate.

3 **What is the difference between a Deemed University and an Autonomy College?**
   A Deemed University is fully autonomous to the extent of awarding its own Degree. A Deemed University is usually a Non-Affiliating version of a University and has similar responsibilities like any University. An Autonomous College enjoys Academic Autonomy alone. The University to which an autonomous college is affiliated will have checks on the performance of the autonomous college.

4 **How will the Foreign Universities or other stake – holders know that we are an Autonomous College?**
   Autonomous status, once declared, shall be accepted by all the stake holders. The Govt. of Telangana mentions autonomous status during the First Year admission procedure. Foreign Universities and Indian Industries will know our status through our website.

5 **What is the change of Status for Students and Teachers if we become Autonomous?**
   An autonomous college carries a prestigious image. Autonomy is actually earned out of our continued past efforts on academic performances, our capability of self- governance and the kind of quality education we offer.

6 **Who will check whether the academic standard is maintained / improved after Autonomy? How will it be checked?**
   There is a built in mechanism in the autonomous working for this purpose. An Internal Committee called Academic Program Evaluation Committee, which will keep a watch on the academics and keep its reports and recommendations every year. In addition the highest academic council also supervises the academic matters. The standards of our question papers, the regularity of academic calendar, attendance of students, speed and transparency of result declaration and such other parameters are involved in this process.

7 **Will the students of IARE as an Autonomous College qualify for University Medals and Prizes for academic excellence?**
   No. IARE has instituted its own awards, medals, etc. for the academic performance of the students. However for all other events like sports, cultural on co-curricular organized by the University the students shall qualify.

8 **Can IARE have its own Convocation?**
   No. Since the University awards the Degree the Convocation will be that of the University, but there will be Graduation Day at IARE.

9 **Can IARE give a provisional degree certificate?**
   Since the examinations are conducted by IARE and the results are also declared by IARE, the college sends a list of successful candidates with their final Grades and Grade Point Averages including CGPA to the University. Therefore with the prior permission of the University the college will be entitled to give the provisional certificate.

10 **Will Academic Autonomy make a positive impact on the Placements or Employability?**
   Certainly. The number of students qualifying for placement interviews is expected to improve, due to

rigorous and repetitive classroom teaching and continuous assessment. Also the autonomous status is more responsive to the needs of the industry. As a result therefore, there will be a lot of scope for industry oriented skill development built-in into the system. The graduates from an autonomous college will therefore represent better employability.

11 What is the proportion of Internal and External Assessment as an Autonomous College?

Presently, it is 60% external and 40% internal. As the autonomy matures the internal assessment component shall be increased at the cost of external assessment.

12 Is it possible to have complete Internal Assessment for Theory or Practicals?

Yes indeed. We define our own system. We have the freedom to keep the proportion of external and internal assessment component to choose.

13 Why Credit based Grade System?

The credit based grade system is an accepted standard of academic performance the world over in all Universities. The acceptability of our graduates in the world market shall improve.

14 What exactly is a Credit based Grade System?

The credit based grade system defines a much better statistical way of judging the academic performance. One Lecture Hour per week of Teaching Learning process is assigned One Credit. One hour of laboratory work is assigned half credit. Letter Grades like A, B,C,D, etc. are assigned for a Range of Marks. (e.g. 91% and above is A+, 80 to 90 % could be A etc.) in Absolute Grading System while grades are awarded by statistical analysis in relative grading system. We thus dispense with sharp numerical boundaries. Secondly, the grades are associated with defined Grade Points in the scale of 1 to 10. Weighted Average of Grade Points is also defined Grade Points are weighted by Credits and averaged over total credits in a Semester. This process is repeated for all Semesters and a CGPA defines the Final Academic Performance

15 What are the norms for the number of Credits per Semester and total number of Credits for UG/PG program?

These norms are usually defined by UGC or AICTE. Usually around 25 Credits per semester is the accepted norm.

16 What is a Semester Grade Point Average (SGPA)?

The performance of a student in a semester is indicated by a number called SGPA. The SGPA is the weighted average of the grade points obtained in all the courses registered by the student during the semester.

$$SGPA = \sum_{i=1}^{n} (C_i G_i) / \sum_{i=1}^{n} C_i$$

Where, C_i is the number of credits of the i^{th} course and G_i is the grade point scored by the student in the i^{th} course and i represent the number of courses in which a student registered in the concerned semester. SGPA is rounded to two decimal places.

17 What is a Cumulative Grade Point Average (CGPA)?

An up-to-date assessment of overall performance of a student from the time of his first registration is obtained by calculating a number called CGPA, which is weighted average of the grade points obtained in all the courses registered by the students since he entered the Institute.

$$CGPA = \sum_{j=1}^{m} (C_j S_j) / \sum_{j=1}^{m} C_j$$

Where, S_j is the SGPA of the j^{th} semester and C_j is the total number of credits upto the semester and m represent the number of semesters completed in which a student registered upto the semester. CGPA is rounded to two decimal places.

18 Is there any Software available for calculating Grade point averages and converting the same into Grades?

Yes, The institute has its own MIS software for calculation of SGPA, CGPA, etc.

19 Will the teacher be required to do the job of calculating SGPAs etc. and convert the same into Grades?

No. The teacher has to give marks obtained out of whatever maximum marks as it is. Rest is all done by the computer.

20 Will there be any Revaluation or Re-Examination System?

No. There will double valuation of answer scripts. There will be a makeup Examination after a reasonable preparation time after the End Semester Examination for specific cases mentioned in the Rules and Regulations. In addition to this, there shall be a 'summer term' (compressed term) followed by the End Semester Exam, to save the precious time of students.

21 How fast Syllabi can be and should be changed?

Autonomy allows us the freedom to change the syllabi as often as we need.

22 Will the Degree be awarded on the basis of only final year performance?

No. The CGPA will reflect the average performance of all the semester taken together.

23 What are Statutory Academic Bodies?

Governing Body, Academic Council, Examination Committee and Board of Studies are the different statutory bodies. The participation of external members in everybody is compulsory. The institute has nominated professors from IIT, NIT, University (the officers of the rank of Pro-vice Chancellor, Deans and Controller of Examinations) and also the reputed industrialist and industry experts on these bodies.

24 Who takes Decisions on Academic matters?

The Governing Body of institute is the top academic body and is responsible for all the academic decisions. Many decisions are also taken at the lower level like Boards of Studies. Decisions taken at the Boared of Studies level are to be ratified at the Academic Council and Governing Body.

25 What is the role of Examination committee?

The Examinations Committee is responsible for the smooth conduct of internal, End Semester and make up Examinations. All matters involving the conduct of examinations spot valuations, tabulations preparation of Grade Sheet etc fall within the duties of the Examination Committee.

26 Is there any mechanism for Grievance Redressal?

The institute has grievance redressal committee, headed by Dean - Student affairs and Dean - IQAC.

27 How many attempts are permitted for obtaining a Degree?

All such matters are defined in Rules & Regulation

28 Who declares the result?

The result declaration process is also defined. After tabulation work wherein the SGPA, CGPA and final Grades are ready, the entire result is reviewed by the Moderation Committee. Any unusual deviations or gross level discrepancies are deliberated and removed. The entire result is discussed in the Examinations and Result Committee for its approval. The result is then declared on the institute notice boards as well put on the web site and Students Corner. It is eventually sent to the University.

29 Who will keep the Student Academic Records, University or IARE?

It is the responsibility of the Dean, Academics of the Autonomous College to keep and preserve all the records.

30 What is our relationship with the JNT University?

We remain an affiliated college of the JNT University. The University has the right to nominate its members on the academic bodies of the college.

31 Shall we require University approval if we want to start any New Courses?

Yes, It is expected that approvals or such other matters from an autonomous college will receive priority.

32 Shall we get autonomy for PG and Doctoral Programs also?

Yes, presently our PG programs also enjoying autonomous status.

MALPRACTICE RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

S. No	Nature of Malpractices/Improper conduct	Punishment
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculator, cell phone, pager, palm computer or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the Controller of Examinations.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate, who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all semester end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and

		project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all semester end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Controller of Examinations /Additional Controller of Examinations/any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the COE or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the COE or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the Institute premises or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears off the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all semester end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.

9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

FAILURE TO READ AND UNDERSTAND THE REGULATIONS IS NOT AN EXCUSE

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad – 500043

COURSE CATALOG

(CIVIL ENGINEERING)

I SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
AHSC01	English	HSMC	Foundation	3	0	0	3	30	70	100
AHSC02	Linear Algebra and Calculus	BSC	Foundation	3	1	0	4	30	70	100
AHSC03	Engineering Physics	BSC	Foundation	3	0	0	3	30	70	100
ACSC01	Python Programming	ESC	Foundation	3	0	0	3	30	70	100
PRACTICAL										
AHSC04	English Language and Communication Skills Laboratory	HSMC	Foundation	0	0	2	1	30	70	100
AHSC05	Physics Laboratory	BSC	Foundation	0	0	3	1.5	30	70	100
ACSC02	Python Programming Laboratory	ESC	Foundation	0	0	3	1.5	30	70	100
TOTAL				**12**	**01**	**08**	**17**	**210**	**490**	**700**

II SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
AHSC06	Chemistry	BSC	Foundation	2	0	0	2	30	70	100
AHSC07	Mathematical Transform Techniques	BSC	Foundation	3	1	0	4	30	70	100
AMEC01	Engineering Mechanics	ESC	Foundation	3	0	0	3	30	70	100
AEEC01	Basic Electrical Engineering	ESC	Foundation	3	0	0	3	30	70	100
ACSC06	Experiential Engineering Education (ExEEd) – Academic Sucess	ESC	Foundation	2	0	0	1	30	70	100
PRACTICAL										
AMEC02	Manufacturing Practice	ESC	Foundation	0	0	2	1	30	70	100
AMEC03	Computer Aided Engineering Drawing	ESC	Foundation	1	0	2	1.5	30	70	100
ACSC03	Programming for Problem Solving Laboratory	ESC	Foundation	0	0	3	1.5	30	70	100
TOTAL				**14**	**01**	**07**	**17**	**240**	**560**	**800**

III SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
ACEC01	Surveying and Geomatics	PCC	Core	3	0	0	3	30	70	100
ACEC02	Strength of Materials	PCC	Core	3	1	0	4	30	70	100
ACEC03	Fluid Mechanics	PCC	Core	3	1	0	4	30	70	100
ACEC04	Engineering Geology	PCC	Core	3	0	0	3	30	70	100
ACSC08	Data Structures	PCC	Core	3	0	0	3	30	70	100
ACSC09	Experiential Engineering Education (ExEEd) – Prototype / Design Building	ESC	Foundation	2	0	0	1	30	70	100
PRACTICAL										
ACEC05	Surveying and Geomatics Laboratory	PCC	Core	0	0	3	1.5	30	70	100
ACEC06	Engineering Geology Laboratory	PCC	Core	0	0	2	1	30	70	100
ACSC10	Data Structures Laboratory	PCC	Core	0	0	3	1.5	30	70	100
MANDATORY / VALUE ADDED COURSE										
AHSC10	Essence of Indian Traditional Knowledge	MC-I	MC	Ref: 8.4 Academic Regulations, UG 20						
TOTAL				**17**	**02**	**08**	**22**	**270**	**630**	**900**

IV SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
ACEC07	Theory of Structures	PCC	Core	3	1	0	4	30	70	100
AHSC08	Probability and Statistics	BSC	Foundation	3	1	0	4	30	70	100
ACEC08	Hydraulics and Hydraulic Machinery	PCC	Core	3	0	0	3	30	70	100
ACEC09	Building Materials – Planning and Construction	PCC	Core	3	0	0	3	30	70	100
ACEC10	Concrete Technology	PCC	Core	3	0	0	3	30	70	100
ACSC14	Experiential Engineering Education (ExEEd) – Fabrication / Model Development	ESC	Foundation	2	0	0	1	30	70	100
PRACTICAL										
ACEC11	Concrete Technology Laboratory	PCC	Core	0	0	2	1	30	70	100
ACEC12	Hydraulics and Hydraulic Machinery Laboratory	PCC	Core	0	0	3	1.5	30	70	100
ACEC13	Strength of Materials Laboratory	PCC	Core	0	0	3	1.5	30	70	100
MANDATORY / VALUE ADDED COURSE										
ACSC18	Fundamentals of Database Systems	VAC-I	Skill	Ref: 8.4 Academic Regulations, UG 20						
TOTAL				**17**	**02**	**08**	**22**	**270**	**630**	**900**

V SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
ACEC14	Analysis of Structures	PCC	Core	3	1	0	4	30	70	100
ACEC15	Hydrology and Water Resources Engineering	PCC	Core	3	1	0	4	30	70	100
ACEC16	Reinforced Concrete Structures Design and Drawing	PCC	Core	3	1	0	4	30	70	100
AHSC13	Business Economics and Financial Analysis	HSMC	Foundation	3	0	0	3	30	70	100
	Professional Elective–I	PEC	Elective	3	0	0	3	30	70	100
ACSC20	ExEEd – Project Based Learning	ESC	Foundation	2	0	0	1	30	70	100
PRACTICAL										
ACEC21	Advanced Surveying Laboratory	PCC	Core	0	0	3	1.5	30	70	100
ACEC22	Advanced Material Testing Laboratory	PCC	Core	0	0	3	1.5	30	70	100
MANDATORY / VALUE ADDED COURSE										
ACSC23	Object Oriented Programming Development and Languages	VAC-II	Skill	Ref: 8.4 Academic Regulations, UG 20						
TOTAL				**17**	**03**	**06**	**22**	**240**	**560**	**800**

VI SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
ACEC23	Steel Structures Design and Drawing	PCC	Core	3	1	0	4	30	70	100
ACEC24	Geotechnical Engineering	PCC	Core	3	1	0	4	30	70	100
ACEC25	Transportation Engineering	PCC	Core	3	1	0	4	30	70	100
	Professional Elective–II	PEC	Elective	3	0	0	3	30	70	100
	Open Elective – I	OEC	Elective	3	0	0	3	30	70	100
ACSC27	ExEEd – Research Based Learning	ESC	Foundation	2	0	0	1	30	70	100
PRACTICAL										
ACEC32	Geotechnical Engineering Laboratory	PCC	Core	0	0	3	1.5	30	70	100
ACEC33	Transportation Engineering Laboratory	PCC	Core	0	0	3	1.5	30	70	100
MANDATORY / VALUE ADDED COURSE										
ACSC29	Design of Algorithms	VAC-III	Skill	Ref: 8.4 Academic Regulations, UG 20						
TOTAL				**17**	**03**	**06**	**22**	**240**	**560**	**800**

VIISEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
ACEC34	Environmental Engineering	PCC	Core	3	1	0	4	30	70	100
ACEC35	Foundation Engineering	PCC	Core	3	0	0	3	30	70	100
	Professional Elective–III	PEC	Elective	3	0	0	3	30	70	100
	Professional Elective–IV	PEC	Elective	3	0	0	3	30	70	100
	Open Elective – II	OEC	Elective	3	0	0	3	30	70	100
PRACTICAL										
ACEC44	Advanced Structural Design Laboratory	PCC	Core	0	0	3	1.5	30	70	100
ACEC45	Project Planning Laboratory	PCC	Core	0	0	3	1.5	30	70	100
ACEC46	Project Work (Phase – I)	PROJ	Project	0	0	4	2	30	70	100
TOTAL				**15**	**01**	**10**	**21**	**240**	**560**	**800**

VIII SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
	Professional Elective–V	PEC	Elective	3	0	0	3	30	70	100
	Professional Elective–VI	PEC	Elective	3	0	0	3	30	70	100
	Open Elective – III	OEC	Elective	3	0	0	3	30	70	100
PRACTICAL										
ACEC55	Project Work(Phase – II)	PCC	Project	0	0	16	8	30	70	100
TOTAL				**09**	**00**	**16**	**17**	**120**	**280**	**400**

PROFESSIONAL ELECTIVES

Course code	PE - I Image Interpretation And Analysis	Course code	PE - II Construction Management	Course code	PE - III Project Management Techniques
ACEC17	Remote Sensing and GIS	ACEC26	Estimation, Costing and Valuation	ACEC36	Construction Engineering and Management
ACEC18	Visual Interpretation	ACEC27	Management in Construction	ACEC37	Foundations of Project Management
ACEC19	Advanced Geographical Information Systems	ACEC28	Construction Scheduling	ACEC38	Project Management: Principles, Practices and Systems
ACEC20	Satellite imagery in GIS	ACEC29	Construction Finance	ACEC39	Project Management: Beyond the basics

Course code	PE - IV Structural Detailing	Course code	PE - V Geotechnical Engineering	Course code	PE - VI Health Monitoring Of Structures
ACEC40	Prestressed Concrete Structures	ACEC47	Ground Improvement Techniques	ACEC51	Repair, Rehabilitation and Retrofitting of Structures
ACEC41	Structural Dynamics	ACEC48	Geotechnical Engineering and Management	ACEC52	Green Building Technologies
ACEC42	Design of Hydraulic Structures	ACEC49	Applied Geotechnics	ACEC53	Structural Analysis by Matrix methods
ACEC43	Elements of Earthquake Engineering	ACEC50	Advanced Geotechnical Engineering	ACEC54	Design of Bridge Structures

OPEN ELECTIVES COURSES

OPEN ELECTIVE - I

Course Code	Course Title
AAEC30	Flight Control Theory
AAEC31	Airframe Structural Design
AMEC34	Industrial Management
AMEC35	Elements of Mechanical Engineering
ACEC30	Modern Construction Materials
ACEC31	Disaster Management

OPEN ELECTIVES – II

Course Code	Course Title
ACSC24	Computer Architecture
ACSC25	Advanced Data Structures
ACSC26	Artificial Intelligence
AITC19	Cyber Crime and Computer Forensics
AITC20	Ethical Hacking
AITC21	Mobile Computing

OPEN ELECTIVE - III

Course Code	Course Title
AHSC15	Soft Skills and Interpersonal Communication
AHSC16	Cyber Law and Ethics
AHSC17	Economic Policies in India
AHSC18	Global Warming and Climate Change
AHSC19	Intellectual Property Rights
AHSC20	Entrepreneurship

MANDATORY / VALUE ADDED COURSES

Course Code	Course Title
AHSC10	Essence of Indian Traditional Knowledge (MC)
ACSC18	Fundamentals of Database Systems (VAC)
ACSC23	Object Oriented Programming Development and Languages (VAC)
ACSC29	Design of Algorithms (VAC)

SYLLABUS
(I - VIII SEMESTERS)

ENGLISH

<table>
<tr><td colspan="8">I Semester: AE / ECE / EEE / ME / CE
II Semester : CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">AHSC01</td><td rowspan="2">Foundation</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
<tr><td colspan="9">Prerequisite: Standard applicability of vocabulary and grammer</td></tr>
</table>

I. COURSE OVERVIEW:

The sole aim of the course is to enhance the communication skills of upcoming engineering graduates to meet the requirements and challenges in a competitive global world. This course is designed to provide a well-rounded introduction to English language learning. Moreover, the course pays special attention to the typical problems and challenges confronted by the Indian learners of English like mispronunciation, spellings, and structures of English due to their mother tongue influence. This course includes General Introduction to Listening Skills, Speaking Skills, Vocabulary and Grammar, Reading Skills, and Writing Skills.

II. COURSE OBJECTIVES:

The Students will try to learn:

I. The theoretical and fundamental inputs to communicate intelligibly in English through standard Pronunciation.
II. The four language skills i.e., Listening, Speaking, Reading and Writing effectively and their application in real-life situations.
III. The Writing strategies of English using correct spelling, grammar, punctuation and appropriate vocabulary.
IV. Different mechanics of writing styles forms of writing emails, reports, formal and informal letters.

III. COURSE SYLLABUS:

MODULE-I: GENERAL INTRODUCTION AND LISTENING SKILLS (09)

Introduction to communication skills; Communication process; Elements of communication; Soft skills vs hard skills; Listening skills; Significance; Stages of listening; Barriers to listening and effectiveness of listening; Listening comprehension.

MODULE –II: SPEAKING SKILLS (09)

Significance; Essentials; Barriers and effectiveness of speaking; Verbal and non-verbal communication; Generating talks based on visual prompts; Public speaking; Exposure to structured talks; Addressing a small group or a large formal gathering; Oral presentation.

MODULE –III: VOCABULARY & GRAMMAR (09)

Vocabulary: The concept of Word Formation; Root words from foreign languages and their use in English; Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Idioms and phrases; One-word substitutes.

Grammar: Sentence structure; Uses of phrases and clauses; Punctuation; Subject verb agreement; Modifiers; Articles; Prepositions.

MODULE –IV: READING SKILLS (09)

Significance; Techniques of reading; Skimming-Reading for the gist of a text; Scanning - Reading for specific information; Intensive; Extensive reading; Reading comprehension; Reading for information transfer; Text to diagram; Diagram to text.

MODULE –V: WRITING SKILLS (09)

Significance; Effectiveness of writing; Organizing principles of Paragraphs in documents; Techniques for writing precisely; Letter writing; Formal and Informal letter writing; E-mail writing, Report Writing.

IV. TEXT BOOKS:

1. Handbook of English for Communication (Prepared by Faculty of English, IARE).

V. REFERENCE BOOKS:

1. Sanjay Kumar and Pushp Lata. “Communications Skills”. Oxford University Press. 2011.
2. Michael Swan. “Practical English Usage”, Oxford University Press, 1995.
3. F.T. Wood. “Remedial English Grammar”. Macmillan. 2007.
4. William Zinsser. “On Writing Well”. Harper Resource Book, 2001.
5. Raymond Murphy, “Essential English Grammar with Answers”, Cambridge University Press 2nd Edition, 2011.

VI. WEB REFERENCES:

1. www.edufind.com
2. www.myenglishpages.com
3. http:grammar.ccc.comment.edu
4. http:owl.english.prudue.edu

VII. E-TEXT BOOKS:

1. http://bookboon.com/en/communication-ebooks-zip
2. http://www.bloomsbury-international.com/images/ezone/ebook/writing-skills-pdf.pdf
3. https://americanenglish.state.gov/files/ae/resource_files/developing_writing.pdf
4. http://learningenglishvocabularygrammar.com/files/idiomsandphraseswithmeaningsandexamplespdf
5. http://www.robinwood.com/Democracy/GeneralEssays/CriticalThinking.pdf

LINEAR ALGEBRA AND CALCULUS

I Semester: Common for All Branches								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AHSC02	**Foundation**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	1	-	4	30	70	100
Contact Classes: 45	**Tutorial Classes: 15**	**Practical Classes: Nil**				**Total Classes: 60**		
Prerequisite: Basic principles of algebra and calculus								

I. COURSE OVERVIEW:

Linear algebra is a sub-field of mathematics concerned with vectors, matrices, and linear transforms. Calculus is the branch of mathematics which majorly deals with derivatives and integrals. Linear algebra is a key foundation to the field of machine learning. Matrices are used in computer animations, color image processing. Eigenvalues are used by engineers to discover new and better designs for the future. Differential equations have wide applications in various engineering and science disciplines as the laws of physics are generally written down as differential equations.The Fourier series has many applications in electrical engineering, image processing etc.The course includes types of Matrices, Rank, methods of finding rank, eigen values and eigen vectors, maxima and minima of functions of several variables, solutions of higher order ordinary differential equations and Fourier series.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The principles of Eigen value analysis and linear transformations, Matrix rank finding methods
II. The calculus of functions of several variables and the concept of maxima-minima for a three-dimensional surface.
III. The analytical methods for solving higher order differential equations with constant coefficients.
IV. Fourier series expansions in standard intervals as well as arbitrary intervals.

III. COURSE SYLLABUS:

MODULE-I: THEORY OF MATRICES (09)

Real matrices: Symmetric, skew-symmetric and orthogonal matrices; Complex matrices: Hermitian, Skew- Hermitian and unitary matrices; Elementary row and column transformations, finding rank of a matrix by reducing to Echelon form and Normal form; Finding the inverse of a matrix using Gauss-Jordan method;

MODULE –II: LINEAR TRANSFORMATIONS (09)

Cayley-Hamilton theorem: Statement, verification, finding inverse and powers of a matrix; Linear dependence and independence of vectors; Linear transformation; Eigen values and Eigen vectors of a matrix; Diagonalization of matrix by linear transformation.

MODULE –III: FUNCTIONS OF SINGLE AND SEVERAL VARIABLES (09)

Mean value theorems: Rolle’s theorem, Lagrange’s theorem, Cauchy’s theorem-without proof.

Functions of several variables: Partial differentiation, Jacobian, functional dependence, maxima and minima of functions with two variables and three variables. Method of Lagrange multipliers.

MODULE –IV: HIGHER ORDER LINEAR DIFFERENTIAL EQUATIONS (09)

Linear differential equations of second and higher order with constant coefficients.

Non-homogeneous term of the type $f(x) = e^{ax}, \sin ax, \cos ax$ and $f(x) = x^n, e^{ax}v(x)$, Method of variation of parameters.

MODULE –V: FOURIER SERIES (09)

Fourier expansion of periodic function in a given interval of length 2π; Fourier series of even and odd functions; Fourier series in an arbitrary interval, Half- range Fourier sine and cosine expansions.

IV. TEXT BOOKS

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36^{th} Edition, 2010.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
3. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11^{th} Reprint 2010.

V. REFERENCE BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9^{th} Edition, John Wiley & Sons, 2006.
2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
3. D. Poole, Linear Algebra: A Modern Introduction, 2^{nd} Edition, Brooks/Cole, 2005.

VI. WEB REFERENCES:

1. http://www.efunda.com/math/math_home/math.cfm
2. http://www.ocw.mit.edu/resourcs/#Mathematics
3. http://www.sosmath.com
4. http://www.mathworld.wolfram.com

VII. E-TEXT BOOKS:

1. http://www.e-booksdirectory.com/details.php?ebook=10166
2. http://www.e-booksdirectory.com/details.php?ebook=7400re

ENGINEERING PHYSICS

<table>
<tr><td colspan="9">I Semester: AE / ME / CE / EEE / ECE</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">AHSC03</td><td rowspan="2">Foundation</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
<tr><td colspan="9">Prerequisite: Basic principles of waves</td></tr>
</table>

I. COURSE OVERVIEW:

This course develops abstract and critical reasoning by studying mathematical and logical proofs and assumptions as applied in basic physics and to make connections between physics and other branches of sciences and technology. The topics covered include waves, non-dispersive transverse and longitudinal waves, light and optics, wave optics, lasers, introduction to quantum mechanics, solution of wave equation and introduction to solids and semiconductors. The course helps students to gain knowledge of basic principles and appreciate the diverse applications in technological fields in respective branches.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basic formulations in wave mechanics for the evolution of energy levels and quantization of energies for a particle in a potential box with the help of mathematical description

II. The fundamental properties of semiconductors including the band gap, charge carrier concentration, doping and charge carrier transport mechanisms

III. The simple optical setups and experimental approaches of Light and Laser using its interaction with matter

IV. The basic studies between different harmonic oscillators and different waves for using those relationships on practical problems.

III. COURSE OBJECTIVES:

MODULE-I: QUANTUM MECHANICS (09)

Introduction to quantum physics, de-broglie's hypothesis, Wave-particle duality, Davisson and Germer experiment, Time-independent Schrodinger equation for wave function, Physical significance of the wave function, Schrodinger equation for one dimensional problems–particle in a box.

MODULE –II: INTRODUCTION TO SOLIDS AND SEMICONDUCTORS (09)

Introduction to classical free electron theory and quantum theory, Bloch's theorem for particles in a periodic potential (Qualitative treatment), Kronig-Penney model (Qualitative treatment), classification: metals, semiconductors, and insulators. Intrinsic and extrinsic semiconductors, Carrier concentration, Dependence of Fermi level on carrier-concentration and temperature, Hall effect.

MODULE –III: LASERS AND FIBER OPTICS (09)

Characteristics of lasers, Spontaneous and stimulated emission of radiation, Metastable state, Population inversion, Lasing action, Ruby laser, He-Ne laser and applications of lasers.

Principle and construction of an optical fiber, Acceptance angle, Numerical aperture, Types of optical fibers (Single mode, multimode, step index, graded index), Optical fiber communication system with block diagram and Applications of optical fibers.

MODULE –IV: LIGHT AND OPTICS (09)

Principle of superposition of waves, Young's double slit experiment, Fringe width, Newton's rings.
Fraunhofer diffraction from a single slit, double slit (extension to N slits) and diffraction grating experiment.

MODULE –V: HARMONIC OSCILLATIONS AND WAVES IN ONE DIMENSION (09)

Simple harmonic oscillator, Damped harmonic oscillator, Forced harmonic oscillator. Transverse waves and Longitudinal wave equation, Reflection and transmission of waves at a boundary, Harmonic waves.

IV. TEXT BOOKS:

1. G. Main, "Vibrations and Waves in Physics", Cambridge University Press, 1993.
2. R. K. Gaur, S. L. Gupta, "Engineering Physics", Dhanpat Rai Publications, 8th Edition, 2001.
3. Dr. K. Vijaya Kumar, Dr. S. Chandralingam, "Modern Engineering Physics", Chand & Co. New Delhi, 1st Edition, 2010.

V. REFERENCE BOOKS:

1. H.J. Pain, "The Physics of Vibrations and Waves", Wiley, 2006.
2. Ghatak, "Optics", McGraw Hill Education, 2012.
3. O. Svelto, "Principles of Lasers", Springer Science & Business Media, 2010.

VI. WEB REFERENCES:

1. http://link.springer.com/book
2. http://www.thphys.physics.ox.ac.uk
3. http://www.sciencedirect.com/science
4. http://www.e-booksdirectory.com

VII. E-TEXT BOOKS:

1. http://www.peaceone.net/basic/Feynman/
2. http://physicsdatabase.com/free-physics-books/
3. http://www.damtp.cam.ac.uk/user/tong/statphys/sp.pdf
4. www.freebookcentre.net/Physics/Solid-State-Physics-Books.html

PYTHON PROGRAMMING

I Semester: Common for all branches								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACSC01	**Foundation**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisites: There are no prerequisites to take this course.								

I. COURSE OVERVIEW:

This course introduces students to writing computer programs. This course presents the principles of structured programming using the Python language, one of the most increasingly preferred languages for programming today. Because of its ease of use, it is ideal as a first programming language and runs on both the PC and Macintosh platforms. However, the knowledge gained in the course can be applied later to other languages such as C and Java. The course uses iPython Notebook to afford a more interactive experience. Topics include fundamentals of computer programming in Python, object-oriented programming and graphical user interfaces.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Acquire programming skills in core Python.
II. Acquire Object-oriented programming skills in Python.
III. Develop the skill of designing graphical-user interfaces (GUI) in Python.
IV. Develop the ability to write database applications in Python.
V. Acquire Python programming skills to move into specific branches - Internet of Things (IoT), Data Science, Machine Learning (ML), Artificial Intelligence (AI) etc.

III. SYLLABUS:

MODULE – I: INTRODUCTION TO PYTHON (09)

Introduction to Python: Features of Python, History and Future of Python, Working with Python – interactive and script mode, Identifiers and Keywords, Comments, Indentation and Multi-lining, Data types – built-in data types, Operators and Expressions, Console Input/Output, Formatted printing, Built-in Functions, Library Functions.

MODULE – II: DECISION CONTROL STATEMENTS (09)

Selection/Conditional Branching Statements: if, if-else, nested if, if-elif-else statement(s), Basic Loop Structures/ Iterative Statements – while and for loop, Nested loops, break and continue statement, pass Statement, else Statement used with loops.

MODULE – III: CONTAINER DATA TYPES (09)

Lists: Accessing List elements, List operations, List methods, List comprehension; Tuples: Accessing Tuple elements, Tuple operations, Tuple methods, Tuple comprehension, Conversion of List comprehension to Tuple, Iterators and Iterables, zip() function.

Sets: Accessing Set elements, Set operations, Set functions, Set comprehension; Dictionaries: Accessing Dictionary elements, Dictionary operations, Dictionary Functions, Nested Dictionary, Dictionary comprehension.

MODULE - IV STRINGS AND FUNCTIONS (09)

Strings: Accessing String elements, String properties, String operations.
Functions: Communicating with functions, Variable Scope and lifetime, return statement, Types of arguments, Lambda functions, Recursive functions.

MODULE - V CLASSES AND OBJECTS (09)

Classes and Objects – Defining Classes, Creating Objects, Data Abstraction and Hiding through Classes, Class Method and self Argument, Class variables and Object variables, __init()__ and __del__() method, Public and private data members, Built-in Class Attributes, Garbage Collection. OOPs Features: Abstraction, Encapsulation, Inheritance, and Polymorphism.

IV. TEXT BOOKS:

1. Reema Thareja, “Python Programming - Using Problem Solving Approach”, Oxford Press, 1st Edition, 2017.
2. Dusty Philips, “Python 3 Object Oriented Programming”, PACKT Publishing, 2nd Edition, 2015.

V. REFERENCE BOOKS:

1. Yashavant Kanetkar, Aditya Kanetkar, “Let Us Python”, BPB Publications, 2nd Edition, 2019.
2. Martin C. Brown, “Python: The Complete Reference”, Mc. Graw Hill, Indian Edition, 2018.
3. Michael H.Goldwasser, David Letscher, “Object Oriented Programming in Python”, Prentice Hall, 1st Edition, 2007.
4. Taneja Sheetal, Kumar Naveen, “Python Programming – A Modular Approach”, Pearson, 1st Edition, 2017.
5. R Nageswar Rao, “Core Python Programming”, Dreamtech Press, 2018.

VI. WEB REFERENCES:

1. https://realPython.com/Python3-object-oriented-programming/
2. https://Python.swaroopch.com/oop.html
3. https://Python-textbok.readthedocs.io/en/1.0/Object_Oriented_Programming.html
4. https://www.programiz.com/Python-programming/

ENGLISH LANGUAGE AND COMMUNICATION SKILLS LABORATORY

<table>
<tr><td colspan="9">I SEMESTER: AE / ECE / EEE / ME / CE
II SEMESTER: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT</td></tr>
<tr><th rowspan="1">Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">AHSC04</td><td rowspan="2">Foundation</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>-</td><td>-</td><td>2</td><td>1</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: 45</td><td colspan="3">Total Classes: 45</td></tr>
<tr><td colspan="9">Prerequisite: There are no prerequisites to take this course.</td></tr>
</table>

I. COURSE OVERVIEW

The sole aim of the course is to enhance the communication skills of upcoming engineering graduates to meet the requirements and challenges in a competitive global world. This course includes General Introduction to Listening Skills, Speaking Skills, Vocabulary and Grammar, Reading Skills, and Writing Skills.

II. COURSE OBJECTIVES:

The students will try to:

I. Improve their ability to listen and comprehend a given text.
II. Upgrade the fluency and acquire a functional knowledge of English Language.
III. Enrich thought process by viewing a problem through multiple angles.

III. COURSE SYLLABUS:

Week-l: LISTENING SKILL

a. Listening to conversations and interviews of famous personalities in various fields; Listening practice related to the TV talk shows and news.
b. Listening for specific information; Listening for summarizing information – Testing.

Week-2: LISTENING SKILL

a. Listening to films of short duration and monologues for taking notes; Listening to answer multiple choice questions.
b. Listening to telephonic conversations; Listening to native Indian: Abdul Kalam, British: Helen Keller and American: Barrack Obama speakers to analyze intercultural differences – Testing.

Week-3: SPEAKING SKILL

a. Functions of English Language; Introduction to pronunciation; Vowels and Consonants
b. Tips on how to develop fluency, body language and communication; Introducing oneself: Talking about yourself, others, leave taking.

Week-4: SPEAKING SKILL

a. Sounds - Speaking exercises involving the use of Vowels and Consonant sounds in different contexts; Exercises on Homophones and Homographs
b. Just a minute (JAM) session.

Week-5: SPEAKING SKILL

a. Stress patterns.
b. Situational Conversations: common everyday situations; Acting as a compare and newsreader; Greetings for different occasions with feedback preferably through video recording.

Week-6: READING SKILL

a. Intonation.
b. Reading newspaper and magazine articles; Reading selective autobiographies for critical commentary.

Week-7: READING SKILL

a. Improving pronunciation through tongue twisters.
b. Reading advertisements, pamphlets; Reading comprehension exercises with critical and analytical questions based on context.

Week-8: WRITING SKILL

a. Listening to inspirational short stories and Writing messages

b. Writing leaflets, Notice; Writing tasks; Flashcards – Exercises

Week-9: WRITING SKILL

a. Write the review on a video clipping of short duration (5 to 10minutes).
b. Write a slogan related to the image; Write a short story of 6-10 lines based on the hints given.

Week-10: WRITING SKILL

a. Minimizing Mother Tongue interference to improve fluency through watching educational videos.
b. Writing practices – précis writing; Essay writing

Week-11: THINKING SKILL

a. Correcting common errors in day to day conversations.

Practice in preparing thinking blocks to decode diagrammatical representations into English words, expressions, idioms, proverbs.

IV. TEXT BOOK:

1. "English Language and Communication Skills" Lab Manual - Prepared by the faculty of English, IARE.

V. REFERENCE BOOKS:

1. Meenakshi Raman, Sangeetha Sharma, "Technical Communication Principles and Practices", Oxford University Press, New Delhi, 3rd Edition, 2015.
2. Rhirdion, Daniel, "Technical Communication", Cengage Learning, New Delhi, 1st Edition, 2009.

PHYSICS LABORATORY

I Semester: AE / ME / CE / ECE / EEE **II Semester:** CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AHSC05	Foundation	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		-	-	3	1.5	30	70	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 36**				**Total Classes: 36**		
Pre-Requisites: Basic principles of Physics								

I. COURSE OVERVIEW:

This course is designed to lay a strong foundation in Engineering Physics that forms a basis to various branches of Engineering. It helps the students to perform experiments, to correlate theory with experimental data, analyse using graphical representations and present them as part of a clear, well-organized lab report. At the end of the course, students will be able to demonstrate a working knowledge of fundamentals of Physics and communicate their ideas effectively, both orally and in writing.

II. COURSE OBJECTIVES:

The students will try to learn:

1. Experimental skills in using optical instruments to determine physical constants.
2. The real time applications of electromagnetic theory.
3. The working principles of various electronic devices.

III. COURSE SYLLABUS:

Week-1: HALL EFFECT (LORENTZ FORCE)
Determination of charge carrier density.

Week-2: MELDE'E EXPERIMENT
Determination of frequency of a given tuning fork.

Week-3: STEWART GEE'S APPARATUS
Magnetic field along the axis of current carrying coil-Stewart and Gee‘s method.

Week-4: B-H CURVE WITH CRO
To determine the energy loss per unit volume of a given magnetic material per cycle by tracing the Hysteresis loop (B-H curve).

Week-5: ENERGY GAP OF A SEMICONDUCTOR DIODE
Determination of energy gap of a semiconductor diode.

Week-6: PHOTO DIODE
Studying V-I characteristics of photo diode.

Week-7: OPTICAL FIBER
Evaluation of numerical aperture of a given optical fiber.

Week-8: WAVE LENGTH OF LASER LIGHT
Determination of wavelength of a given laser light using diffraction grating.

Week-9: PLANCK'S CONSTANT
Determination of Planck‘s constant using LED.

Week-10: LIGHT EMITTING DIODE
Studying V-I characteristics of LED

Week-11: NEWTONS RINGS
Determination of radius of curvature of a given plano-convex lens.

Week-12: SINGLE SLIT DIFFRACTION

Determination of width of a given single slit.

IV. MANUALS:

1. C. L. Arora, “Practical Physics”, S. Chand & Co., New Delhi, 3rd Edition, 2012.
2. VijayKumar, Dr.T.Radhakrishna, “Practical Physics for Engineering Students”, SM Enterprises, 2nd Edition, 2014.

V. WEB REFERENCE:

http://www.iare.ac.in

PYTHON PROGRAMMING LABORATORY

I Semester: Common from all branches									
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACSC02	Foundation	L	T	P	C	CIA	SEE	Total
		0	0	3	1.5	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 36				Total Classes:36		
Prerequisite: There are no prerequisites to take this course.								

I. COURSE OVERVIEW:

This course introduces students to writing computer programs. This course presents the principles of structured programming using the Python language, one of the most increasingly preferred languages for programming today. Because of its ease of use, it is ideal as a first programming language and runs on both the PC and Macintosh platforms. However, the knowledge gained in the course can be applied later to other languages such as C and Java. The course uses iPython Notebook to afford a more interactive experience. Topics include fundamentals of computer programming in Python, object-oriented programming and graphical user interfaces.

II. COURSE OBJECTIVES:

The students will try to learn:

VI. Acquire programming skills in core Python.
VII. Acquire Object-oriented programming skills in Python.
VIII. Develop the skill of designing graphical-user interfaces (GUI) in Python.
IX. Develop the ability to write database applications in Python.
X. Acquire Python programming skills to move into specific branches - Internet of Things (IoT), Data Science, Machine Learning (ML), Artificial Intelligence (AI) etc.

III. COURSE SYLLABUS:

Week – 1: OPERATORS

a. Read a list of numbers and write a program to check whether a particular element is present or not using membership operators.
b. Read your name and age and write a program to display the year in which you will turn 100 years old.
c. Read radius and height of a cone and write a program to find the volume of a cone.
d. Write a program to compute distance between two points taking input from the user (Hint: use Pythagorean theorem)

Week – 2: CONTROL STRUCTURES

a. Read your email id and write a program to display the no of vowels, consonants, digits and white spaces in it using if…elif…else statement.
b. Write a program to create and display a dictionary by storing the antonyms of words. Find the antonym of a particular word given by the user from the dictionary using while loop.
c. Write a Program to find the sum of a Series 1/1! + 2/2! + 3/3! + 4/4! +…….+ n/n!. (Input :n = 5, Output : 2.70833)
d. In number theory, an abundant number or excessive number is a number for which the sum of its proper divisors is greater than the number itself. Write a program to find out, if the given number is abundant. (Input: 12, Sum of divisors of 12 = 1 + 2 + 3 + 4 + 6 = 16, sum of divisors 16 > original number 12)

Week – 3: LIST

a. Read a list of numbers and print the numbers divisible by x but not by y (Assume x = 4 and y = 5).
b. Read a list of numbers and print the sum of odd integers and even integers from the list.(Ex: [23, 10, 15, 14, 63], odd numbers sum = 101, even numbers sum = 24)
c. Read a list of numbers and print numbers present in odd index position. (Ex: [10, 25, 30, 47, 56, 84, 96], The numbers in odd index position: 25 47 84).
d. Read a list of numbers and remove the duplicate numbers from it. (Ex: Enter a list with duplicate elements: 10 20 40 10 50 30 20 10 80, The unique list is: [10, 20, 30, 40, 50, 80])

Week – 4: TUPLE

a. Given a list of tuples. Write a program to find tuples which have all elements divisible by K from a list of tuples. test_list = [(6, 24, 12), (60, 12, 6), (12, 18, 21)], K = 6, Output : [(6, 24, 12), (60, 12, 6)]
b. Given a list of tuples. Write a program to filter all uppercase characters tuples from given list of tuples. (Input: test_list = [("GFG", "IS", "BEST"), ("GFg", "AVERAGE"), ("GfG",), ("Gfg", "CS")], Output : [('GFG', 'IS', 'BEST')]).
c. Given a tuple and a list as input, write a program to count the occurrences of all items of the list in the tuple. (Input : tuple = ('a', 'a', 'c', 'b', 'd'), list = ['a', 'b'], Output : 3)

Week – 5: SET

a. Write a program to generate and print a dictionary that contains a number (between 1 and n) in the form (x, x*x).
b. Write a program to perform union, intersection and difference using Set A and Set B.
c. Write a program to count number of vowels using sets in given string (Input : "Hello World", Output: No. of vowels : 3)
d. Write a program to form concatenated string by taking uncommon characters from two strings using set concept (Input : S1 = "aacdb", S2 = "gafd", Output : "cbgf").

Week – 6: DICTIONARY

a. Write a program to do the following operations:
   i. Create a empty dictionary with dict() method
   ii. Add elements one at a time
   iii. Update existing key's value
   iv. Access an element using a key and also get() method
   v. Deleting a key value using del() method
b. Write a program to create a dictionary and apply the following methods:
   i. pop() method
   ii. popitem() method
   iii. clear() method
c. Given a dictionary, write a program to find the sum of all items in the dictionary.
d. Write a program to merge two dictionaries using update() method.

Week – 7: STRINGS

a. Given a string, write a program to check if the string is symmetrical and palindrome or not. A string is said to be symmetrical if both the halves of the string are the same and a string is said to be a palindrome string if one half of the string is the reverse of the other half or if a string appears same when read forward or backward.
b. Write a program to read a string and count the number of vowel letters and print all letters except 'e' and 's'.
c. Write a program to read a line of text and remove the initial word from given text. (Hint: Use split() method, Input : India is my country. Output : is my country)
d. Write a program to read a string and count how many times each letter appears. (Histogram).

Week – 8: USER DEFINED FUNCTIONS

a. A generator is a function that produces a sequence of results instead of a single value. Write a generator function for Fibonacci numbers up to n.
b. Write a function merge_dict(dict1, dict2) to merge two Python dictionaries.
c. Write a fact() function to compute the factorial of a given positive number.
d. Given a list of n elements, write a linear_search() function to search a given element x in a list.

Week – 9: BUILT-IN FUNCTIONS

a. Write a program to demonstrate the working of built-in statistical functions mean(), mode(), median() by importing statistics library.
b. Write a program to demonstrate the working of built-in trignometric functions sin(), cos(), tan(), hypot(), degrees(), radians() by importing math module.
c. Write a program to demonstrate the working of built-in Logarithmic and Power functions exp(), log(), log2(), log10(), pow() by importing math module.
d. Write a program to demonstrate the working of built-in numeric functions ceil(), floor(), fabs(), factorial(), gcd()

by importing math module.

Week – 10: CLASS AND OBJECTS

a. Write a program to create a BankAccount class. Your class should support the following methods for
   i) Deposit
   ii) Withdraw
   iii) GetBalanace
   iv) PinChange
b. Create a SavingsAccount class that behaves just like a BankAccount, but also has an interest rate and a method that increases the balance by the appropriate amount of interest (Hint:use Inheritance).
c. Write a program to create an employee class and store the employee name, id, age, and salary using the constructor. Display the employee details by invoking employee_info() method and also using dictionary (__dict__).
d. Access modifiers in Python are used to modify the default scope of variables. Write a program to demonstrate the 3 types of access modifiers: public, private and protected.

Week – 11: MISCELLANEOUS PROGRAMS

a. Write a program to find the maximum and minimum K elements in Tuple using slicing and sorted() method (Input: test_tup = (3, 7, 1, 18, 9), k = 2, Output: (3, 1, 9, 18))
b. Write a program to find the size of a tuple using getsizeof() method from sys module and built-in __sizeof__() method.
c. Write a program to check if a substring is present in a given string or not.
d. Write a program to find the length of a string using various methods:
   i. Using len() method
   ii. Using for loop and in operator
   iii. Using while loop and slicing

Week – 12: ADDITIONAL PROGRAMS - FILE HANDLING

1. Write a program to read a filename from the user, open the file (say firstFile.txt) and then perform the following operations:
   i. Count the sentences in the file.
   ii. Count the words in the file.
   iii. Count the characters in the file.
2. Create a new file (Hello.txt) and copy the text to other file called target.txt. The target.txt file should store only lower case alphabets and display the number of lines copied.
3. Write a Python program to store N student's records containing name, roll number and branch. Print the given branch student's details only.

IV. REFERENCE BOOKS:

1. Michael H Goldwasser, David Letscher, "Object Oriented Programming in Python", Prentice Hall, 1st Edition, 2007.
2. Yashavant Kanetkar, Aditya Kanetkar, "Let us Python", BPB publication, 1st Edition, 2019.
3. Ashok Kamthane, Amit Kamthane, "Programming and Problem Solving with Python", McGraw Hill Education (India) Private Limited, 2018.
4. Taneja Sheetal, Kumar Naveen, "Python Programming – A modular approach", Pearson, 2017.
5. R Nageswara Rao, "Core Python Programming", Dreamtech press, 2017 Edition.

V. WEB REFERENCES:

1. https://realpython.com/python3-object-oriented-programming/
2. https://python.swaroopch.com/oop.html
3. https://python-textbok.readthedocs.io/en/1.0/Object_Oriented_Programming.html
4. https://www.programiz.com/python-programming/
5. https://www.geeksforgeeks.org/python-programming-language/

CHEMISTRY

I Semester: CSE / CSE (AI&ML) / CSE (DS) / CSE (CS) / / CSIT / IT II Semester: AE / ME / CE / ECE / EEE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AHSC06	Foundation	L	T	P	C	CIA	SEE	Total
		2	-	-	2	30	70	100
Contact Classes: 45	Tutorial Classes: 0	Practical Classes: Nil				Total Classes: 45		
Prerequisite: There are no prerequisites to take this course.								

I. COURSE OVERVIEW:

The concepts developed in this course involve elements and compounds and their applied industrial applications. It deals with topics such as batteries, corrosion and control of metallic materials, water and its treatment for different purposes, engineering materials such as plastics, elastomers and biodegradable polymers, their preparation, properties and applications, energy sources and environmental science. Sustainable chemistry that focuses on the design of the products and processes that minimize or eliminate the use and generation of hazardous substances is also included.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The concepts of electrochemical principles and causes of corrosion in the new developments and breakthroughs efficiently in engineering and technology.
II. The different parameters to remove causes of hardness of water and their reactions towards complexometric method.
III. The polymerization reactions with respect to mechanisms and its significance in industrial applications.
IV. The Significance of Green chemistry to reduce pollution in environment by using natural resources.

III. COURSE SYLLABUS

MODULE-I: ELECTROCHEMISTRY AND CORROSION (09)

Electro chemical cells: Electrode potential, standard electrode potential, Calomel electrode and Nernst equation; Electrochemical series and its applications; Numerical problems; Batteries: Primary (Dry cell) and secondary batteries (Lead-acid storage battery, Li-ion battery). Corrosion: Causes and effects of corrosion: Theories of chemical and electrochemical corrosion, mechanism of electrochemical corrosion; Corrosion control methods: Cathodic protection, sacrificial anode and impressed current Cathodic protection; Surface coatings: Metallic coatings- Methods of coating-Hot dipping- galvanization and tinning, electroplating.

MODULE –II: WATER TECHNOLOGY (09)

Introduction: Hardness of water, causes of hardness; types of hardness: temporary and permanent hardness, expression and units of hardness; estimation of hardness of water by complexometric method; potable water and its specifications, Steps involved in the treatment of water, disinfection of water by chlorination and ozonization; External treatment of water; Ion-exchange process; Desalination of water: Reverse osmosis, numerical problems.

MODULE-III: ENGINEERING MATERIALS (09)

Polymers-classification with examples, polymerization-addition, condensation and co-polymerization;
Plastics: Thermoplastics and thermosetting plastics; Compounding of plastics; Preparation, properties and applications of polyvinyl chloride, Teflon, Bakelite and Nylon-6, 6; Elastomers: Natural rubber, processing of natural rubber, vulcanization; Buna-s and Thiokol rubber; Biodegradable polymers.

Lubricants: characteristics of lubricants, mechanism of lubrication – thick film, thin film, extreme pressure lubrication, properties – flash and fire point, cloud and pour point, viscosity and oiliness of lubricants.

MODULE –IV: GREEN CHEMISTRY AND FUELS (09)

Introduction: Definition of green chemistry, methods of green synthesis: aqueous phase, microwave method, phase transfer catalyst and ultra sound method. Fuels: definition, classification of fuels ; Solid fuels: coal; analysis of coal: proximate and ultimate analysis; Liquid fuels: Petroleum and its refining; Gaseous fuels: Composition, characteristics and applications of LPG and CNG; Calorific value: Gross Calorific value(GCV) and Net Calorific value(NCV), numerical problems.

MODULE –V: NATURAL RESOURCES AND ENVIRONMENTAL POLLUTION (09)

Natural resources: Classification of resources, living and nonliving resources; Water resources: Use and over utilization of surface and ground water, floods and droughts, dams, benefits and problems; Land resources; Energy resources: renewable and non-renewable energy sources, use of alternate energy source. Environmental pollution: Causes, effects and control measures of air pollution, water pollution, soil pollution and noise pollution.

IV. TEXT BOOKS:

1. P. C. Jain and Monica Jain, "Engineering Chemistry", DhanpatRai Publishing Company, 16th Edition, 2017.
2. ShashiChawla, "Text Book of Engineering Chemistry" DhanatRai and Company, 2017.
3. Prashanthrath, B.Rama Devi, Ch.VenkataRamana Reddy, Subhendu Chakroborty, Cengage Learning Publishers, 1st Edition, 2018.

V. REFERENCE BOOKS:

1. Bharathi Kumari, "Engineering Chemistry", VGS Book Links, 10th Edition, 2018.
2. B. Siva Shankar, "Engineering Chemistry", Tata McGraw Hill Publishing Limited, 3rd Edition, 2015.
3. S. S. Dara, Mukkanti, "Text of Engineering Chemistry", S. Chand & Co, New Delhi, 12th Edition, 2006.

VI. WEB REFERENCES:

1. Engineering chemistry (NPTEL Web-book), by B.L.Tembe, Kamaluddin and M.S.Krishnan. http://www.cdeep.iitb.ac.in/webpage_data/nptel/Core%20Science/Engineering%20Chemistry%201/About-Faculty.html
2. Polymer Science (NPTEL Web-book), by Prof. Dibakar Dhara https://onlinecourses.nptel.ac.in/noc20_cy21/preview
3. Environmental Chemistry and Analysis(NPTEL Web-book), by Prof. M.S.Subramanian https://nptel.ac.in/courses/122/106/122106030/

MATHEMATICAL TRANSFORM TECHNIQUES

II Semester: AE / ME / CE / ECE / EEE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AHSC07	Foundation	L	T	P	C	CIA	SEE	Total
		3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

Prerequisite: Basic principles of calculus

I. COURSE OVERVIEW:

This course focuses on transformations from theoretical based mathematical laws to its practical applications in the domain of various branches of engineering field. The course includes the transformations such as Laplace, Fourier, applications of scalar and vector field over surface, volume and multiple integrals. The course is designed to extract the mathematical developments, skills, from basic concepts to advance level of engineering problems to meet the technological challenges.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The transformation of ordinary differential equations in Laplace field and its applications.
II. The operation of the non-periodic functions by Fourier transforms.
III. The concepts of *multiple integration for finding* areas and volumes of physical quantities.
IV. The Integration of the several functions by transforming the co-ordinate system in scalar and vector fields.

III. COURSE SYLLABUS

MODULE-I: LAPLACE TRANSFORMS (09)

Definition of Laplace transform, linearity property, piecewise continuous function, existence of Laplace transform, function of exponential order, first and second shifting theorems, change of scale property, Laplace transforms of derivatives and integrals, multiplied by t, divided by t, Laplace transform of periodic functions.

Inverse Laplace transform: Definition of Inverse Laplace transform, linearity property, first and second shifting theorems, change of scale property, multiplied by s, divided by s; Convolution theorem and applications to ordinary differential equations.

MODULE –II: FOURIER TRANSFORMS (09)

Fourier integral theorem, Fourier sine and cosine integrals; Fourier transforms; Fourier sine and cosine transform, properties, inverse transforms, finite Fourier transforms. .

MODULE –III: MULTIPLE INTEGRALS (09)

Double Integrals: Evaluation of double integrals in Cartesian coordinates and Polar coordinates; Change of order of integration; Area as a double integral; Transformation of coordinate system.

Triple Integrals: Evaluation of triple integrals in Cartesian coordinates; volume of a region using triple integration.

MODULE –IV: VECTOR DIFFERENTIAL CALCULUS (09)

Scalar and vector point functions; Definitions of Gradient, divergent and curl with examples; Solenoidal and irrotational vector point functions; Scalar potential function. Line integral, surface integral and volume integral, Green's theorem in a plane, Stoke's theorem and Gauss divergence theorem without proofs.

MODULE –V: PARTIAL DIFFERENTIAL EQUATIONS (09)

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equations; Charpit's method;

IV. TEXT BOOKS:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 36th Edition, 2010.
2. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2008.
3. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill New Delhi, 11th Reprint, 2010

V. REFERENCE BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 9th Edition, 2006.
2. Veerarajan T., "Engineering Mathematics for first year", Tata McGraw-Hill, New Delhi, 2008.
3. D. Poole, "Linear Algebra: A Modern Introduction", Brooks/Cole, 2nd Edition, 2005.
4. Dr. M Anita, "Engineering Mathematics-I", Everest Publishing House, Pune, First Edition, 2016.

VI. WEB REFERENCES:

1. http://www.efunda.com/math/math_home/math.cfm
2. http://www.ocw.mit.edu/resourcs/#Mathematics
3. http://www.sosmath.com
4. http://www.mathworld.wolfram.com.

VII. E-TEXT BOOKS:

1. http://www.e-booksdirectory.com/details.php?ebook=10166
2. http://www.e-booksdirectory.com/details.php?ebook=7400re

ENGINEERING MECHANICS

II Semester: AE / ME / CE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC01	Foundation	L	T	P	C	CIA	SEE	Total
		3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			
Prerequisite: Knowledge of Linear Algebra and Calculus								

I. COURSE OVERVIEW:

Engineering Mechanics is a branch of Physics that deals with the study of the system of forces acting on a particle which is at rest or in motion. The course emphasizes thorough understanding of theories and principles related to static and dynamic equilibrium of rigid bodies to acquire the analytical capability required for solving engineering problems and is one of the foundation courses that forms the basis of many of the traditional branches of engineering such as aerospace, civil and mechanical engineering.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The application of mathematics and science principles to represent the free body diagrams in the area of rigid body mechanics.

II. The conditions of static and dynamic equilibrium of bodies subjected to a particular force system for solving the field problems.

III. The effects of force and motion while carrying out the innovative design functions of engineering.

III. COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO ENGINEERING MECHANICS (10)

Classification of Engineering Mechanics, Basic Terminologies in Mechanics, Laws of Mechanics, Derived Laws, Characteristics of a Force, System of Forces, Composition of Forces, Resolution of Forces, Composition of Forces by Method of Resolution, Resultant of Non-Concurrent Force System, Supports and Reactions, Free Body Diagrams, Equilibrium of Bodies, Equilibrant, Equilibrium of Connected Bodies, Moment of a Force, Varignon's Theorem, Couple, Resolution of a Force into a Force and a Couple.

MODULE –II: FRICTION (08)

Frictional Force, Laws of Friction, Angle of Friction, Angle of Repose and Cone of Friction, Types of friction, Limiting friction, Static and Dynamic Friction; Ladder friction, wedge friction, screw jack & differential screw jack.

MODULE –III: CENTROID, CENTRE OF GRAVITY AND MOMENT OF INERTIA (10)

Centre of Gravity, Centroid, Difference between Centre of gravity and Centroid, Determination of Centroid of Simple Figures from First Principle, Centroid of Composite Sections, Centre of Gravity from First Principles, Centre of Gravity of Composite Bodies.

Moment of Inertia, Polar Moment of Inertia, Radius of Gyration, Theorems of Moment of Inertia, Moment of Inertia from First Principle, Moment of Inertia of Standard Sections and Composite sections, Mass Moment of Inertia, Determination of Mass Moment of Inertia from First Principles, Parallel Axis Theorem/Transfer Formula, Mass Moment of Inertia of Composite Bodies.

MODULE –IV: PARTICLE DYNAMICS AND WORK ENERGY PRINCIPLE (09)

Kinetics of Rigid Bodies – Newton's II law, D'Alembert's principle and its applications in plane motion and connected bodies. Work, Work Done by a Varying Force, Energy, Power, Work Energy Equation for Translation, Work Done by a Spring.

MODULE –V: IMPULSE MOMENTUM AND MECHANICAL VIBRATIONS (08)

Linear Impulse and Momentum, Connected Bodies, Conservation of Momentum, Coefficient of restitution, Types of Impact. Vibrations - Basic terminology, free and forced vibrations, types of pendulum, Derivation for frequency and time period of simple, compound and torsion pendulums.

IV. TEXT BOOKS:

1. Irving H. Shames (2006), “Engineering Mechanics”, Prentice Hall, 4th Edition, 2013
2. S.Bhavikatti, “A Text Book of Engineering Mechanics”, New Age International, 1st Edition, 2012.
3. R. C. Hibbler (2006), “Engineering Mechanics: Principles of Statics and Dynamics”, Pearson Press.

V. REFERENCE BOOKS:

1. F. P. Beer and E. R. Johnston (2011), “Vector Mechanics for Engineers”, Vol I - Statics, Vol II, – Dynamics, Tata McGraw Hill, 9th Edition, 2013.
2. A.K.Tayal, “Engineering Mechanics”, Uma Publications, 14th Edition, 2013.
3. R. K. Bansal “Engineering Mechanics”, Laxmi Publication, 8th Edition, 2013.
4. Basudeb Bhattacharya, “Engineering Mechanics”, Oxford University Press, 2nd Edition, 2014.
5. K.Vijay Reddy, J. Suresh Kumar, “Singer’s Engineering Mechanics Statics and Dynamics”, B S Publishers, 1st Edition, 2013.

VI. WEB REFERENCES:

1. https://en.wikipedia.org/wiki/Dynamics_(mechanics)
2. https://www.youtube.com/playlist?list=PLUl4u3cNGP62esZEwffjMAsEMW_YArxYC

VII. E-TEXT BOOKS:

1. http://www.freeengineeringbooks.com/Civil/Engineering-Mechanics-Books.php
2. http://www.textbooksonline.tn.nic.in/books/11/stdxi-voc-ema-em-2.pdf
3. http://www.faadooengineers.com/threads/17024-Engineering-mechanics-pdf-Free-Download

BASIC ELECTRICAL ENGINEERING

<table>
<tr><td colspan="10">I Semester : CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT
II Semester : AE / ME / CE</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">AEEC01</td><td rowspan="2">Foundation</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
<tr><td colspan="10">Prerequisites: Linear Algebra and Calculus</td></tr>
</table>

I. COURSE OVERVIEW:

The Basic Electrical Engineering enables knowledge on electrical quantities such as current, voltage, power, energy to know the impact of technology in global and societal context, provides knowledge on basic DC and AC circuits used in electrical and electronic devices, highlights the importance of transformers, electrical machines in generation, transmission and distribution of electric power, identify the types of electrical machines suitable for particular applications.

II. COURSE OBJECTIVES:

The students will try to learn:

Understand the basic electrical circuits and circuit laws to study the behavior AC and DC circuits.
Analyze electrical circuits with the help of network theorems.
Outline the concepts of network topology to reduce complexity of network and study its behavior.
Demonstrate the working principle of AC and DC machines.
Analyse single phase transformers circuits.

III.COURSE SYLLABUS:

MODULE – I: INTRODUCTION TO ELECTRICAL CIRCUITS (09)

Circuit concept: Ohm's law, Kirchhoff's laws, equivalent resistance of networks, Source transformation, Star to delta transformation, mesh and nodal analysis; Single phase AC circuits: Representation of alternating quantities, RMS, average, form and peak factor, concept of impedance and admittance.

MODULE – II: NETWORK THEOREMS AND NETWORK TOPOLOGY (09)

Network Theorems: Superposition, Reciprocity, Thevenin's, Norton's, Maximum power transfer for DC excitations circuits. Network Topology: Definitions, Graph, Tree, Incidence matrix, Basic Cut Set and Basic Tie Set Matrices for planar networks.

MODULE – III: DC MACHINES (09)

DC generators: Principle of operation, construction, EMF equation, types of DC generators. Losses and efficiency. **Critical field resistance, speed control.**

DC motors: Principle of operation, back EMF, torque equation, types of DC motors, Losses and efficiency, **condition for maximum efficiency**, numerical problems.

MODULE –IV: SINGLE PHASE TRANSFORMERS (08)

Single Phase Transformers: Principle of operation, construction, types of transformers, EMF equation, operation of transformer under no load and on load, Phasor diagrams, equivalent circuit, efficiency, regulation and numerical problems.

MODULE – V: AC MACHINES (09)

Three Phase Induction motor: Principle of operation, slip, slip -torque characteristics, efficiency and applications; Alternators: Introduction, principle of operation, constructional features, calculation of regulation by synchronous impedance method and numerical problems.

IV. TEXT BOOKS:

1. A Chakrabarthy, "Electric Circuits", DhanipatRai& Sons, 6th Edition, 2010.
2. A Sudhakar, Shyammohan S Palli, "Circuits and Networks", Tata McGraw-Hill, 4th Edition, 2010.
3. A E Fitzgerald and C Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
4. I JNagrath, DP Kothari, "Electrical Machines", Tata McGraw-Hill publication, 3rd Edition, 2010.

V. REFERENCE BOOKS:

1. John Bird, "Electrical Circuit Theory and Technology", Newnes, 2nd Edition, 2003.
2. C L Wadhwa, "Electrical Circuit Analysis including Passive Network Synthesis", International, 2nd Edition, 2009.
3. David A Bell, "Electric circuits", Oxford University Press, 7th Edition, 2009.
4. PS Bimbra, "Electrical Machines", Khanna Publishers, 2nd Edition, 2008.

VI. WEB REFERENCES:

1. https://www.igniteengineers.com
2. https://www.ocw.nthu.edu.tw
3. https://www.uotechnology.edu.iq
4. https://www.iare.ac.in

VII. E-TEXT BOOKS

1. https://www.bookboon.com/en/concepts-in-electric-circuits-ebook
2. https://www.www.jntubook.com
3. https://www.allaboutcircuits.com
4. https://www.freeengineeringbooks.com

EXPERIENTIAL ENGINEERING EDUCATION (ExEEd) - ACADEMIC SUCCESS

I Semester: **CSE / CSE (AI&ML) / CSE (DS) / CSE(CS) / IT / CSIT**

II Semester: **AE / ME / CE / ECE / EEE**

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
ACSC06	Foundation	2	-	-	1	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 36				Total Classes: 36		

Prerequisite: **There are no prerequisites to take this course**

I.COURSE OVERVIEW:

The course aims to provide students with an understating of the different learning –coding platforms, role of the entrepreneur, innovation and technology in customer centric engineering.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The different ways in engaging continuous learning process through the interaction with peers in related topics.
II. The skills and potential opportunities using well know frameworks and analytical tools.
III. The attitudes, values, characteristics, behavior and processes with processing an entrepreneurial mindset.

III. COURSE OBJECTIVES:

WEEK – I

Introduction to ExEED - Dr. Ch. Srinivasulu

WEEK – II:

Skill Development - Dr. G Ramu

WEEK – III:

Skill Development - Dr. G Ramu

WEEK – IV:

Open Source platforms for Learning , Practice and Excel in their field - Dr. M MadhuBala

WEEK – V:

Opportunities and challenges - Respective Department HOD's

WEEK – VI:

Skill Development - Dr. G Ramu

WEEK – VII:

Skill Development - Dr. G Ramu

WEEK –VIII:

Entrepreneurial Mindset - Dr. J Sirisha Devi

WEEK – IX:

Entrepreneurial Mindset - Dr. J Sirisha Devi

WEEK – X:

Innovation Culture - Dr. M Pala Prasad Reddy

WEEK – XI:

Support & Funding from various organizations - Dr. M Pala Prasad Reddy

WEEK – XII:
Rapid Prototyping - Prof. V V S H Prasad

WEEK – XIII:
Intellectual Property Rights - Mr. K Aditya Nag

WEEK – XIV:
Story Telling by Students - Dr. Ch. Srinivasulu

MANUFACTURING PRACTICE

II Semester: AE / ME / CE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC02	Foundation	L	T	P	C	CIA	SEE	Total
		0	0	2	1	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 36				Total Classes: 36		
Prerequisite: There are no prerequisites to take this course.								

I. COURSE OVERVIEW:

The course is intended to provide the basic concepts about Engineering tools for cutting and measuring used in a workshop. The students will be benefited from hands on training process as well as knowledge to carry out a particular process for making a product. This course provides wider perspective of manufacturing, processes to learn and introduces major trades as well as digital manufacturing facilities.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The application of jigs and fixtures, measuring, marking and cutting tools in various types of manufacturing processes.
II. The preparation of different joints in carpentry and fitting and also familiarizes wood working machinery.
III. The concepts of forming processes by forging, black-smithy and tin-smithy with an application extracts of Engineering Drawing.
IV. The standard electrical wiring practices for domestic and industrial appliances.
V. The current advancements in developing the prototype models through digital manufacturing facilities.

III. COURSE SYLLABUS:

Week-1: CARPENTRY-I

Batch I: Preparation of lap joint as per given dimensions.
Batch II: Preparation of dove tail joint as per given taperangle.

Week-2: CARPENTRY-II

Batch I: Preparation of dove tail joint as per given taper angle.
Batch II: Preparation of lap joint as per given dimensions.

Week-3: FITTING

Batch I & II: Make a straight fit and straight fit for given dimensions.
Make a square fit for straight fit for given sizes.

Week-4: ELECTRICAL AND ELECTRONICS

Batch I & II: Make an electrical connection to demonstrate domestic voltage and current sharing.
Make an electrical connection to control one bulb with two switches-stair case connection.

Week-5: BLACKSMITHY- I, TINSMITHY- I

Batch I: Prepare S-bend & J-bend for given MS rod using open hearth furnace.
Batch II: Prepare the development of a surface and make a rectangular tray and a round tin.

Week-6: TINSMITHY- I, BLACKSMITHY- I

Batch I: Prepare the development of a surface and make a rectangular tray and a round tin.
Batch II: Prepare S-bend & J-bend of given MS rod using open hearth furnace.

Week-7: MOULD PREPARATION

Batch I: Prepare a wheel flange mould using a given wooden pattern.
Batch II: Prepare a bearing housing using an aluminum pattern.

Week-8: **MOULD PREPARATION**
Batch I: Prepare a bearing housing using an aluminum pattern.
Batch II: Prepare a wheel flange mould using a given wooden pattern.
Week-09: WELDING
Batch I: Arc welding & Gas Welding.
Batch II: Gas welding & Arc Welding.

Week-10: INJECTION MOULDING
Batch I & II: Injection moulding.

Week-11: BLOW MOULDING
Batch I & II: Blow moulding.

Week-12: MACHINE SHOP-Turning and Milling
Batch I & II: Working on central lathe and shaping machine.
Working on milling machine.

Week-13: **ADVANCED MACHINE SHOP-I**
Batch I & II: Working on CNC Turning machines.
Working on CNC Vertical Drill Tap Center.

Week-14: **ADVANCED MACHINE SHOP-II**
Batch I & II: Working on CNC Laser Engraving Machine.
Working on 5 Axis CNC Routing Machine.

IV. REFERENCE BOOKS:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and NirjharRoy S.K., “Elements of Workshop Technology”, Media promoters and publishers private limited, Mumbai, Vol. I 2008 and Vol. II 2010.
2. Kalpakjian S, Steven S. Schmid, “Manufacturing Engineering and Technology”, Pearson Education India Edition, 4th Edition, 2002.
3. Gowri P. Hariharan, A. Suresh Babu,” Manufacturing Technology – I”, Pearson Education, 2008.
4. Roy A. Lindberg, “Processes and Materials of Manufacture”, Prentice Hall India, 4th Edition, 1998.
5. Rao P.N., “Manufacturing Technology”, Vol. I and Vol. II, Tata McGraw-Hill House, 2017.

V. WEB REFERENCES:

http://www.iare.ac.in

COMPUTER AIDED ENGINEERING DRAWING

II Semester: AE / ME / CE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC03	**Foundation**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		1	-	2	1.5	30	70	100
Contact Classes: 15	**Tutorial Classes: Nil**	**Practical Classes: 45**				**Total Classes: 60**		
Prerequisite: There are no prerequisites to take this course.								

I. COURSE OVERVIEW:

One of the best ways to communicate one's idea is through some form of picture or drawing. Engineering Drawing is the accurate technique that develops the ability to visualize any object with all physical and dimensional configurations. During the process of design, the designer may have to carry out a large amount of computations to generate optimum design and develops engineering drawings for manufacturing a product using interactive computer graphics. The computer aided engineering drawing assists in preparation of 3D and 2D drawings to carry out sophisticated design and analysis. This course forms the foundation for the development of computer graphics and CAD/CAM technologies in the era of digital manufacturing.

II. COURSE OBJECTIVES:

The students will try to learn:

VI. The basic knowledge about engineering drawing as a communicative language of engineers in ideation.

VII. The ability to visualize, create and edit any object with all the physical and dimensional configurations using computer aided drawing tools.

VIII. The code of engineering drawing practice as per the Bureau of Indian Standards and International practices.

III. COURSE OBJECTIVES:

MODULE – I: INTRODUCTION TO ENGINEERING DRAWING AND OVERVIEW OF COMPUTER GRAPHICS

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering.
Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software.

MODULE – II: CONIC SECTIONS AND SCALES

Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales-Plain, Diagonal and Vernier Scales.

MODULE – III: PROJECTION OF POINTS AND LINES

Principles of Orthographic Projections-Conventions-Projections of Points and lines inclined to both planes.

Projections of planes, Planes inclined to both the planes.

MODULE – IV: PROJECTION OF REGULAR SOLIDS

Draw the orthographic views of geometrical solids of Prism, Pyramid, Cylinder and Cone.

MODULE – V: ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS

Principles of Isometric projection–Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa.

IV. TEXT BOOKS:

1. N. D. Bhatt, "Engineering Drawing", Charotar Publications, New Delhi, 49th Edition, 2010.
2. C.M. Agarwal, Basant Agarwal, "Engineering Drawing", Tata McGraw Hill, 2nd Edition, 2013.

V. REFERENCE BOOKS:

1. K. Venugopal, "Engineering Drawing and Graphics". New Age Publications, 2nd Edition, 2010.
2. Dhananjay. A. Johle, "Engineering Drawing", Tata McGraw Hill, 1st Edition, 2008.
3. S.Trymbaka Murthy, "Computer Aided Engineering Drawing", I.K. International Publishers, 3rd Edition, 2011.

4. A.K.Sarkar, A.P Rastogi, “Engineering graphics with Auto CAD”, PHI Learning, 1st Edition, 2010.

VI. WEB REFERENCES:

1. http://nptel.ac.in/courses/112103019
2. http://www.autocadtutorials.net/
3. http://gradcab.com/questions/tutorial-16-for-beginner-engineering-drawing-I

PROGRAMMING FOR PROBLEM SOLVING LABORATORY

II Semester: AERO / MECH / CIVIL

Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACSC03	Foundation	L	T	P	C	CIA	SEE	Total
		0	0	3	1.5	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 36				Total Classes:36		

Prerequisite: Knowledge of Python programming

I.COURSE OVERVIEW:

This course introduces students to writing computer programs. This course presents the principles of structured programming using the Python language, one of the most increasingly preferred languages for programming today. Because of its ease of use, it is ideal as a first programming language and runs on both the PC and Macintosh platforms. However, the knowledge gained in the course can be applied later to other languages such as C and Java. The course uses iPython Notebook to afford a more interactive experience. Topics include fundamentals of computer programming in Python, object-oriented programming and graphical user interfaces.

II.COURSE OBJECTIVES:

The students will try to learn:

I. The programming skills of core Python.
II. The Object-oriented programming skills of Python.
III. Designing skills required to develop graphical-user interfaces (GUI) in Python.
IV. To write database applications in Python.
V. Python programming to move into specific branches like- Internet of Things (IoT), Data Science, Machine Learning (ML), Artificial Intelligence (AI) etc.

III.COURSE SYLLABUS

Week – 1: STUDENTS IN A COLLEGE

1. There are D departments in a college and each department has A_i number of students. Your task is to find the total number of students in the college.

   Input Format:
   The first line of input contains an integer D , the number of departments
   The second line of input contains D space-separated integers denoting number of students in each department.

   Output Format:
   A single integer(the total number of students in the college)

   Example:
   Input:
   3
   1 2 3

   Output:
   6

2. In Statistics, range is defined as the difference between highest and lowest values. Given marks of students in a class, find the range.

   Input Format:
   The first line of input contains an integer N, the number of students
   The second line of input contains N space-separated integers denoting the marks of each student in the class.

   Output Format:
   A single integer(the range)

Example:
Input:
5
10 20 40 20 30

Output:
30

Week – 2: TRIANGLES

1. What is the maximum number of squares of size **2x2** that can be fit in a right angled isosceles triangle of base **B**. One side of the square must be parallel to the base of the isosceles triangle. Base is the shortest side of the triangle.

Input Format:
The first line of input contains an integer T , denoting number of test cases.
Each of the next T lines contain a single integer , B (base)

Output Format:
For each test case , print a single integer, the number of squares.

Example:
Input:
3
1
1
4
11
Output:
0
0
1
10

2. Given 3 sides of a triangle, check whether the given three sides form a triangle and if so , check if it is an equilateral , isosceles or scalene triangle, also print its area.

Input Format:
The first line of input contains an integer T , denoting number of test cases.
Each of the next T lines contain 3 space separated integers , the 3 sides

Output Format:
For each test case , if the given 3 sides form a triangle ,
Print "EQUILATERAL" / "ISOSCELES" /"SCALENE" followed by the area (up to 2 decimal places)
If they do not form a triangle , print "NOT A TRIANGLE"

Example:
Input:
5
3 3 3
3 5 3
3 7 3
4 2 3
1 2 3

Output:
EQUILATERAL 3.89
ISOSCELES 4.14
NOT A TRIANGLE
SCALENE 2.90

NOT A TRIANGLE

Week – 3: MAGIC SQUARE

1. A magic square of size N is a square matrix of order NxN that satisfies these conditions.
   a. It should contain all elements from 1 to N^2 without repetitions.
   b. The sum of the numbers in any row,column or diagonal should be equal.

   Write a Python program to check whether a given matrix is a magic square or not

   Input Format:
   The first line of input contains an integer N, the order of the square matrix
   Each of the next N lines contain N-space separated integers denoting the elements of the matrix

   Output Format:
   Print "YES" if it is a magic square, else print "NO".

   Example:
   Input:
   3
   8 1 6
   3 5 7
   4 9 2

   Output:
   YES

Week – 4: RUNNING RACE

1. The scores of participants in a running race are given, find the runner up.

   Input Format:
   The first line of input contains an integer T, the number of test cases
   Each of the next T lines contain some space separated integers denoting the participant's scores

   Output Format:
   For each test case, print a single integer denoting the score of the runner up. If there is no runner up, print "NONE".

   Example:
   Input:
   5
   1 2 3 4 5
   5 5 5 5 2 5 5 2
   5 5 5 5 5 5
   10 20 30 40 50
   19 76 89 12 34 78 90 90 76 89 90
   Output:
   4
   2
   NONE
   40
   89

2. The scores of participants in a running race were recorded but the person recording the scores made some errors and added some duplicate entries. Remove all duplicate entries and print the count of the errors made.

   Input Format:
   The first line of input contains an integer N, the number of scores that were recorded
   The second line of input contains N space-separated integers denoting the recorded scores.

Output Format:
The first line of output should contain the distinct scores after removing duplicate entries.
The second line of output should contain an integer denoting the number of errors made.

Example:
Input:
10
1 2 3 1 1 3 4 2 8 9

Output:
1 2 3 4 8 9
4

Week – 5: PANGRAM

1. Given a string check if it is Pangram or not. A pangram is a sentence containing every letter in the English Alphabet. Ignore case and special characters.

Input Format:
The first line of input contains an integer T, the number of test cases.
Each of the following T lines contain a string

Output Format:
For each test case, print "PANGRAM" or "NOT PANGRAM".

Example:
Input:
3
The quick brown fox jumps over the lazy dog
$!#@ ABC DEF ghi jkl mnop qrst uvw XYZ @#!$
Institute of Aeronautical Engineering

Output:
PANGRAM
PANGRAM
NOT PANGRAM

Week – 6: FREQUENCY OF LETTERS

1. Given a sentence, print the frequency of each English letter present in the sentence, in alphabetic order. Consider all characters to be lowercase.

Input Format:
A sentence

Output Format:
For every character, print the character followed by a hyphen and then the frequency (in alphabetic order). Ignore digits and special characters and consider uppercase letters also as lowercase.

Example:
Input:
12345 This is a sentence @IARE
Output:
a-2
c-1
e-4
h-1
i-3
n-2

r-1
s-3
t-2

Week – 7: BINARY NUMBERS

1. Write a program to convert a given decimal number into binary.

   Input Format:
   The first line of input contains an integer T denoting the number of test cases.
   Each of the next T lines contains decimal integers.

   Output Format:
   For each test case, print the binary equivalent.

   Example:
   Input:
   4
   1
   3
   5
   10

   Output:
   1
   11
   101
   1010

2. Write a program to convert a given binary number into decimal form.

   Input Format:
   The first line of input contains an integer T denoting the number of test cases.
   Each of the next T lines contains binary integers.

   Output Format:
   For each test case, print the decimal equivalent.

   Example:
   Input:
   4
   1
   11
   101
   1001

   Output:
   1
   3
   5
   9

Week – 8: PATTERNS

1. Write a Python program to print the following pattern.

```
N=5
  *
 ***
*****
 ***
  *
```

2. Write a Python program to print the following pattern.

```
S= SCHOOL
 IIIIIII
 IAAAAAI
 IARRRAI
 IARERAI
 IARRRAI
 IAAAAAI
  IIIIIII
```

Week – 9: COMBINATIONS

1. Given an array of size n, generate and print all possible combinations of r elements in array.

Input Format:
First line contains Space-separated integers denoting array elements.
Second line contains r , size of each combination

Output Format:
Print each combination in a separate line and every combination should have comma separated integers.

Example:
Input:
1 2 3 4
2

Output:
1,2
1,3
1,4
2,3
2,4
3,4

Week – 10: CLASS AND OBJECTS

1. Create a Temperature class. Make two methods.
   i. Convert Fahrenheit - It will take Celsius and will print it into Fahrenheit.
   ii. Convert Celsius - It will take Fahrenheit and will convert it into Celsius.

2. Create a Time class and initialize it with hours and minutes.
   i. Make a method add Time which should take two time object and add them. E.g.- (2 hour and 50 min) + (1 hr and 20 min) is (4 hr and 10 min)
   ii. Make a method display Time which should print the time.
   iii. Make a method Display Minute which should display the total minutes in the Time. E.g.- (1 hr 2 min) should display 62 minute.

Week – 11: ROMAN NUMERAL

1. Write a Python program to convert a decimal number into its roman numeral form.

   Input Format:
   The first line of input contains an integer T denoting the number of test cases.
   Each of the next T lines contains decimal integers.

   Output Format:
   For each test case, print the roman numeral equivalent.

   Example:
   Input:
   4
   10
   100
   999
   2020

   Output:
   X
   C
   CMXCIX
   MMXX

2. Write a Python program to convert a roman numeral into its decimal form.

   Input Format:
   The first line of input contains an integer T denoting the number of test cases.
   Each of the next T lines contains roman numbers.

   Output Format:
   For each test case, print the decimal equivalent.

   Example:
   Input:
   4
   XII
   C
   DXCVII
   MMXX

   Output:
   12
   100
   597
   2020

Week – 12: FILE HANDLING

1. Write a Python program to count the number of characters, words, lines in a file.

   Example:

   Input File:
   First line
   Second line
   Third line

Output:
Characters:31
Words:6
Lines:3

2. Write a Python program to add line numbers to a file.

Example:

Input File:
First line
Second line
Third line

Output:
1. First line
2. Second line
3. Third line

IV. REFERENCE BOOKS:

1. Michael H Goldwasser, David Letscher, "Object Oriented Programming in Python", Prentice Hall, 1st Edition, 2007.
2. Yashavant Kanetkar, Aditya Kanetkar, "Let us Python", BPB publication, 1st Edition, 2019.
3. Ashok Kamthane, Amit Kamthane, "Programming and Problem Solving with Python", McGraw Hill Education (India) Private Limited, 2018.
4. Taneja Sheetal, Kumar Naveen, "Python Programming – A modular approach", Pearson, 2017.
5. R Nageswara Rao, "Core Python Programming", Dreamtech Press, 2017 Edition.

V. WEB REFERENCES:

1. https://www.codesdope.com/practice/python-your-class/
2. https://www.geeksforgeeks.org/python-programming-language/
3. https://www.hackerrank.com/
4. https://www.codechef.com/

SURVEYING AND GEOMATICS

III Semester: CE									
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
ACEC01	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Engineering Physics								

I. COURSEOVERVIEW

Surveying is the technique, profession, science and art of making all essential measurements to determine the relative position of points or physical and cultural details above, on, or beneath the surface of the Earth, and to depict them in their objectives. Surveyors use elements of mathematics (geometry and trigonometry), physics, engineering and law. Surveyor measures certain dimensions that generally occur on the surface of the Earth. Surveying equipment, such as levels and theodolites, are used for accurate measurement of angular deviation, horizontal, usable form, or to establish the position of points or details. These points are usually on the surface of the earth, and they are often used to establish land maps and boundaries for ownership or governmental purposes. To accomplish vertical and slope distances with computerization, electronic distance measurement (EDM), totalstations, remotes sensing, Photogrammetry, GPS surveying and laser scanning have supplemented to alarge extent.

II. COURSEOBJECTIVES

The Students will try to learn:

1. The importance and fundamentals of surveying for measuring field parameters using traditional and modern instruments involved in civil construction.
2. The designing of curves and path alignment at suitable locations by implementing the principles of geometry and trigonometry.
3. The programming tools of perspective geometry for preparing 3D geographical maps using aerial and terrestrial photogrammetric surveying.
4. The applications of Remote Sensing in civil construction alteration works, detecting land use and land cover, creating base maps for visual reference.
5. The Modern surveying techniques for addressing the field measurement problems in real time.

III. COURSESYLLABUS

MODULE-I:INTRODUCTION TO SURVEYING (09)

Principles, Linear, angular and graphical methods, Survey stations, Survey lines ranging, chain surveying, bearing of survey lines, levelling: Plane table surveying, Principles of levelling booking and reducing levels; differential, reciprocal levelling, profile levelling and cross sectioning. Digital and Auto Level, Errors in levelling; contouring: Characteristics, methods, uses; areas and volumes.

MODULE–II:THEODOLITE SURVEY AND CURVES(07)

Theodolite survey: Instruments, Measurement of horizontal and vertical angle; Horizontal and vertical control methods, Inter visibility of height and distances, Trigonometric levelling, and Tacheometric surveying. Elements of simple and compound curves, Method of setting out, Elements of Reverse curve, Transition curve, length of curve, Elements of transition curve, Vertical curves.

MODULE–III:ADVANCED SURVEYING (09)

Principle of Electronic Distance Measurement, Modulation, Types of EDM instruments, Distomat, Total Station, Parts of a Total Station, Accessories, Advantages and Applications, Field Procedure for total station survey, Errors in Total Station Survey.

Global Positioning Systems (GPS), Segments, GPS measurements, errors and biases, Surveying with GPS, Co-ordinate transformation, accuracy considerations.

MODULE–IV:PHOTOGRAMMETRIC SURVEYING (08)

Introduction, Basic concepts, perspective geometry of aerial photograph, relief and tilt displacements, terrestrial photogrammetry, flight planning; Stereoscopy, ground control extension for photographic mapping aerial triangulation, radial triangulation, methods; photographic mapping, mapping using paper prints, mapping using stereo plotting instruments, mosaics, map substitutes

MODULE–V:REMOTE SENSING(12)

Introduction, Electromagnetic Spectrum, interaction of electromagnetic radiation with the atmosphere and earth surface, remote sensing data acquisition: platforms and sensors; visual image interpretation; digital image processing.

IV. TEXT BOOKS:

1. Madhu, N, Sathikumar, R and Satheesh Gobi, "Advanced Surveying: Total Station, GIS and Remote Sensing", Pearson India, 2nd Edition, 2006.
2. Manoj, K. Arora and Badjatia, "Geomatics Engineering", Nem Chand & Bros, 2011.
3. Bhavikatti, S.S., "Surveying and Levelling", I.K. International, Vol. I and II, 2010.

V. REFERENCE BOOKS

1. Chandra, A.M., "Higher Surveying", New Age International (P) Limited, 3rd Edition, 2002.
2. Anji Reddy, M., "Remote sensing and Geographical information system", B. S. Publications, 2001
3. Arora, K.R., "Surveying", Standard Book House, Vol-I, II and III, 2015.

VI. WEB REFERENCES:

1. https://nptel.ac.in/courses/105104100/43
2. https://www.coloradomesa.edu/wccc/programs/land-surveying-geomatics.html.
3. https://books.google.co.in/books?id=FaCgAAQBAJ&printsec=frontcover&dq=surveying+and+geomatics+ONLINE+text+books&hl=en&sa=X&ved=0ahUKEwi1wP3x24HgAhUJ5o8KHS2EDzkQ6AEIMzAB#v=onepage&q&f=false

VII. E-TEXT BOOKS:

1. https://www.jntubook.com/surveying-textbook-free-download.
2. http://www.freeengineeringbooks.com/Civil/Surveying-Books.php
3. https://www2.unb.ca/gge/Study/Undergraduate/Handbook.pdf
4. http://learningenglishvocabularygrammar.com/files/idiomsandphraseswithmeaningsandexamplespdf
5. http://www.robinwood.com/Democracy/GeneralEssays/CriticalThinking.pdf

STRENGTH OF MATERIALS

III Semester: CE								
Course Code	Category	Hours/Week			Credits	Maximum Marks		
ACEC02	Core	L	T	P	C	CIA	SEE	Total
		3	1	0	4	30	70	100
Contact Classes:45	Tutorial Classes:15	Practical Classes: Nil				Total Classes: 60		
Prerequisite: Engineering Mechanics								

I. COURSEOVERVIEW

Strength of Materials, deals with deformable solids, requires basic knowledge of principles of mechanics from Engineering Mechanics course and acts as a pre-requisite to the advanced courses on Structural Analysis and Design. This course introduces study of simple stresses, strains and principal stresses on deformable solids. It focuses on the analysis of members subjected to axial, bending, and torsional loads. In a nutshell, the course aims at developing the skill to solve engineering problems on strength of materials. Eventually, through this course content, engineers can analyze the response of various structural members under different loading conditions and design the same, satisfying the safety and serviceability conditions.

II. COURSEOBJECTIVES

The Students will try to learn:

1. The concepts and principles, understand the theory of elasticity including strain/displacement and Hooke’s law relationships; and perform calculations, relative to the strength and stability of structures and mechanical components.
2. The characteristics and calculate the magnitude of combined stresses in individual members and complete structures; analyze solid mechanics problems using classical methods and energy methods.
3. The various situations involving structural members subjected to combined stresses by application of Mohr’s circle of stress; locate the shear center of thin wall beams.
4. The deflection at any point on a beam subjected to a combination of loads.

III. COURSESYLLABUS

MODULE-I:SIMPLE STRESSES AND STRAINS (12)

Concept of stress and strain, types of stresses and strains, Hooke’s law, stress - strain diagram for mild steel, elasticity and plasticity, working stress, factor of safety, elastic moduli and the relationship between them; Bars of varying section, composite bars, temperature stresses. Strain energy – Resilience, Gradual, sudden, impact loadings, simple applications.

MODULE–II:SHEAR FORCE AND BENDING MOMENTS (12)

Introduction, Types of supports and beams, Sign convention for SF and BM, Shear Force and Bending Moment diagrams. BM and SF diagrams for cantilevers and simply supported beams with and without overhangs. Calculation of maximum BM and SF and the point of contra-flexure under concentrated loads, uniformly distributed loads over the whole span or part of span, combination of loads, uniformly varying load and couples.

MODULE–III:BENDING AND SHEAR STRESSES IN BEAMS (12)

BENDING STRESS: Assumptions in the theory of simple bending, derivation of bending equation, Neutral axis, determination bending stresses, section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections, design of simple beam.

SHEAR STRESS: Derivation of formula – Shear stress distribution in rectangular, triangular, circular, I and T sections.

MODULE–IV:TORSION OF CIRCULAR SHAFTS AND SPRINGS (12)

TORSION OF CIRCULAR SHAFTS: Theory of pure torsion, derivation of torsion equations: Assumptions made in the theory of pure torsion, torsional moment of resistance, polar section modulus, power transmitted by shafts, combined bending and torsion and end thrust, design of shafts according to theories of failure.
SPRINGS: Introduction, types of springs, deflection of close and open coiled helical springs under axial pull and axial couple, springs in series and parallel**.**

MODULE–V:PRINCIPAL STRESSES AND STRAINS AND THEORIES OF FAILURES (12)
PRINCIPAL STRESSES AND STRAINS: Introduction, stresses on an inclined section of a bar under axial loading, compound stresses, normal and tangential stresses on an inclined plane for biaxial stresses, two perpendicular normal stresses accompanied by a state of simple shear, Mohr's circle of stresses, principal stresses and strains, introduction to analytical and graphical solutions.
THEORIES OF FAILURES: Various theories of failures like Maximum principal stress theory, maximum principal strain theory, maximum shear stress theory, maximum strain energy theory, maximum shear strain energy theory.

III. TEXT BOOKS

1. R. K. Bansal, "A Textbook of Strength of Materials", Laxmi publications Pvt. Ltd., New Delhi, 2nd Edition, 2007.
2. F. Beer, E. R. Johnston, J. DeWolf, "Mechanics of Materials", Tata McGraw-Hill Publishing Company Ltd., New Delhi, India, 1st Edition, 2008.
3. S. S. Bhavikatti, "Strength of Materials", Vikas Publishing House Pvt. Ltd., New Delhi, 5th Edition, 2013.

IV. REFERENCE BOOKS

1. B. C. Punmia, Ashok K Jain and Arun K Jain, "Mechanics of Materials", Laxmi Publications Pvt. Ltd., New Delhi, 12th Edition, 2007.
2. R. Subramanian, "Strength of Materials", Oxford University Press, 2nd Edition, 2010.
3. Hibbeler, R. C., "Mechanics of Materials", East Rutherford, NJ: Pearson Prentice Hall, 6th Edition, 2004.

VI.WEB REFERENCES

1. http://www.nptelvideos.in/2012/11/strength-of-materials- prof.html.
2. http://ocw.mit.edu/courses/civil-and-environmental-engineering/1-050-solid-mechanics-fall- 2004/lecturenotes/.
3. https://www.youtube.com/watch?v=coRgpxG2pyY&list=PLLbvVfERDon3oDfCYxkwRct1Q6YeOzi9g

VII.E-TEXTBOOKS

1. http://www.freeengineeringbooks.com/Civil/Strength-of-Material-Books.php
2. http://royalmechanicalbuzz.blogspot.in/2015/04/strength-of-materials-book-by-r-k-bansal.html.
3. https://books.google.co.in/books?id=I8gg0Q4OQ4C&printsec=frontcover&dq=STRENGTH+OF+MATERIALS &hl=en&sa=X&ved=0ahUKEwjpveCD44HgAhWBad4KHacUAgYQ6AEIMDAB#v=onepage& q=STRENGTH%20OF%20MATERIALS&f=false.

FLUID MECHANICS

III Semester: CE								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
ACEC03	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	1	0	4	30	70	100
Contact Classes:45	**Tutorial Classes: 15**	**Practical Classes: Nil**				**Total Classes:60**		
Prerequisite: Engineering Mechanics								

I. COURSEOVERVIEW

Fluid Mechanics is a branch of physics concerned with the mechanics of fluids, the forces acting on them and basic understanding on fluid properties, fluid dynamics, fluid flow in closed and open conduits. The flow of incompressible fluids in pressure systems constitute as the major portion of this course. This course enables to work and formulate the models necessary to study and analyze fluid systems through the application of control volume. Further, the principles used in Fluid Mechanics help to study the concepts in Hydraulic Machinery and Water Resources Engineering.

II. COURSEOBJECTIVES

The Students will try to learn:

1. The fundamental knowledge of fluid properties at rest, in transit for various conditions in both closed and open channels.
2. The concept of buoyancy, stability of floating bodies and the forces acting on immersed bodies by employing the concept of pressure.
3. The basic laws of continuity, energy and momentum and their governing equations.
4. The analysis of intensive, extensive properties by basic bifurcation and similitude.

III. COURSESYLLABUS

MODULE-I:PROPERTIES OF FLUIDS (12)

Distinction between a fluid and a solid; Properties of fluids, intrinsic and extrinsic, Newton law of viscosity with classification, cavitation, surface tension, capillarity, Bulk modulus of elasticity, and compressibility.

MODULE–II:FLUID STATICS(12)

Fluid Pressure: Pressure at a point, Pascal’s law, Pressure measuring devices, piezometer, different types of manometers and pressure gauges; Hydrostatic pressure for submerged bodies. buoyancy and stability of floating bodies.

MODULE–III:FLUID KINEMATICS (12)

Classification of fluid flow with respect to time, space, rotation about its axis, Reynolds number, Froude number, combinations of fluid flows.

Flow patterns, Laplace equations and flow net, Derivation of Continuity equations in Cartesian coordinate system with practical applications.

MODULE–IV:FLUID DYNAMICS(12)

Surface and body forces, law of conservation of mass and energy, equations of motion, Euler’s equation and derivation of Bernoulli’s equation, TEL and HGL of pipes; Practical applications of Bernoulli’s equation; Momentum principle, applications.

MODULE–V:FLOW THROUGH PIPES (12)

Major losses (Derivation of Darcy’s Weischbach – Equation) and minor losses thorough pipes, Pipes in series, equivalent pipes, pipes in parallel. Analysis of pipe networks - Hardy Cross method.

IV. TEXT BOOKS

1. S. Ramamrutham, “Hydraulic Fluid Mechanics and Fluid Machines”, Dhanpat Rai Publishing Company Private Limited, 9th Edition, 2014.
2. C. S. P. Ojha, R. Berndtsson and P. N. Chadramouli, “Fluid Mechanics and Machinery”, Oxford University Press, 2010.

3. P M Modi and S M Seth, “Hydraulics and Fluid Mechanics”, Standard Book House, 2014.

V. REFERENCE BOOKS

1. K. Subramanya, “Theory and Applications of Fluid Mechanics”, Tata McGraw Hill.
2. R.L. Daugherty, J.B. Franzini and E.J. Finnemore, “Fluid Mechanics with Engineering Applications”, International Student Edition, Tata Mc Graw Hill.
3. Jack b. Evett, Cheng Liu, “2500 Solved Problems in Fluid Mechanics and Hydraulics”, MCGRAW-HILL, INC.

VI. WEB REFERENCES

1. http://nptel.ac.in/courses/112105171/1
2. http://nptel.ac.in/courses/105101082/
3. http://nptel.ac.in/courses/112104118/ui/TOC.htm

VII. E-TEXT BOOKS

1. http://engineeringstudymaterial.net/tag/fluid-mechanics-books/
2. http://www.allexamresults.net/2015/10/Download-Pdf-Fluid-Mechanics-and-Hydraulic-Machines-by-rk-Bansal.html
3. http://varunkamboj.typepad.com/files/engineering-fluid-mechanics-1.pdf

ENGINEERING GEOLOGY

<table>
<tr><td colspan="9">III Semester: CE</td></tr>
<tr><th rowspan="1">Course Code</th><th>Category</th><th colspan="3">Hours/Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">ACEC04</td><td rowspan="2">Core</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes:45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">TotalClasses:45</td></tr>
<tr><td colspan="9">Prerequisite: Chemistry</td></tr>
</table>

I. COURSEOVERVIEW:

This course provides engineers and geologists with an overview of engineering geology. Engineering geology routinely deals with the application of geologic site characterization and the evaluation of geological and geotechnical conditions for the design, construction, operation, and maintenance of engineering structures. This course is designed to provide a general background of geologic considerations, identification, classification and engineering properties of soil and rock. Additionally, geotechnical field exploration methods used in engineering geology will be covered. The intent is to give the reader a basic understanding of some of the investigation and classification methods for soil and rock when used as a construction material in engineering applications.

II. COURSEOBJECTIVES

The Students will try to learn:

1. The process of formation of rocks, their classifications and properties of minerals.
2. The identification of different geological structures encountered in nature.
3. The different hazards such as earthquakes, landslides etc. causes and their effects
4. The importance of geophysical and geological studies of sites for tunnels, dams and Reservoirs.

III. COURSESYLLABUS

MODULE-I:INTRODUCTION AND WEATHERING OF ROCKS (09)

Introduction: Importance of geology from civil engineering point of view. Brief study of case histories of failures of some civil engineering constructions due to geological draw backs. Importance of physical geology, petrology and structural geology. Weathering of rocks: Its effect over the properties of rocks importance of weathering with reference to dams, reservoirs and tunnels weathering of common rocks.

MODULE–II:MINERALOGY AND PETROLOGY (09)

Mineralogy: Definition of mineral, importance of study of minerals, different methods of study of minerals. Advantages of study of minerals by physical properties. Role of study of physical properties of minerals in the identification of minerals. Petrology: Definition of rock, geological classification of rocks into igneous, sedimentary and metamorphic. Dykes and Sills, common structures and textures of igneous, sedimentary and metamorphic rocks.

MODULE–III:STRUCTURAL GEOLOGY (09)

Indian stratigraphy, paleontology and geological time scale, out crop, strike and dip study of common geological structures associating with the rocks such as fold, faults unconformities, and joint types.

Ground water: Water table, common types of ground water movement, ground water exploration. Earth quakes, their causes and effects, shield hazards, water in landslides their causes and effects, measures to be taken to prevent their occurrence. Importance of study of ground water, earthquake and landslides.

MODULE–IV:GEOLOGY OF DAMS AND RESERVOIRS (09)

Types of dams and bearing of geology of site in their selection, geological considerations in the selection of a dam site. Factors contributing to the success of a reservoir, geological factors influencing water tightness and life of reservoirs, geo hazards, ground subsidence. Geophysical studies: Importanceofgeophysical studies principles of geophysical study by gravity methods, magnetic methods, electrical methods, seismic methods, radio metric methods and geothermal method. Special importance ofelectrical resistivity methods and seismic refraction methods. Improvement of competence of sites by grouting etc.Fundamental aspects of rock mechanics and environmental geology.

MODULE–V:TUNNELS (09)

Purpose of tunneling, effects of tunneling on the ground, role of geological considerations in tunneling over break and lining in tunnels, tunnels in rock, subsidence over old mines.

IV. TEXT BOOKS

1. N.Chennkesavulu,"Engineering Geology', Mc Milan India Private Limited, New Delhi, India, 12th Edition,2009.
2. VenkatReddy, "Engineering Geology", Vikas Publications, New Delhi,India,2nd Edition,2011.
3. Vasudev Kanithi, "Engineering Geology', University Press, 1st Edition, 2013.
4. Gokhale,"Principles of Engineering Geology, BS Publications, 2009.

V. REFERENCE BOOKS

1. F.G.Bell, "Fundamentals of Engineering Geology, Butterworth's Publications, 3rd Edition, New Delhi, 1992.
2. K.V.G.K.Gokhale, "Principles of Engineering Geology, BS Publications, New Delhi, India, 5th Edition, 2008.

VI. WEB REFERENCES

1. http://ocw.mit.edu/courses/earth-atmospheric-and-planetary-sciences/12-001-introduction-to-geology-fall-2013/
2. http://nptel.ac.in/courses/105105106/
3. http://www.journals.elsevier.com/engineering-geology
4. http://www.springer.com/earth+sciences+and+geography/engineering+geology/journal/10706
5. http://www.springer.com/earth+sciences+and+geography/engineering+geology/journal/10064
6. http://www.sciencedirect.com/science/journal/00137952

VII. E-TEXT BOOKS

1. http://cepdf.blogspot.in/2012/07/geology-for-civil-engineers-pdf-book.html
2. http://nptel.ac.in/courses/105105106/
3. https://www.studynama.com/community/threads/187-Engineering-Geology-Ebook-Lecture-Notes-PDF-download-for-Civil-Engineers.
4. http://www.civilenggforall.com/p/engineering-geology-list-of-books.html

DATA STRUCTURES

III Semester: Common for all branches								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACSC08	Core	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes:45		
Prerequisites: Python Programming								

I. COURSE OVERVIEW:

The course covers some of the general-purpose data structures and algorithms, and software development. Topics covered include managing complexity, analysis, static data structures, dynamic data structures and hashing mechanisms. The main objective of the course is to teach the students how to select and design data structures and algorithms that are appropriate for problems that they might encounter in real life. This course reaches to student by power point presentations, lecture notes, and lab which involve the problem solving in mathematical and engineering areas.

II. COURSE OBJECTIVES:

The students will try to learn:

I. To provide students with skills needed to understand and analyze performance trade-offs of different algorithms / implementations and asymptotic analysis of their running time and memory usage.
II. To provide knowledge of basic abstract data types (ADT) and associated algorithms: stacks, queues, lists, tree, graphs, hashing and sorting, selection and searching.
III. The fundamentals of how to store, retrieve, and process data efficiently.
IV. To provide practice by specifying and implementing these data structures and algorithms in Python.
V. Understand essential for future programming and software engineering courses.

III. SYLLABUS:

MODULE – I: INTRODUCTION TO DATA STRUCTURES, SEARCHING AND SORTING (09)

Basic concepts: Introduction to data structures, classification of data structures, operations on data structures; Algorithm Specification, Recursive algorithms, Data Abstraction, Performance analysis- time complexity and space complexity, Asymptotic Notation-Big O, Omega, and Theta notations. Introduction to Linear and Non-Linear data structures, Searching techniques: Linear and Binary search; Sorting techniques: Bubble, Selection, Insertion, Quick and Merge Sort and comparison of sorting algorithms.

MODULE – II: LINEAR DATA STRUCTURES (09)

Stacks: Stack ADT, definition and operations, Implementations of stacks using array, applications of stacks, Arithmetic expression conversion and evaluation; Queues: Primitive operations; Implementation of queues using Arrays, applications of linear queue, circular queue and double ended queue (deque).

MODULE – III: LINKED LISTS (09)

Linked lists: Introduction, singly linked list, representation of a linked list in memory, operations on a single linked list; Applications of linked lists: Polynomial representation and sparse matrix manipulation.

Types of linked lists: Circular linked lists, doubly linked lists; Linked list representation and operations of Stack, linked list representation and operations of queue.

MODULE - IV NON-LINEAR DATA STRUCTURES (09)

Trees: Basic concept, binary tree, binary tree representation, array and linked representations, binary tree traversal, binary tree variants, threaded binary trees, application of trees, Graphs: Basic concept, graph terminology, Graph Representations - Adjacency matrix, Adjacency lists, graph implementation, Graph traversals – BFS, DFS, Application of graphs, Minimum spanning trees – Prims and Kruskal algorithms.

MODULE - V BINARY TREES AND HASHING (09)

Binary search trees: Binary search trees, properties and operations; Balanced search trees: AVL trees; Introduction to M-Way search trees, B trees; Hashing and collision: Introduction, hash tables, hash functions, collisions, applications of hashing.

IV. TEXT BOOKS:

1. Rance D. Necaise, “Data Structures and Algorithms using Python”, Wiley Student Edition.
2. Benjamin Baka, David Julian, “Python Data Structures and Algorithms”, Packt Publishers, 2017.

V. REFERENCE BOOKS:

1. S. Lipschutz, “Data Structures”, Tata McGraw Hill Education, 1st Edition, 2008.
2. D. Samanta, “Classic Data Structures”, PHI Learning, 2nd Edition, 2004.

VI. WEB REFERENCES:

1. https://www.tutorialspoint.com/data_structures_algorithms/algorithms_basics.htm
2. https://www.codechef.com/certification/data-structures-and-algorithms/prepare
3. https://www.cs.auckland.ac.nz/software/AlgAnim/dsToC.html
4. https://online-learning.harvard.edu/course/data-structures-and-algorithms

EXPERIENTIAL ENGINEERING EDUCATION (EXEED) – PROTOTYPE / DESIGN BUILDING

III Semester: Common for all branches								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACSC09	Foundation	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		2	0	0	1	30	70	100
Contact Classes: 28	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 28**		
Prerequisite: There are no prerequisites to take this course								

I. COURSE OVERVIEW:

This course provides an overall exposure to the various methods and tools of prototyping. This course discusses Low- Fidelity, paper, wireframing and tool based prototyping techniques along with design principles and patterns.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basic principles and design aspect of prototyping.
II. The various techniques, design guidelines and patterns.
III. The applications of prototyping using various tools and platforms.

WEEK NO	TOPIC
WEEK – I	An introduction to Prototyping
WEEK – II	Low - Fidelity Prototyping and Paper Prototyping
WEEK – III	Wireframing and Tool based Prototyping
WEEK – IV	Physical Low- Fidelity Prototyping
WEEK – V	Tool based prototyping
WEEK – VI	Design Principles and Patterns- Graphic Design
WEEK – VII	Design Principles and Patterns- Interaction Design
WEEK –VIII	Commercial design guidelines and standards.
WEEK - IX	Universal design: Sensory and cognitive impairments
WEEK - X	Universal design: Tools, Limitations and standards
WEEK - XI	Introduction platforms and context : Mobile UI design, Wearable
WEEK - XII	Introduction platforms and context : Automotive user interface
WEEK - XIII	Introduction platforms and context : IoT and Physical Computing
WEEK - XIV	Assessment

SURVEYING AND GEOMATICS LABORATORY

III Semester: CE								
Course Code	Category	Hours/Week			Credits	Maximum Marks		
ACEC05	Core	L	T	P	C	CIA	SEE	Total
		0	0	3	1.5	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes:45				Total Classes:45		
Prerequisite: No Prerequisites required								

I. COURSE OVERVIEW:

The purpose of this laboratory is to draw plans of individual site, industry, as well as the maps of town, city, district and India, and also to execute the all constructions. The Surveying and Geomatics Laboratory is equipped with the instruments and tools students use throughout the surveying course. Students learn techniques for gathering field data with both traditional and modern instruments. A set of traditional and modern instruments are used, including auto level, theodolite, total station, level rods, tripods, tape measures, chaining pins, and other common surveying tools and ancillary equipment.

II. COURSES OBJECTIVES:

The students will try to learn

a) The practical knowledge on computation of an area, volume of an irregular and regular land surface using chains and tapes.
b) The different types of instruments in surveying. Perform levelling and contouring of ground surfaces.
c) Mathematics in surveying field to calculate areas and volumes for different projects.
d) Survey data and design the civil engineering projects.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO1	Utilize the concept of bearing system to measure azimuth and survey lines in filed. .
CO2	Make use of digital theodolite apparatus to measure vertical and horizontal distances, gradients and elevations.
CO3	Demonstrate the two point and three point problem in plane table surveying for tracing out the centering point or station point.
CO4	Identify the reduced levels using leveling apparatus for illustrating longitudinal section and cross section and plotting.
CO5	Make use of Rankine's curve setting procedure for investigating the suitable path along the alignment and conflict points.
CO6	Distinguish between Tacheometry and trigonometry surveying for various operating conditions data record keeping.

IV. COURE CONTENT:

EXCERCISES ON SURVEYING & GEOMATICS

Note: Students are encouraged to wear shoes for laboratory practice session.

1. Getting Started Exercises

1.1 Introduction

The purpose is to Identify survey equipment like chain, tape, compass, levelling, plane table, theodolite, and total stations as shown in Fig.1.1. Remembering the suitability and application of equipment.

I. Showing Surveying Equipment
II. Purpose and Application
III. Precision and Accuracy
IV. Calibration

Fig.1.1 Various equipment used in surveying

Try:

1. Identify the parts of equipment

2. Survey of an area by chain survey closed traverse and plotting

2.1 closed traverse and plotting

Surveying using chain and getting the area of a particular place. Fig.2.1 shows the chain and Fig.2.2 shows the chain surveying. In the reconnaissance survey given area is surveyed by closed traverse and plotted using chain.

.

Fig.2.1 Chain

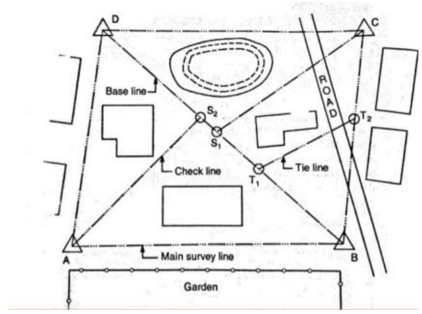


Fig.2.2 Chain surveying

Try:

a) Using compass
b) Using plane table
c) Using tape
d) Using total station

3. Chaining across obstacles

3.1 Description

Whenever it is required to plot or to know the length of a line which is passing across the river, building, uphill, valley, we will use different techniques to measure length of line. Fig.3.1 shows the Chaining across building obstacle.

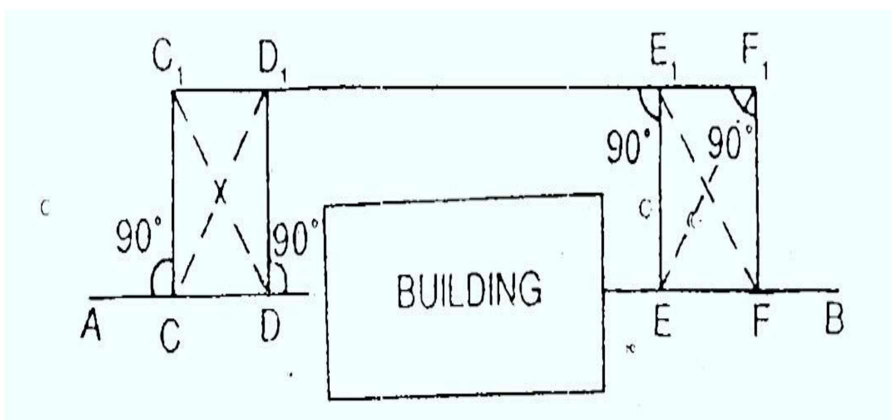


Fig.3.1 Chaining across building obstacle

Try:

1. water body obstruction

4. Determine of distance between two inaccessible points with compass

4.1 Description

To measure the distance between the points which are not accessible like distance between moon and sun we will utilise this method by using compass as shown in Fig.4.1

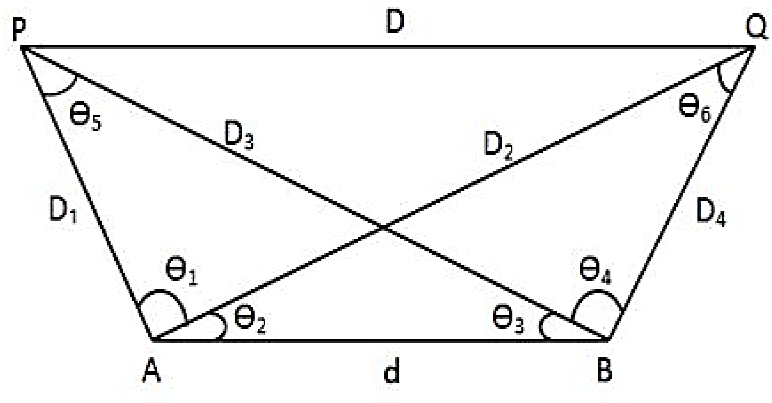


Fig.4.1 Length of inaccessible line using compass

5.0 Surveying of a given area by prismatic compass closed traverse and plotting after adjustment

5.1 Closed traverse and plotting after adjustment

5.2 Description

The given area is surveyed closed traverse and plotted after adjustment is done using prismatic compass as shown in Fig.5.1.

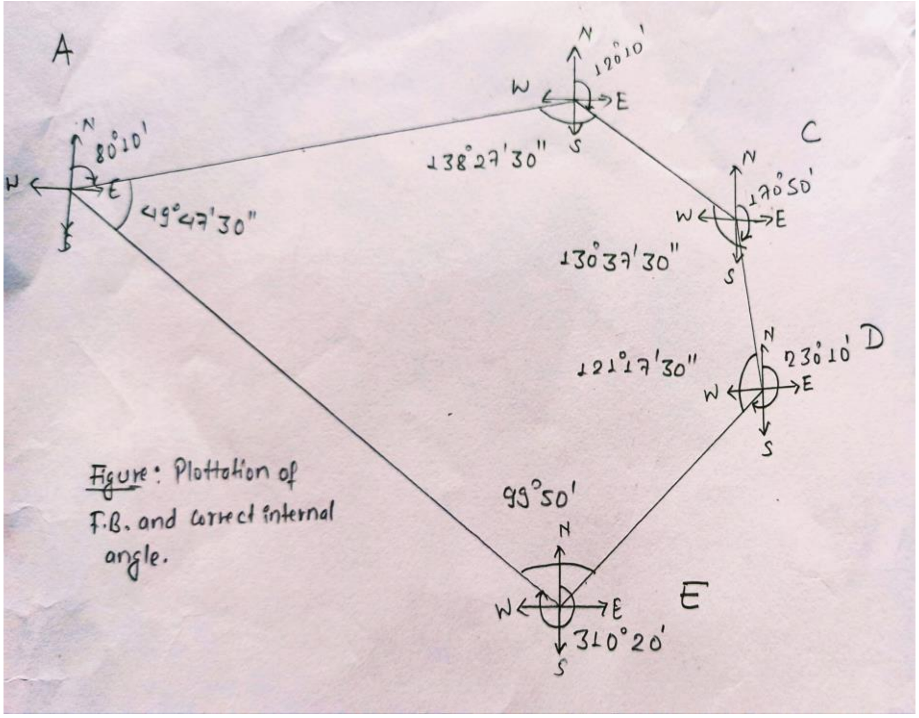


Fig. 5.1 Prismatic compass closed traverse

Try:

a) Using theodolite
b) Using Total station

6. Correction for Local Attraction by Prismatic Compass

6.1 Local Attraction by Prismatic Compass

Local attraction will occur whenever surveying is done with compass near electric iron poles or ground having iron ore inside as magnet needle affects with iron material.

6.2 Description

Plotting is done after adjusting error of due to Local Attraction area using prismatic compass as shown in Fig.6.1.

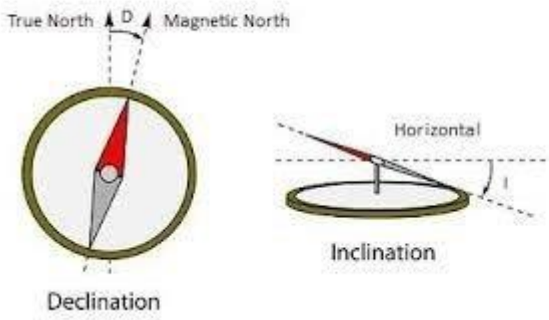


Fig. 6.1 Local attraction

7. Radiation method, intersection methods by plane table survey

7.1 Description

Plotting of an area can be done using plane table by radiation and intersection methods.
Fig.7.1 shows the Plane table, plotting of an area by radiation method is as shown in Fig.7.2 Plotting of an area by intersection method is as shown in Fig.7.3.

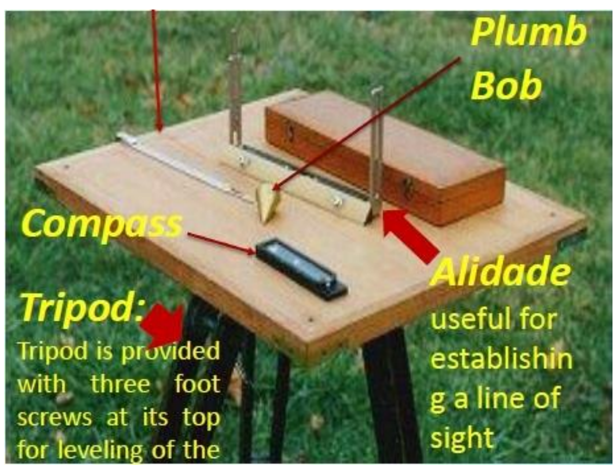


Fig.7.1 Plane table

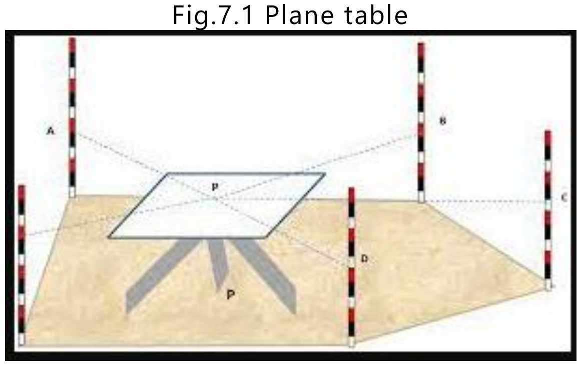


Fig.7.2 Plane table Radiation Method

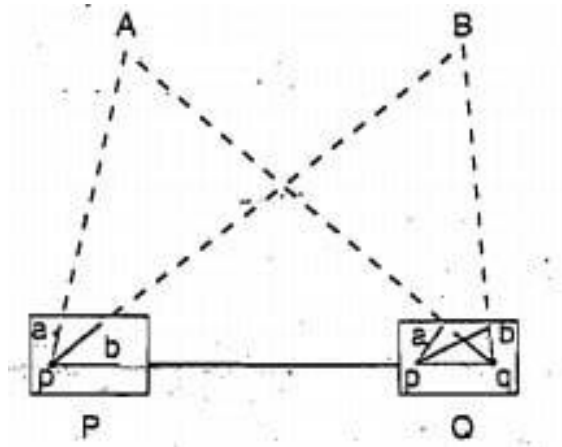


Fig.7.3 Plane table intersection Method

8. Two point problems in plane table survey

8.1 Description

If two points are already in the existing drawing sheet and in the site, then Location of point P by two-point problem in plane table as shown in Fig.8.1.

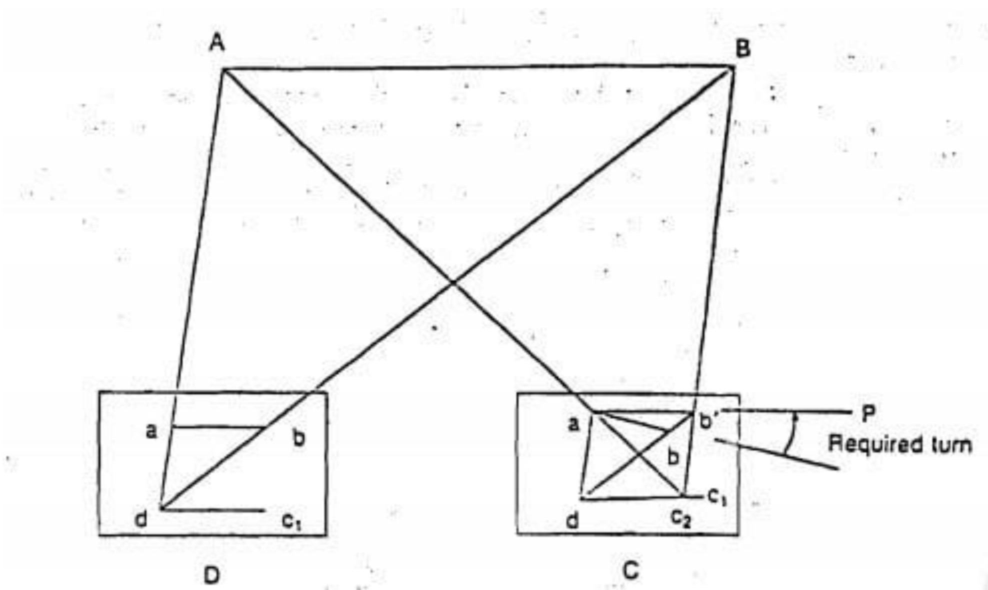


Fig.8.1 Two point problems in plane table survey

9. Three point problems in plane table survey

9.1 Description

If three points are already in the existing drawing sheet and in the site, then Location of point P can be done by three-point method using plane table as shown in Fig.9.1.

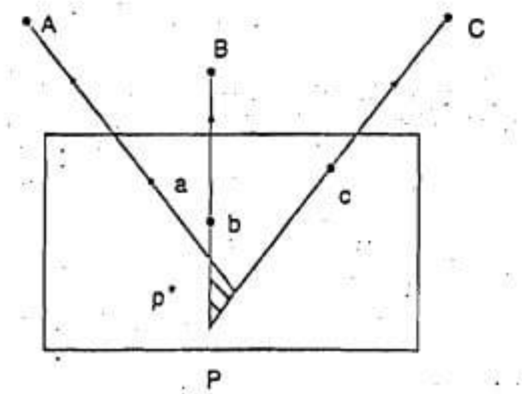


Fig.9.1 Three-point problem in plane table

10. Traversing by plane table survey

10.1 Description

Plotting of an area by Traversing using plane table as shown in Fig. 10.1.

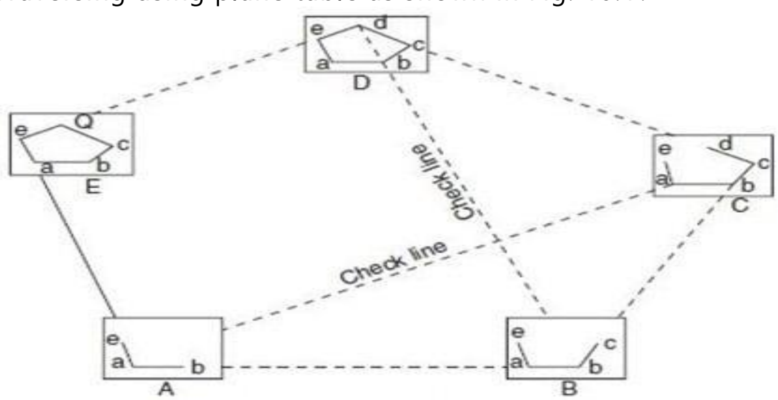


Fig. 10.1 Plotting of an area by traversing using plane table

Try:

a) Using theodolite
b) Using Total station

11. Fly leveling differential leveling

11.1 Description

Differential leveling is the method of leveling to determine the elevation of points located at some distance apart or determine the elevation difference between two points or establish benchmarks. When differential leveling is done in order to connect a bench mark to the starting point of the alignment of any project, it is called fly leveling. Fly leveling is done to connect the BM to any intermediate point of the alignment for checking the accuracy of the work. Fig.11.1 shows the Level equipment and Fig.11.2 shows the fly levelling.

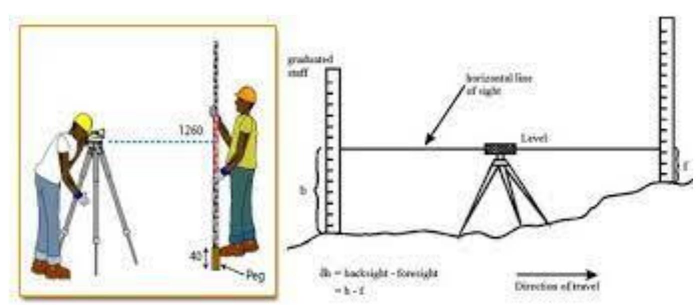


Fig.11.1 Level equipment

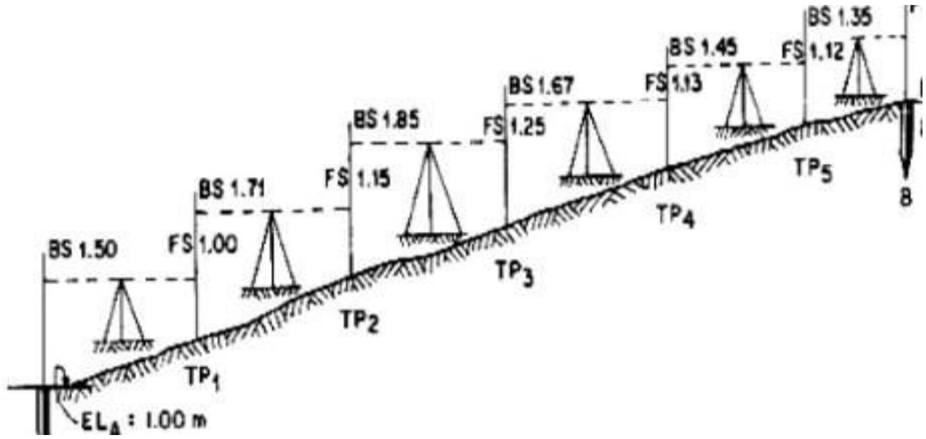


Fig.11.2 Fly leveling

Try:

a) Using tacheometer
b) Using tilt level
c) Using Auto level
d) Using Total station

12. Exercise of Longitudinal Section and Cross Section and Plotting

12.1 Description

Road quantity is calculated by longitudinal and cross sectioning before and after road construction. Road surveying before and after laying road as shown in Fig. 12.1.

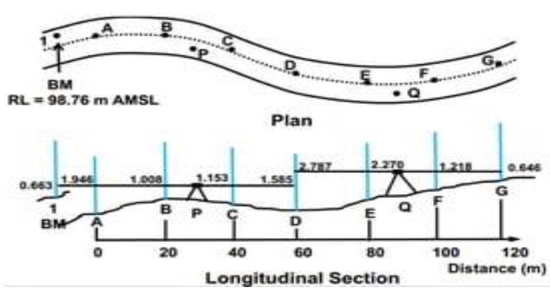


Fig. 12.1 Road surveying before and after laying road

Try:

a) Using tacheometer
b) Using tilt level
c) Using Auto level
d) Using Total station

13. Two exercises on contouring

13.1 Description

Laying of ghat roads, Capacity of reservoir and calculation of earth quantity is done by contouring. Flat ground and hilly area contouring as shown in Fig. 13.1.

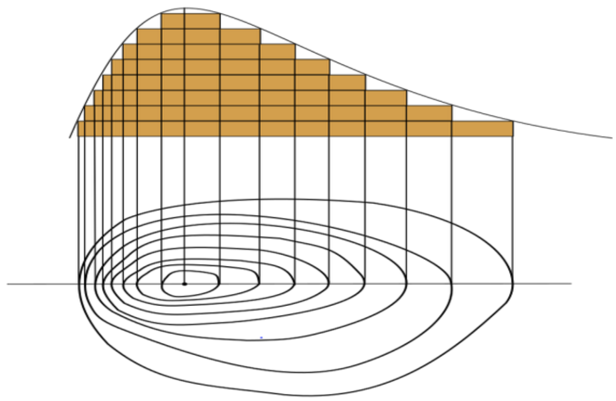


Fig. 13.1 Contouring in hilly area

Try:

a) Using tacheometer
b) Using tilt level
c) Using Auto level
d) Using Total station

V. TEXT BOOKS:

1) H. S. Moondra, Rajiv Gupta, "Laboratory Manual for Civil Engineering", CBS Publishers Pvt.Ltd., New Delhi, 2nd *e*dition, 2013.
2) S. S. Bhavikatti, "Surveying Theory and Practice", IK Books, New Delhi, 2010.

VI. REFERENCE BOOKS:

1) James M. Anderson, Edward M. Mikhail, "Surveying: Theory and Practice", Tata Mc Graw Hill Education, 2012.

VII. ELECTRONICS RESOURCES:

1) https://www.iare.ac.in/sites/default/files/lab1/Surveying
2) https://aust.edu/lab-manuals/CE/ce-104.pdf

VIII. MATERIALS ONLINE:

1) Course Template
2) Laboratory manual

ENGINEERING GEOLOGY LABORATORY

III SEMESTER: CE									
Course Code	Category	Hours / Week			Credits	Maximum Marks			
ACEC06	Core	L	T	P	C	CIA	SEE	Total	
		0	0	2	1	30	70	100	
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 24				Total Classes: 24			
Prerequisite: No Prerequisites required									

I. COURSEOVERVIEW

Engineering Geology provides a systematic study of the structure and properties of construction materials and their occurrence. It involves in investigating subsurface features by geophysical methods. This course also addresses study and selection of site for dams, reservoirs and improvement of competence of the site and design considerations of constructing underground structures.

II. COURSE OBJECTIVES

The students will try to learn:

I. The basics knowledge of geology that is required for constructing various Civil Engineering Structure, basic Geology, Geological Hazardous and Environmental Geology
II. The core activities of engineering geologists – site characterization and geologic
III. Various types of Hazards identification and mitigation.
IV. The importance of geophysical and geological studies of sites for tunnels, dams and reservoirs.
V. Planning and construction of major Civil Engineering projects.

III. COURSE OUTCOMES

At the end of the course students will be able to:

CO 1 Classify rocks using basic geological systems for selective construction material.

CO 2 Compare past tectonic settings of an area for evaluation of current structures.

CO 3 Interpret graphs and models used in structural geology for demonstrating stress, strain and tectonics.

CO 4 Identification and study of rock properties using geological selection.

CO 5 Apply the concepts of how minerals form and their uses for identifying the rock forming.

CO 6 Apply the geologic concepts and approaches of rock for engineering projects.

IV. COURSE CONTENT

EXERCISES ON ENGINEERING GEOLOGY LAB

Safety

Safety is a vital issue in all workplaces. Before using any equipment and machines or attempting practical work in a laboratory everyone must understand basic safety rules. These rules will help keep all safe in the laboratory.

Safety Rules

1. New students must receive an orientation on lab operating procedures before working in a lab.
2. Students shall publish a safety checklist for equipment for which they are responsible.
3. Students must read the safety checklist for each piece of equipment before operating it.
4. Ensure you know the location of the emergency stop button before starting equipment.
5. Always depressurize accumulators or pneumatic reservoirs before working on fluid power apparatus.
6. Check the application pressure, system pressure, and component pressure before connecting a system to a pump or pressure source. The maximum operating pressures are listed on equipment labels or published on manufacturer websites.

Getting Started Exercises

1. Physical Properties of Minerals

1.1 Mineral

A mineral may be defined as a natural, inorganic, homogenous, solid substance having a definite chemical composition and regular atomic structure.

1.2 Common methods of study for the identification of minerals

I. Slicing of stepped pulley using. still format
II. Laying of stepped pulley using 3D printing

1.2.1 X-ray analysis

Based on the study of atomic structure, distinctive for every mineral. Its limitation is expensive, time consuming.

1.2.2 Chemical Analysis

Based on the study of chemical composition. Its limitation is expensive, time consuming and not suitable for minerals exhibiting polymorphism (two or more minerals exhibit different physical properties in spite of possessing the same chemical composition).

1.2.3 Chemical Analysis

Based on the net effect of chemical composition and atomic structure. Its limitation is expensive.

1.2.4 Mineral

A mineral may be defined as a natural, inorganic, homogenous, solid substance having a definite chemical composition and regular atomic structure.

1.3 Common methods of study for the identification of minerals

1.3.1 X-ray analysis

Based on the study of atomic structure, distinctive for every mineral. Its limitation is expensive, time-consuming.

1.3.2 Chemical Analysis

Based on the study of chemical composition. Its limitation is expensive, time consuming and not suitable for minerals exhibiting polymorphism (two or more minerals exhibit different physical properties in spite of possessing the same chemical composition).

1.3.3 Optical Study

Based on the net effect of chemical composition and atomic structure. Its limitation is expensive.

1.3.4 Study of physical properties

Based on the consistency in physical properties which are due to the definite chemical composition and regular atomic structure.

2. Group of Minerals

2.1 Introduction

Minerals are grouped by their chemical composition. Silicates, oxides, sulfates, sulfides, carbonates, native elements, and halides are all major mineral groups.

1. Silicates
2. Oxides
3. Sulfates
4. Sulfides
5. Carbonates
6. Native Elements
7. Halides

2.2 Crystaline solids

Minerals are crystalline solids. A crystal is a solid in which the atoms are arranged in a regular, repeating pattern. The pattern of atoms in different samples of the same mineral is the same. Is glass a mineral? Without a crystalline structure, even natural glass is not a mineral.

2.3 Inorganic Substances

Organic substances are carbon-based compounds made by living creatures and include proteins carbohydrates, and oils. Inorganic substances have a structure that is not characteristic of living bodies. Coal is made of plant and animal remains. Is it a mineral? Coal is a classified as a sedimentary rock but is not a mineral.

2.4 Natural Processes

Minerals are made by natural processes, those that occur in or on Earth. A diamond created deep in Earth's crust is a mineral. Is a diamond created in a laboratory by placing carbon under high pressures a mineral? No. Do not buy a laboratory-made "diamond" for jewelry without realizing it is not technically a mineral.

2.5 Chemical Composition

Nearly all (98.5% of Earth's crust is made up of only eight elements – oxygen, silicon, aluminum, iron, calcium, sodium, potassium, and magnesium – and these are the elements that make up most minerals.

3. Identification of Silica Group Minerals

3.1 Introduction

Silica mineral, any of the forms of silicon dioxide (SiO2), including quartz, tridymite, cristobalite, coesite, stishovite, lechatelierite, and chalcedony. Various kinds of silica minerals have been produced synthetically; one is keatite.

3.2 General Considerations

Silica minerals make up approximately 26 percent of Earth's crust by weight and are second only to the feldspars in mineral abundance. Free silica occurs in many crystalline forms with a composition very close to that of silicon dioxide, 46.75 percent by weight being silicon and 53.25 percent oxygen. Quartz is by far the most commonly occurring form. Tridymite, cristobalite, and the hydrous silica mineral opal are uncommon, and vitreous (glassy) silica, coesite, and stishovite have been reported from only a few localities. Several other forms have been produced in the laboratory but have not been found in nature.

3.3 Physical and chemical Properties

The crystallographic structures of the silica minerals, except stishovite, are three-dimensional arrays of linked tetrahedrons, each consisting of a silicon atom coordinated by four oxygen atoms. The tetrahedrons are usually quite regular, and the silicon-oxygen bond distances are 1.61 0.02 Principal differences are related to the geometry of the tetrahedral linkages, which may cause small distortions within the silica tetrahedrons. High pressure forces silicon atoms to coordinate with six oxygen atoms, producing nearly regular octahedrons in the stishovite structure.

3.4 Individual silica minerals

Quartz

Quartz occurs in many varieties in almost all types of igneous, sedimentary, and meta- morphic rocks. It has also been found in meteorites and in some lunar rocks.

High quartz

High quartz, is the more symmetrical form quartz takes at sufficiently high temperatures (about 573 C at one atmosphere of pressure), but the relationship is pressure- sensitive. High quartz may be either left- or right-handed, and its c axis is one of sixfold symmetry rather than threefold; thus, many twin laws of ordinary quartz cannot occur. High quartz twins typically involve inclined sets of axes. High quartz can form directly from silicatemagma or from high-temperature gases or solutions.

4. Identification of feldspar group Minerals

4.1 Introduction

Introduction Feldspars are a group of closely related minerals that together are the most abun- dant mineral in the Earth's crust. A thorough knowledge of the feldspars is what separates geologists from the rest of us.

4.2 How to Tell Feldspar

Feldspars are hard minerals, all of them with a hardness of 6 on the Mohs scale. This lies between the hardness of a steel knife (5.5) and the hardness of quartz (7). In fact, feldspar is the standard for hardness 6 in the Mohs scale. Feldspars usually are white or nearly white, though they may be clear or light shades of orange or buff. They usually have a glassy luster. Feldspar is called a rock-forming mineral, very common, and usually makes up a large part of the rock. In sum, any glassy mineral that's slightly softer than quartz is very likely considered a feldspar. The main mineral that might be confused with feldspar is quartz. Besides hardness, the biggest difference is how the two minerals break. Quartz breaks in curvy and irregular shapes (conchoidal fracture). Feldspar, however, breaks readily along flat faces, a property called cleavage. As you turn a piece of rock in the light, quartz glitters and feldspar flashes. Other differences: quartz is usually clear and feldspar is usually cloudy. Quartz appears in crystals more commonly than feldspar, and the six-sided spears of quartz are very different from the generally blocky crystals of feldspar.

4.3 Feldspar Formulas and Structure

The basic feldspar recipe is $X(Al,Si)_4O_8$, where X stands for Na, K, or Ca. The exact composition of the various feldspar minerals depends on what elements balance the oxygen, which has two bonds to fill (remember H_2O?). Silicon makes four chemical bonds with oxygen; that is, it's tetravalent. Aluminum makes three bonds (trivalent), calcium makes two (divalent) and sodium and potassium make one (monovalent). So the identity of X depends on how many bonds are needed to make up the total of 16.

5. Identification of Minerals

5.1 Introduction

A mineral may be defined as a natural, inorganic, homogenous, solid substance having a definitechemical composition and regular atomic structure.

5.2 Experimental

- Form :
- Colour :
- Streak :
- Lustre :
- Fracture:
- Cleavage :
- Hardness :
- Specific Gravity :
- Degree of Transparency :
- Special Property

5.3 Inference

- Chemical Composition :
- Crystal System :
- Nature of Origin :
- Occurrence :
- Uses :
- Remarks :

6. Identification of Amphibole Group Minerals

6.1 Introduction

Amphibole is a crucial institution of usually darkish-colored, inosilicate minerals, forming prism or needlelike crystals, composed of double chain SiO4 tetrahedra, connected at the vertices and normally containing ions of iron and/or magnesium in their systems. Amphiboles may be in- experienced, black, colorless, white, yellow, blue, or brown. The International Mineralogical association presently classifies amphiboles as a mineral supergroup, inside which might be busi- nesses and several subgroups.

6.2 Amphibole Origin and Occurrence

Exhibiting an extensive range of possible cation substitutions, amphiboles crystallize in both igneous and metamorphic rocks with a broad range of bulk chemical compositions. Because of their relative instability to chemical weathering at the Earth's surface, amphiboles make up only a minor constituent in most sedimentary rocks.

6.3 Amphibole Origin and Occurrence

Types of Amphiboles

7.1 Introduction

These are characterized by vesicular structure, amygdaloidal structure and Aphanitic structure if they are volcanic. If they are Hypabyssal or plutonic, they are dense, compact and exhibit interlocking texture.

7.2 Igneous Rocks

Terminology related for the description of igneous rocks

7.3 Texture

7.4 Structure

7.5 Colour

7.6 Minerals

7.7 Silica saturation

7.8 Depth of formation

- Colour:
- Grain:
- Texture or Structure:
- Mineral Present:

7.9 Inference:

- Essential Minerals :
- Accessories :
- Mode of Origin :

8. Identification of Sedimentary Rocks

8.1 Introduction

Occurrence of normal or cross bedding, cementing material, fossils, ripple marks, mud cracks, tracks and trails and peculiar forms such as modular, concretionary, Pisolitic, Oolitic, etc indicate that the rocks under study of sedimentary rocks. Details relevant for the study of sedimentary rocks

8.1.1 Bedding or Stratification

a) Different beds can be recognized based on colour, grain size, texture, hardness and other physical properties.
b) In case of cross bedding sets of layers will not be parallel but mutually inclined.

8.1.2 Cementing Material

Get complete discussion of Slider crank and Geneva Mechanism.

8.1.3 Fossils

May be plant (leaf) fossils or shells (complete or broken) - common in shales and lime stones.

8.1.4 Ripple Marks

8.2 Inference

I. Essential Minerals :
II. Accessories :
III. Mode of Origin:

9. Identification of Metamorphic Rocks

9.1. Introduction

Occurrence of alignment of minerals (lineation, foliation) and metamorphic minerals indicate the rocks under the study of metamorphic group in the lab. Details relevant for the study of metamorphic rocks

9.1.1 Foliation

It refers to the parallel alignment of platy or lamellar minerals in metamorphic rocks.

9.1.2. Lineation

It refers to the parallel alignment of prismatic or columnar minerals in metamorphic rocks.

9.1.3 Metamorphic minerals

Minerals like garnet, tale, chlorite, graphite are suggestive of metamorphic origin of a rock.

9.1.4 Gneissose structure

It is generally observed in granite gneisses where in alternating black (hornblende) and white (feldspars and quartz) colour bands appear.

9.1.5. Schistose structure

They have predominantly lamellar (mica, tale, chlorite) or prismatic (hornblende, Kyanite etc) minerals. These do not have any alternating colour bands.

a) Colour :
b) Grain :
c) Texture or Structure :
d) Mineral Present :

9.2 Inference:

a) Essential Minerals
b) Accessories
c) Mode of Origin

10. Topographical Features

10.1. Map I:

A Case of Horizontal beds.

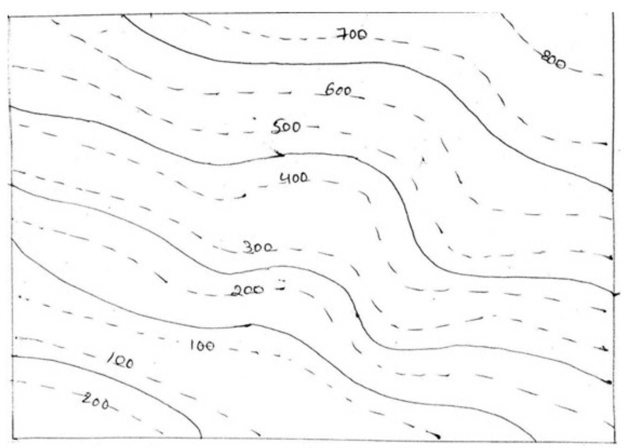
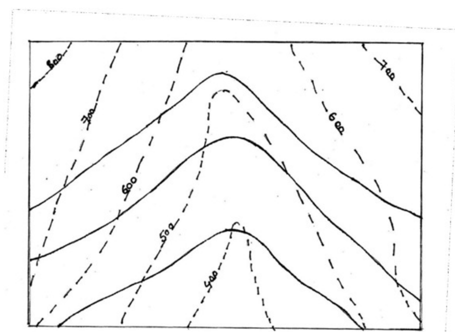


Figure 10.1. Horizontal Beds

10.2. Map II:



A Case of Vertical beds.

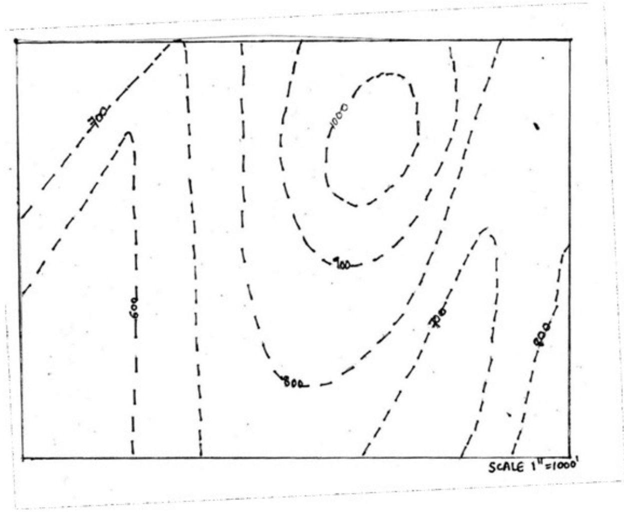


Figure 10.2. Vertical Beds

10.3. Map III:

A case of inclined beds

Figure 10.3 Vertical Beds

10.4. Map IV:

A case of faulted beds

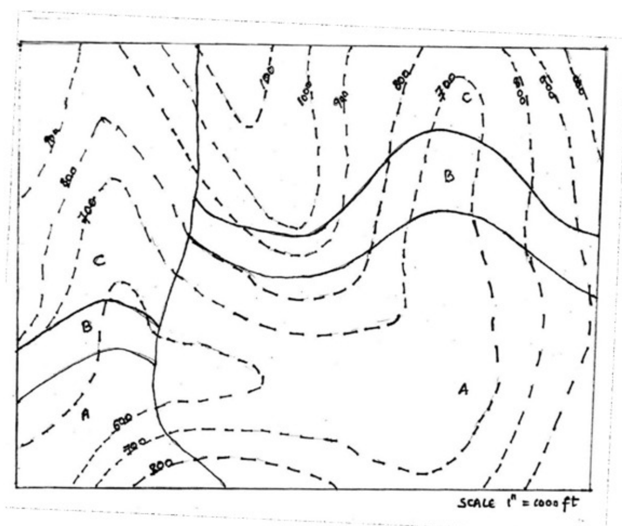


Figure 10.4 Faulted Beds

10.5. Map V:

A case of folded Beds

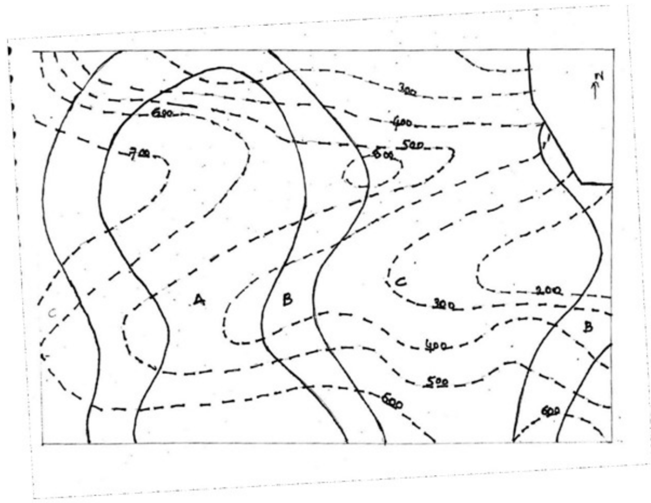


Figure 10.5 Folded Beds

11. Geological Problems (Interpretation of lithology and structure)

11.1Horizontal Beds

I. If the bedding planes and associating contours are mutually parallel it indicates beds are Horizontal.
II. Highest elevation is the youngest
III. Can't have Strike and Dip

11.2 Vertical Beds

If the bedding planes appear as straight lines and also cuts across the associating contours, it indicates beds are vertical.

a) Bedding plane itself is their strike direction
b) No dip direction but dip amount is 90

11.3 Inclined Beds

If the bedding planes are curved and cut across the associating contours, it indicates beds are inclined.
Choose any bedding plane which cuts across the same contour minimum at two places. Draw a line passing through. It gives the strike direction of beds.

Next check where the bedding planes cut next contour, draw a parallel line passing through this point.
If the bedding plane refers to A/B contact and contour passes at the intersection point (where bedding plane, strike line, contour line intersect) is 500 and is called A/B 500. Second value is either A/B 600 or A/B 400.

A short line perpendicular to the strike line in the decreasing side is the Dip direction.
i) Dip amount = (contour interval*60)/strike interval.
Since the arrow head of the dip direction points to successively younger Beds, Order of Superposition is known
Strike direction is expressed both with N or S, but dip direction is expressed only either N or
S. For example if N 10 E is dip direction, then strike direction is N 80 W or S 80 E

12.Geological Maps

12.1 Geological map

A map is described as representation of an area on a plain paper to a scale. The geological map is one which reveals the geological information in terms of topography, litho logy, and geological structure, order of superposition, thickness of beds and geological history of that region. A geological map is a contour map over which geological formations, structures etc are marked.

12.2 Civil Engineering Importance

For safe, stable, successful and economical Civil Engineering constructions such as dams, reser- voirs, tunnels, etc., detailed geological information is essential. Proper interpretation of a geo- logical map provides all details which a Civil Engineer requires. This study of geological maps is of great importance.

13. Interpretation

In a geological map, normally contours are marked as dotted lines with elevation value and bedding planes, fault planes etc are marked as continuous lines. The interpretation comprises of details of topography, lithology, structure and geological history.

13.1 Interpretation of Topography

From the study of contour the information noted is about

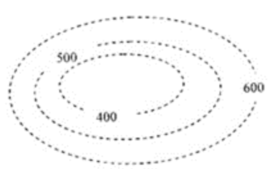
a) Maximum height, Minimum height, Surface relief
b) Number of Hills, Valleys, ridges, etc
c) Nature of slope, whether it is uniform or irregular and steep or gentle Relevant details 1. Area in the map indicated as below

14. Hills

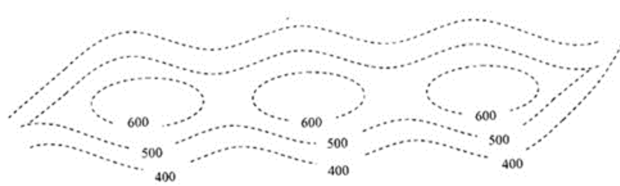
14.1 Hill ranges

Closed contour with contour values increasing inwards

Repeated appearance of the same in a row is Hill Range
Contours also indicate shape of Hills



Hill



Hill Range

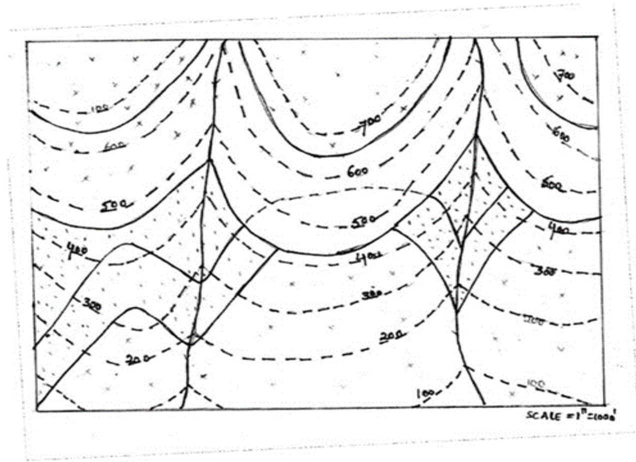


Figure 14.1 Hill Range

I. Maximum height is the elevation that is more than the highest contour marked in the map.
II. Minimum height is the elevation that is less than the lowest contour marked in the map.
III. Surface relief is the difference between the maximum height and the minimum height.

14.2 Valleys:

These are a series of V-shaped (sharply bent) contours with successively higher elevation towards the pointed ends (convex side) of the contours.

- The sharpness of bends indicates the stage of valley development
- Young valleys have sharply contours but mature valleys have bluntly curve contours

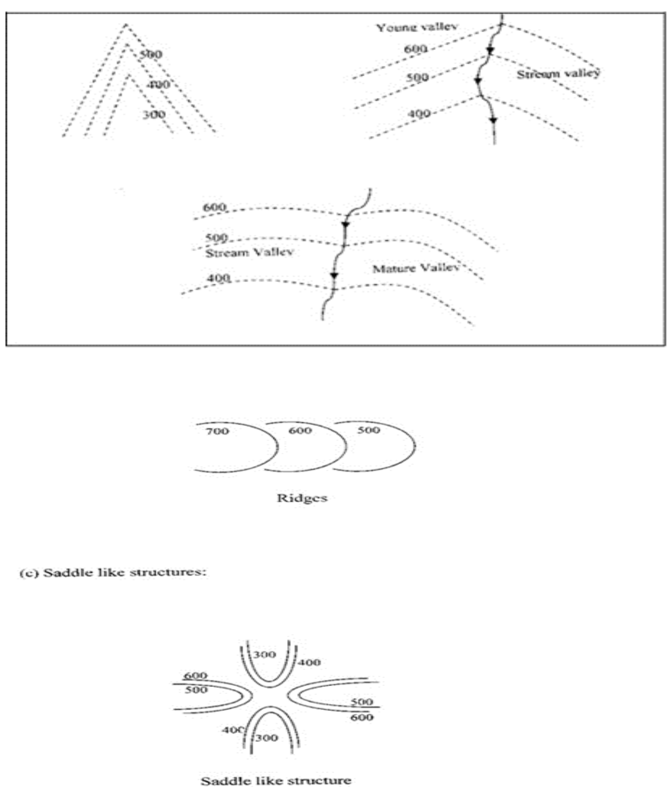


Figure 14.2 Hill Range

V. TEXT BOOK

1. Parbin Singh, “Engineering and General Geology, , S K Kataria & Sons, 8th edition, 2010.
2. 2. Text Book of Engineering Geology, N. ChennaKesavulu, Macmillan Publishers India, 2nd edition, 2009.

IV. WEB REFERENCES

1. https://www.youtube.com/results?search_query=engineering+geology+lab.
2. http://www.wctmgurgaon.com/pdf/EG%20Lab%20Manual.pdf 3. http://civil.gecgudlavalleru.ac.in/pdf/manuals/EngineeringGeologyLabManual.pdf

DATA STRUCTURES LABORATORY

<table>
<tr><td colspan="9">III Semester: Common for all branches</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">ACSC10</td><td rowspan="2">Core</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>1.5</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: Nil</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: 45</td><td colspan="3">Total Classes: 45</td></tr>
<tr><td colspan="9">Prerequisite: Programming for Problem Solving using C and Python Programming</td></tr>
</table>

I. COURSE OVERVIEW:

The course covers some of the general-purpose data structures and algorithms, and software development. Topics covered include managing complexity, analysis, static data structures, dynamic data structures and hashing mechanisms. The main objective of the course is to teach the students how to select and design data structures and algorithms that are appropriate for problems that they might encounter in real life. This course reaches to student by power point presentations, lecture notes, and lab which involve the problem solving in mathematical and engineering areas.

II. COURSES OBJECTIVES:

The students will try to learn

I. The skills needed to understand and analyze performance trade-offs of different algorithms / implementations and asymptotic analysis of their running time and memory usage.

II. The basic abstract data types (ADT) and associated algorithms: stacks, queues, lists, tree, graphs, hashing and sorting, selection and searching.

III. The fundamentals of how to store, retrieve, and process data efficiently.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO 1	Interpret the complexity of algorithm using the asymptotic notations.
CO 2	Select appropriate searching and sorting technique for a given problem.
CO 3	Construct programs on performing operations on linear and nonlinear data structures for organization of a data
CO 4	Make use of linear data structures and nonlinear data structures solving real time applications.
CO 5	Describe hashing techniques and collision resolution methods for efficiently accessing data with respect to performance.
CO 6	Compare various types of data structures; in terms of implementation, operations and performance.

IV. COURSE CONTENT:

EXERCISES FOR DATA STRUCTURES LABORATORY

Note: Students are encouraged to bring their own laptops for laboratory practice sessions.

1. Getting Started Exercises

1.1 Implicit Recursion

A specific type of recursion called **implicit recursion** occurs when a function calls itself without making an explicit recursive call. This can occur when a function calls another function, which then calls the original code once again and starts a recursive execution of the original function.

Using implicit recursion find the second-largest elements from the array.

In this case, the **find_second_largest** method calls the **find_largest()** function via implicit recursion to locate the second-largest number in a provided list of numbers. Implicit recursion can be used in this way to get the second-largest integer without having to write any more code

Input: nums = [1, 2, 3, 4, 5]

Output: 4

```
def find_largest(numbers):
     # Write code here
     …

def find_second_largest(numbers):
    # Write code here
     …

# Driver code
numbers = [1, 2, 3, 4, 5]

# Function call
second_largest = find_second_largest(numbers)
print(second_largest)
```

1.2 Towers of Hanoi

Tower of Hanoi is a mathematical puzzle where we have three rods (A, B, and C) and N disks. Initially, all the disks are stacked in decreasing value of diameter i.e., the smallest disk is placed on the top and they are on rod A. The objective of the puzzle is to move the entire stack to another rod (here considered C), obeying the following simple rules:

- Only one disk can be moved at a time.
- Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack i.e. a disk can only be moved if it is the uppermost disk on a stack.
- No disk may be placed on top of a smaller disk.

Input: 2

Output: Disk 1 moved from A to B

Disk 2 moved from A to C
Disk 1 moved from B to C

Input: 3

Output: Disk 1 moved from A to C

Disk 2 moved from A to B
Disk 1 moved from C to B

Disk 3 moved from A to C

Disk 1 moved from B to A

Disk 2 moved from B to C

Disk 1 moved from A to C

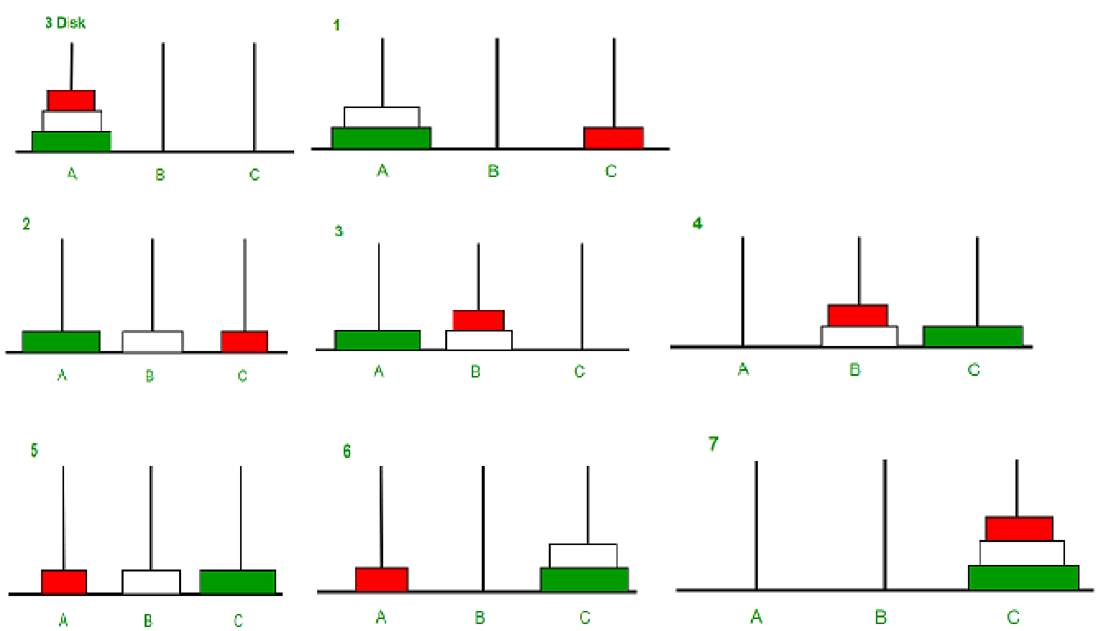
Tower of Hanoi using Recursion:

The idea is to use the helper node to reach the destination using recursion. Below is the pattern for this problem:

- Shift 'N-1' disks from 'A' to 'B', using C.
- Shift last disk from 'A' to 'C'.
- Shift 'N-1' disks from 'B' to 'C', using A.

Follow the steps below to solve the problem:

- Create a function towerOfHanoi where pass the N (current number of disk), from_rod, to_rod, aux_rod.
- Make a function call for N – 1 th disk.
- Then print the current the disk along with from_rod and to_rod
- Again make a function call for N – 1 th disk.




```
# Recursive Python function to solve Tower of Hanoi
def TowerOfHanoi(n, from_rod, to_rod, aux_rod):
    if n == 0:
        return
    # Write code here
```

```
    …

# Driver code
N = 3

# A, C, B are the name of rods
TowerOfHanoi(N, 'A', 'C', 'B')
```

1.3 Recursively Remove all Adjacent Duplicates

Given a string, recursively remove adjacent duplicate characters from the string. The output string should not have any adjacent duplicates.

Input: s = "azxxzy"

Output: "ay"

Explanation:

- First "azxxzy" is reduced to "azzy".
- The string "azzy" contains duplicates
- So it is further reduced to "ay"

Input: "caaabbbaacdddd"

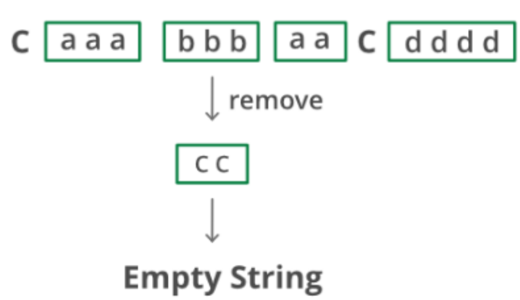
Output: Empty String

Input: "acaaabbbacdddd"

Output: "acac"

Procedure to remove duplicates:

- Start from the leftmost character and remove duplicates at left corner if there are any.
- The first character must be different from its adjacent now. Recur for string of length n-1 (string without first character).
- Let the string obtained after reducing right substring of length n-1 be rem_str. There are three possible cases
  - ➢ If first character of rem_str matches with the first character of original string, remove the first character from rem_str.
  - ➢ If remaining string becomes empty and last removed character is same as first character of original string. Return empty string.
  - ➢ Else, append the first character of the original string at the beginning of rem_str.
- Return rem_str.



```
# Program to remove all adjacent duplicates from a string

# Recursively removes adjacent duplicates from str and returns
# new string. last_removed is a pointer to last_removed character

def removeUtil(string, last_removed):

      # Write code here
        …
def remove(string):
    # Write code here
    …
# Utility functions
def toList(string):
    x = []
    for i in string:
        x.append(i)
    return x

def toString(x):
    return ''.join(x)

# Driver program
string1 = "azxxxzy"
print remove(string1)

string2 = "caaabbbaac"
print remove(string2)

string3 = "gghhg"
print remove(string3)

string4 = "aaaacddddcappp"
print remove(string4)

string5 = "aaaaaaaaaa"
print remove(string5)
```

1.4 Product of Two Numbers using Recursion

Given two numbers x and y find the product using recursion.

Input: x = 5, y = 2

Output: 10

Input: x = 100, y = 5

Output: 500

Procedure

1. If x is less than y, swap the two variables value
2. Recursively find y times the sum of x
3. If any of them become zero, return 0

```
# Find Product of two Numbers using Recursion

# recursive function to calculate multiplication of two numbers
def product( x , y ):
    # Write code here
    …
# Driver code
x = 5
y = 2
print( product(x, y))
```

1.5 Binary to Gray Code using Recursion

Given the Binary code of a number as a decimal number, we need to convert this into its equivalent Gray Code. Assume that the binary number is in the range of integers. For the larger value, we can take a binary number as string.

In gray code, only one bit is changed in 2 consecutive numbers.

Input: 1001

Output: 1101

Explanation: 1001 -> 1101 -> 1101 -> 1101

Input: 11

Output: 10

Explanation: 11 -> 10

Procedure:

The idea is to check whether the last bit and second last bit are same or not, if it is same then move ahead otherwise add 1.

Follow the steps to solve the given problem:

binary_to_grey(n)
if n == 0
    grey = 0;
else if last two bits are opposite to each other
    grey = 1 + 10 * binary_to_gray(n/10))
else if last two bits are same
    grey = 10 * binary_to_gray(n/10))

```
# Convert Binary to Gray code using recursion
# Function to change Binary to Gray using recursion
def binary_to_gray(n):
    # write code here
    …
# Driver Code
binary_number = 1011101
print(binary_to_gray(binary_number), end='')
```

1.6 Count Set-bits of a number using Recursion

Given a number N. The task is to find the number of set bits in its binary representation using recursion.

Input: 21

Output: 3

Explanation: 21 represented as 10101 in binary representation

Input: 16

Output: 1

Explanation: 16 represented as 10000 in binary representation

Procedure:

1. First, check the LSB of the number.
2. If the LSB is 1, then we add 1 to our answer and divide the number by 2.
3. If the LSB is 0, we add 0 to our answer and divide the number by 2.
4. Then we recursively follow step 1 until the number is greater than 0.

```
# Find number of set bits in a number
# Recursive function to find number of set bits in a number
def CountSetBits(n):
    # write code here
    …
# Driver code
n = 21;
# Function call
print(CountSetBits(n));
```

1.7 Fibonacci Series in Reverse Order using Recursion

Given an integer N, the task is to print the first N terms of the Fibonacci series in reverse order using Recursion.

Input: N = 5

Output: 3 2 1 1 0

Explanation: First five terms are – 0 1 1 2 3

Input: N = 10

Output: 34 21 13 8 5 3 2 1 1 0

The idea is to use recursion in a way that keeps calling the same function again till N is greater than 0 and keeps on adding the terms and after that starts printing the terms.

Follow the steps below to solve the problem:

1. Define a function fibo (int N, int a, int b) where
    i. N is the number of terms and
    ii. a and b are the initial terms with values 0 and 1.
2. If N is greater than 0, then call the function again with values N-1, b, a+b.
3. After the function call, print a as the answer.

```
# Function to print the Fibonacci series in reverse order.
def fibo(n, a, b):
    # write code here
    …
# Driver Code
N = 10
fibo(N, 0, 1)
```

1.8 Length of Longest Palindromic Sub-string using Recursion

Given a string S, the task is to find the length longest sub-string which is a palindrome.

Input: S = “aaaabbaa”

Output: 6

Explanation: Sub-string “aabbaa” is the longest palindromic sub-string.

Input: S = “banana”

Output: 5

Explanation: Sub-string “anana” is the longest palindromic sub-string.

The idea is to use recursion to break the problem into smaller sub-problems. In order to break the problem into two smaller sub-problems, compare the start and end characters of the string and recursively call the function for the middle substring.

```
# Find the length of longest palindromic sub-string using Recursion
# Function to find maximum of the two variables
def maxi(x, y):
    if x > y:
        return x
    else:
        return y
 # Function to find the longest palindromic substring: Recursion
def longestPalindromic(strn, i, j, count):
    # write code here
    …
# Function to find the longest palindromic sub-string
def longest_palindromic_substr(strn):
    # write code here
    …
strn = "aaaabbaa"
# Function Call
print(longest_palindromic_substr(strn))
```

1.9 Find the Value of a Number Raised to its Reverse

Given a number N and its reverse R. The task is to find the number obtained when the number is raised to the power of its own reverse

Input : N = 2, R = 2

Output: 4

Explanation: Number 2 raised to the power of its reverse 2 gives 4 which gives 4 as a result after performing modulo 10^9+7

Input: N = 57, R = 75

Output: 262042770

Explanation: 57^{75} modulo 10^9+7 gives us the result as 262042770

```
# Function to return ans with modulo
def PowerOfNum(N, R):
    # write code here
     …
# Driver code
N = 57
R = 75
# Function call
print(int(PowerOfNum(N, R)))
```

1.10 Mean of Array using Recursion

Find the mean of the elements of the array.

Mean = (Sum of elements of the Array) / (Total no of elements in Array)

Input: 1 2 3 4 5

Output: 3

Input: 1 2 3

Output: 2

To find the mean using recursion assume that the problem is already solved for N-1 i.e. you have to find for n

Sum of first N-1 elements = (Mean of N-1 elements) * (N-1)

Mean of N elements = (Sum of first N-1 elements + N-th elements) / (N)

```
# Program to find mean of array
# Function definition of findMean function
def findMean(A, N):
    # write code here
    …
```

```
# Driver Code
Mean = 0
A = [1, 2, 3, 4, 5]
N = len(A)
print(findMean(A, N))
```

Try:

1. Given two numbers **N** and **r**, find the value of $^{N}C_{r}$ using recursion.

$$C(n,r) = C(n-1,r-1) + C(n-1,r)$$

Input: N = 5, r = 2

Output: 10

Explanation: The value of 5C2 is 10

2. Predict the output of the following program. What does the following fun() do in general?

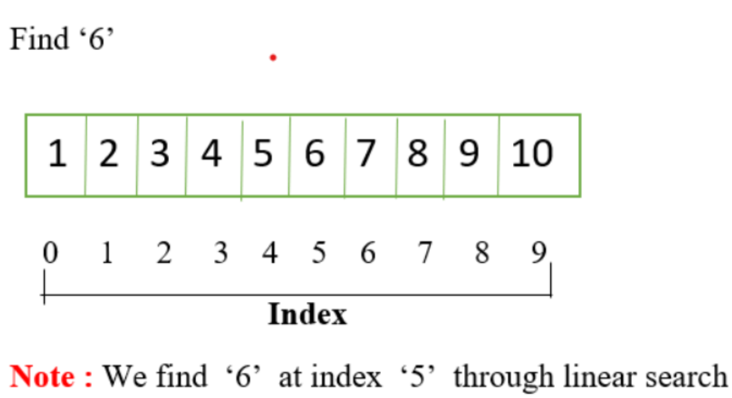
```
fp = 15
def fun(n):
    global fp
    if (n <= 2):
        fp = 1
        return 1

    t = fun(n - 1)
    f = t + fp
    fp = t
    return f

# Driver code
print(fun(5))
```

3. **Tail recursion:** Calculate factorial of a number using a Tail-Recursive function.

2. Searching

2.1 Linear / Sequential Search

Linear search is defined as the searching algorithm where the list or data set is traversed from one end to find the desired value. Given an array arr[] of n elements, write a recursive function to search a given element x in arr[].



Linear search procedure:

1. Start from the leftmost element of arr[] and one by one compare x with each element of arr[]

2. If x matches with an element, return the index.

3. If x doesn't match with any of the elements, return -1.

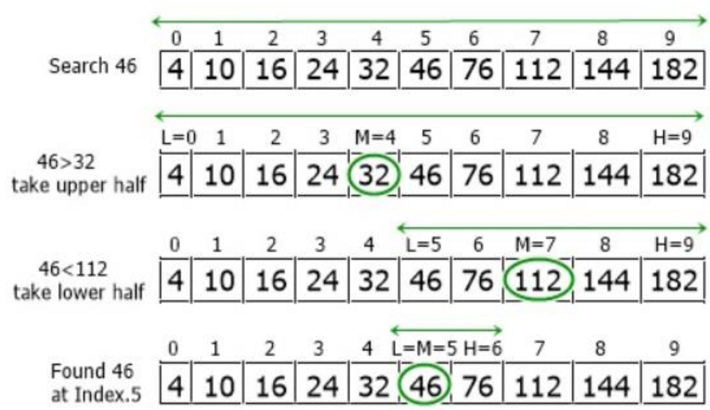
Input: arr[] = {10, 20, 80, 30, 60, 50, 110, 100, 130, 170}
x = 110;
Output: 6
Element x is present at index 6

Input: arr[] = {10, 20, 80, 30, 60, 50, 110, 100, 130, 170}
x = 175;
Output: -1
Element x is not present in arr[].

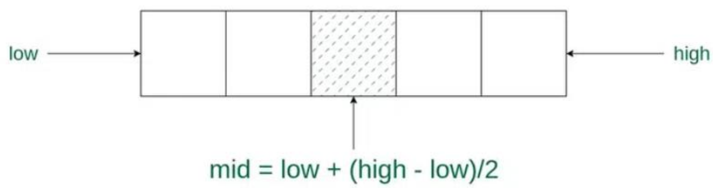
```
# Recursive linear search
def linear_search(arr, curr_index, key):
    # write code here
    …

# Driver code
arr = [10, 20, 80, 30, 60, 50, 110, 100, 130, 170]
x = 110
linear_search(arr, 0, x)
```

2.2 Binary Search

Binary Search is defined as a searching algorithm used in a sorted array by repeatedly dividing the search interval in half. The idea of binary search is to use the information that the array is sorted and reduce the time complexity to O(log N).



Conditions for Binary Search algorithm:
1. The data structure must be sorted.
2. Access to any element of the data structure takes constant time.



Binary Search Procedure:
1. Divide the search space into two halves by finding the middle index "mid".
2. Compare the middle element of the search space with the key.
3. If the key is found at middle element, the process is terminated.
4. If the key is not found at middle element, choose which half will be used as the next search space.
    a. If the key is smaller than the middle element, then the left side is used for next search.
    b. If the key is larger than the middle element, then the right side is used for next search.
5. This process is continued until the key is found or the total search space is exhausted.

Input: arr = [2, 5, 8, 12, 16, 23, 38, 56, 72, 91]
Output: target = 23
Element 23 is present at index 5

```
# Program for recursive binary search.

# Returns index of x in arr if present, else -1
def binarySearch(arr, l, r, x):
    # write code here
    …

# Driver Code
arr = [2, 3, 4, 10, 40]
x = 10
result = binarySearch(arr, 0, len(arr)-1, x)

if result != -1:
    print("Element is present at index", result)
else:
    print("Element is not present in array")
```

2.3 Uniform Binary Search

Uniform Binary Search is an optimization of Binary Search algorithm when many searches are made on same array or many arrays of same size. In normal binary search, we do arithmetic operations to find the mid points. Here we precompute mid points and fills them in lookup table. The array look-up generally works faster than arithmetic done (addition and shift) to find the mid-point.

Input: array = {1, 3, 5, 6, 7, 8, 9}, v=3
Output: Position of 3 in array = 2

Input: array = {1, 3, 5, 6, 7, 8, 9}, v=7
Output: Position of 7 in array = 5

The algorithm is very similar to Binary Search algorithm, the only difference is a lookup table is created for an array and the lookup table is used to modify the index of the pointer in the array which makes the search faster. Instead of maintaining lower and upper bound the algorithm maintains an index and the index is modified using the lookup table.

```
# Implementation of above approach

MAX_SIZE = 1000

# lookup table
lookup_table = [0] * MAX_SIZE

# create the lookup table for an array of length n
def create_table(n):
    # write code here
    …
# binary search

def binary(arr, v):
    # write code here
    …

# Driver code
arr = [1, 3, 5, 6, 7, 8, 9]
n = len(arr)

# create the lookup table
create_table(n)

# print the position of the array
print("Position of 3 in array = ", binary(arr, 3))
```

2.4 Interpolation Search

Interpolation search works better than Binary Search for a Sorted and Uniformly Distributed array. Binary search goes to the middle element to check irrespective of search-key. On the other hand, Interpolation search may go to different locations according to search-key. If the value of the search-key is close to the last element, Interpolation Search is likely to start search toward the end side. Interpolation search is more efficient than binary search when the elements in the list are uniformly distributed, while binary search is more efficient when the elements in the list are not uniformly distributed.

Interpolation search can take longer to implement than binary search, as it requires the use of additional calculations to estimate the position of the target element.

Input: arr = [1, 2, 3, 4, 5, 6, 7, 8, 9]
Output: target = 5

```
# Interpolation search
def interpolation_search(arr, target):
    # write code here
    …


# Driver code
arr = [1, 2, 3, 4, 5, 6, 7, 8, 9]
target = 5

index = interpolation_search(arr, target)
```

```python
if index == -1:
    print(f"{target} not found in the list")
else:
    print(f"{target} found at index {index}")
```

2.5 Fibonacci Search

Given a sorted array arr[] of size n and an element x to be searched in it. Return index of x if it is present in array else return -1.

Input: arr[] = {2, 3, 4, 10, 40}, x = 10
Output: 3
Element x is present at index 3.

Input: arr[] = {2, 3, 4, 10, 40}, x = 11
Output: -1
Element x is not present.

Fibonacci Search is a comparison-based technique that uses Fibonacci numbers to search an element in a sorted array.
Fibonacci Numbers are recursively defined as F(n) = F(n-1) + F(n-2), F(0) = 0, F(1) = 1. First few Fibonacci Numbers are 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, …

Fibonacci Search Procedure:

Let the searched element be x. The idea is to first find the smallest Fibonacci number that is greater than or equal to the length of the given array. Let the found Fibonacci number be fib (m'th Fibonacci number). We use (m-2)'th Fibonacci number as the index (If it is a valid index). Let (m-2)'th Fibonacci Number be i, we compare arr[i] with x, if x is same, we return i. Else if x is greater, we recur for subarray after i, else we recur for subarray before i.

Let arr[0..n-1] be the input array and the element to be searched be x.

1. Find the smallest Fibonacci number greater than or equal to n. Let this number be fibM [m'th Fibonacci number]. Let the two Fibonacci numbers preceding it be fibMm1 [(m-1)'th Fibonacci Number] and fibMm2 [(m-2)'th Fibonacci Number].

2. While the array has elements to be inspected:

   i. Compare x with the last element of the range covered by fibMm2

   ii. If x matches, return index

   iii. Else If x is less than the element, move the three Fibonacci variables two Fibonacci down, indicating elimination of approximately rear two-third of the remaining array.

   iv. Else x is greater than the element, move the three Fibonacci variables one Fibonacci down. Reset offset to index. Together these indicate the elimination of approximately front one-third of the remaining array.

3. Since there might be a single element remaining for comparison, check if fibMm1 is 1. If Yes, compare x with that remaining element. If match, return index.

```python
# Fibonacci search
from bisect import bisect_left

# Returns index of x if present, else returns -1

def fibMonaccianSearch(arr, x, n):
    # write code here
    …

# Driver Code
arr = [10, 22, 35, 40, 45, 50, 80, 82, 85, 90, 100,235]
n = len(arr)
x = 235
ind = fibMonaccianSearch(arr, x, n)
if ind>=0:
  print("Found at index:",ind)
else:
  print(x,"isn't present in the array");
```

3. Sorting

3.1 Bubble Sort

Bubble Sort is the simplest sorting algorithm that works by repeatedly swapping the adjacent elements if they are in the wrong order. This algorithm is not suitable for large data sets as its average and worst-case time complexity is quite high.

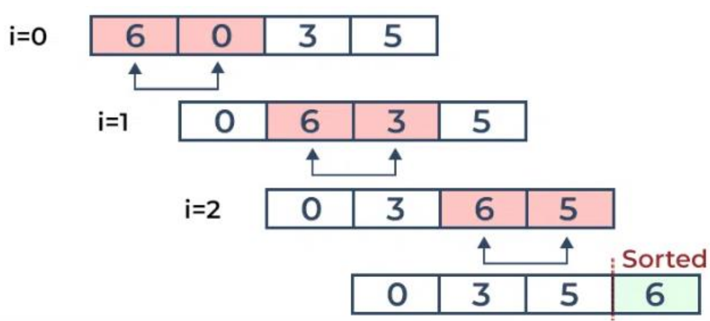
Bubble Sort Procedure:

1. Traverse from left and compare adjacent elements and the higher one is placed at right side.
2. In this way, the largest element is moved to the rightmost end at first.
3. This process is then continued to find the second largest and place it and so on until the data is sorted.

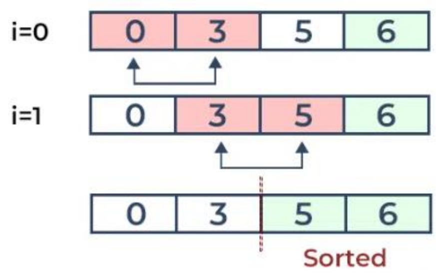
Input: arr = [6, 3, 0, 5]

Output:

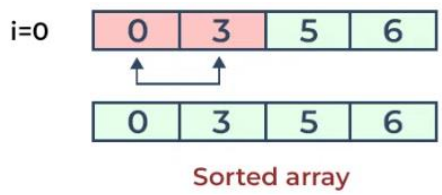
First Pass:



Second Pass:



Third Pass:




```
# Implementation of Bubble Sort

def bubbleSort(arr):
      # write code here
      …

# Driver code to test above
arr = [64, 34, 25, 12, 22, 11, 90]

bubbleSort(arr)

print("Sorted array:")
for i in range(len(arr)):
    print("%d" % arr[i], end=" ")
```

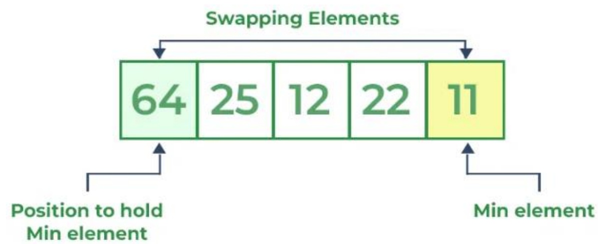
3.2 Selection Sort

Selection sort is a simple and efficient sorting algorithm that works by repeatedly selecting the smallest (or largest) element from the unsorted portion of the list and moving it to the sorted portion of the list. The algorithm repeatedly selects the smallest (or largest) element from the unsorted portion of the list and swaps it with the first element of the unsorted part. This process is repeated for the remaining unsorted portion until the entire list is sorted.

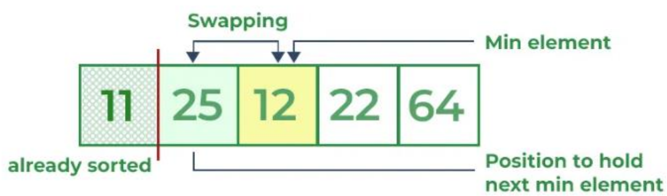
Input: arr = [64, 25, 12, 22, 11]

Output: arr = [11, 12, 22, 25, 64]

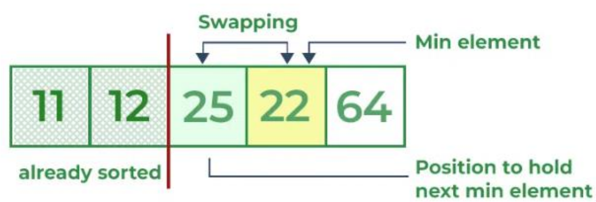
First Pass: For the first position in the sorted array, the whole array is traversed from index 0 to 4 sequentially. The first position where 64 is stored presently, after traversing whole array it is clear that 11 is the lowest value. Thus, replace 64 with 11. After one iteration 11, which happens to be the least value in the array, tends to appear in the first position of the sorted list.



Second Pass: For the second position, where 25 is present, again traverse the rest of the array in a sequential manner. After traversing, we found that 12 is the second lowest value in the array and it should appear at the second place in the array, thus swap these values.



Third Pass: Now, for third place, where 25 is present again traverse the rest of the array and find the third least value present in the array. While traversing, 22 came out to be the third least value and it should appear at the third place in the array, thus swap 22 with element present at third position.



Fourth Pass: Similarly, for fourth position traverse the rest of the array and find the fourth least element in the array. As 25 is the 4th lowest value hence, it will place at the fourth position.

Fifth Pass: At last the largest value present in the array automatically get placed at the last position in the array. The resulted array is the sorted array.


```
# Implementation of selection sort
import sys
A = [64, 25, 12, 22, 11]

# Traverse through all array elements
for i in range(len(A)):
```

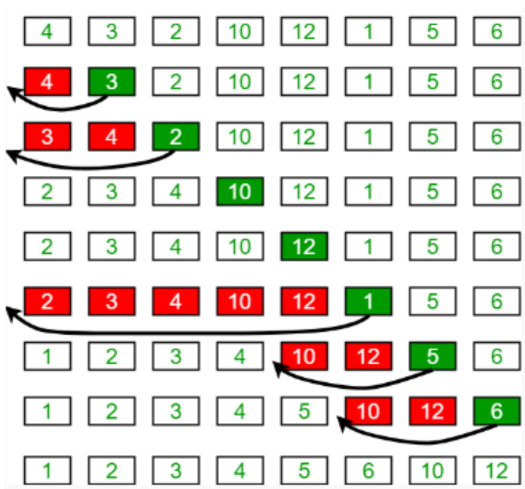
```
    # write code here
    …
# Driver code
print ("Sorted array")
for i in range(len(A)):
    print("%d" %A[i],end=" , ")
```

3.3 Insertion Sort

Insertion sort is a simple sorting algorithm that works similar to the way you sort playing cards in your hands. The array is virtually split into a sorted and an unsorted part. Values from the unsorted part are picked and placed at the correct position in the sorted part.

Insertion Sort Procedure:

1. To sort an array of size N in ascending order iterate over the array and compare the current element (key) to its predecessor, if the key element is smaller than its predecessor, compare it to the elements before.
2. Move the greater elements one position up to make space for the swapped element.



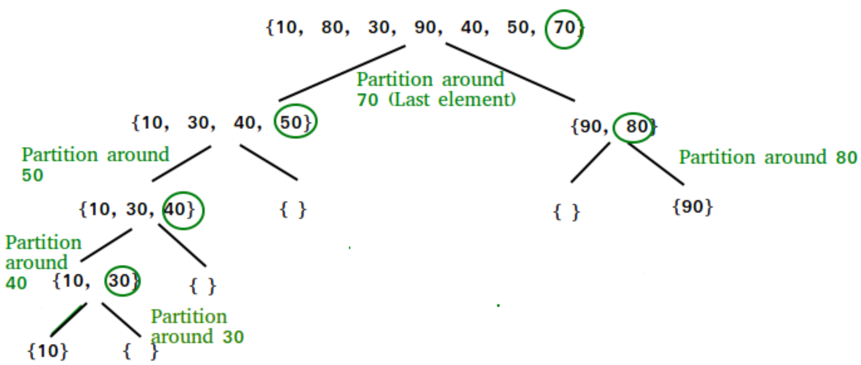
Input: arr = [4, 3, 2, 10, 12, 1, 5, 6]
Output: arr = [1, 2, 3, 4, 5, 6, 10, 12]

```
# Implementation of Insertion Sort

# Function to do insertion sort
def insertionSort(arr):
    # write code here
    …

# Driver code
arr = [12, 11, 13, 5, 6]
insertionSort(arr)
for i in range(len(arr)):
    print ("% d" % arr[i])
```

4. Divide and Conquer

4.1 Quick Sort

QuickSort is a sorting algorithm based on the Divide and Conquer algorithm that picks an element as a pivot and partitions the given array around the picked pivot by placing the pivot in its correct position in the sorted array. The key process in quickSort is a partition(). The target of partitions is to place the pivot (any element can be chosen to be a pivot) at its correct position in the sorted array and put all smaller elements to the left of the pivot, and all greater elements to the right of the pivot. Partition is done recursively on each side of the pivot after the pivot is placed in its correct position and this finally sorts the array.



The quick sort method can be summarized in three steps:
1. **Pick:** Select a pivot element.
2. **Divide:** Split the problem set, move smaller parts to the left of the pivot and larger items to the right.
3. **Repeat and combine:** Repeat the steps and combine the arrays that have previously been sorted.

Algorithm for Quick Sort Function:

```
//start –> Starting index,  end --> Ending index
Quicksort(array, start, end)
{
        if (start < end)
        {
                pIndex = Partition(A, start, end)
                Quicksort(A,start,pIndex-1)
                Quicksort(A,pIndex+1, end)
        }
}
```

Algorithm for Partition Function:

```
partition (array, start, end)
{
        // Setting rightmost Index as pivot
        pivot = arr[end];

        i = (start - 1)  // Index of smaller element and indicates the
            // right position of pivot found so far
        for (j = start; j <= end- 1; j++)
        {
                // If current element is smaller than the pivot
                if (arr[j] < pivot)
```

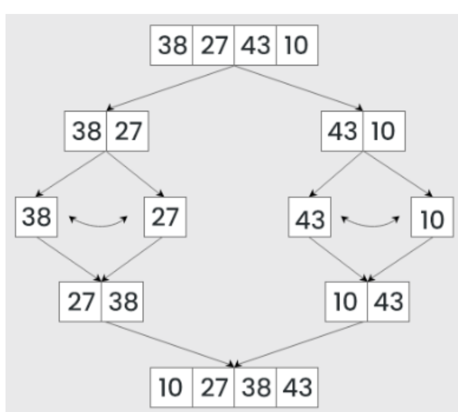
```
                {
                        i++;    // increment index of smaller element
                        swap arr[i] and arr[j]
                }
        }
        swap arr[i + 1] and arr[end])
        return (i + 1)
}
```

Input: arr = [10, 80, 30, 90, 40, 50, 70]
Output: arr = [10, 30, 40, 50, 70, 80, 90]

```python
# Implementation of QuickSort

# Function to find the partition position
def partition(array, low, high):
    # write code here
    …

# Function to perform quicksort
def quicksort(array, low, high):
    # write code here
    …

# Driver code
array = [10, 7, 8, 9, 1, 5]
N = len(array)

# Function call
quicksort(array, 0, N - 1)
print('Sorted array:')
for x in array:
    print(x, end=" ")
```

4.2 Merge Sort

Merge sort is defined as a sorting algorithm that works by dividing an array into smaller subarrays, sorting each subarray, and then merging the sorted subarrays back together to form the final sorted array. In simple terms, we can say that the process of merge sort is to divide the array into two halves, sort each half, and then merge the sorted halves back together. This process is repeated until the entire array is sorted.



Input: arr = [12, 11, 13, 5, 6, 7]
Output: arr = [5, 6, 7, 11, 12, 13]

```
# Implementation of MergeSort

def mergeSort(arr):
    # write code here
    …

# print the list
def printList(arr):
    for i in range(len(arr)):
        print(arr[i], end=" ")
    print()


# Driver Code
arr = [12, 11, 13, 5, 6, 7]
print("Given array is")
printList(arr)
mergeSort(arr)
print("\nSorted array is ")
printList(arr)
```

4.3 Heap Sort

Heap sort is a comparison-based sorting technique based on Binary Heap data structure. It is similar to the selection sort where we first find the minimum element and place the minimum element at the beginning. Repeat the same process for the remaining elements.

Heap Sort Procedure:

First convert the array into heap data structure using heapify, then one by one delete the root node of the Max-heap and replace it with the last node in the heap and then heapify the root of the heap. Repeat this process until size of heap is greater than 1.

- Build a heap from the given input array.
- Repeat the following steps until the heap contains only one element:
    - Swap the root element of the heap (which is the largest element) with the last element of the heap.
    - Remove the last element of the heap (which is now in the correct position).
    - Heapify the remaining elements of the heap.
    - The sorted array is obtained by reversing the order of the elements in the input array.

Input: arr = [12, 11, 13, 5, 6, 7]
Output: Sorted array is 5 6 7 11 12 13

```
# Implementation of heap Sort
# To heapify subtree rooted at index i.
# n is size of heap
```

```
 def heapify(arr, N, i):
    # write code here
    …

# The main function to sort an array of given size
def heapSort(arr):
    # write code here
    …

# Driver code
arr = [12, 11, 13, 5, 6, 7]

# Function call
heapSort(arr)
N = len(arr)
print("Sorted array is")
for i in range(N):
    print("%d" % arr[i], end=" ")
```

4.4 Radix Sort

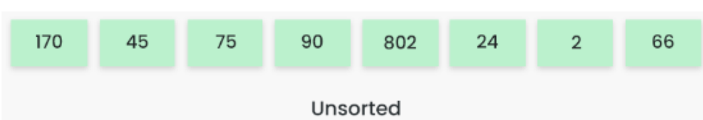
Radix Sort is a linear sorting algorithm that sorts elements by processing them digit by digit. It is an efficient sorting algorithm for integers or strings with fixed-size keys. Rather than comparing elements directly, Radix Sort distributes the elements into buckets based on each digit's value. By repeatedly sorting the elements by their significant digits, from the least significant to the most significant, Radix Sort achieves the final sorted order.

Radix Sort Procedure:

The key idea behind Radix Sort is to exploit the concept of place value.

1. It assumes that sorting numbers digit by digit will eventually result in a fully sorted list.
2. Radix Sort can be performed using different variations, such as Least Significant Digit (LSD) Radix Sort or Most Significant Digit (MSD) Radix Sort.

To perform radix sort on the array [170, 45, 75, 90, 802, 24, 2, 66], we follow these steps:



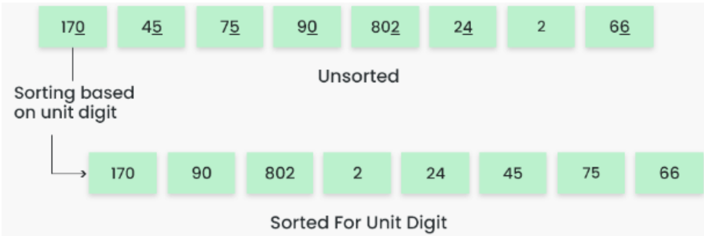
Step 1: Find the largest element in the array, which is 802. It has three digits, so we will iterate three times, once for each significant place.

Step 2: Sort the elements based on the unit place digits (X=0). We use a stable sorting technique, such as counting sort, to sort the digits at each significant place.

Sorting based on the unit place:

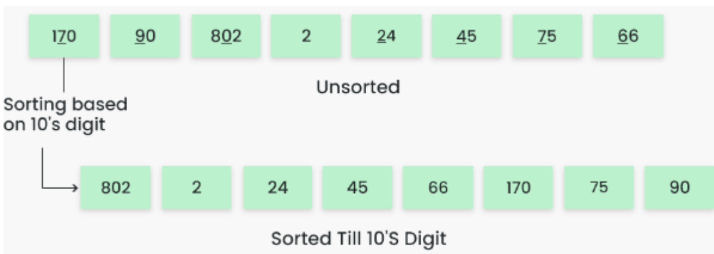
Perform counting sort on the array based on the unit place digits.

The sorted array based on the unit place is [170, 90, 802, 2, 24, 45, 75, 66]



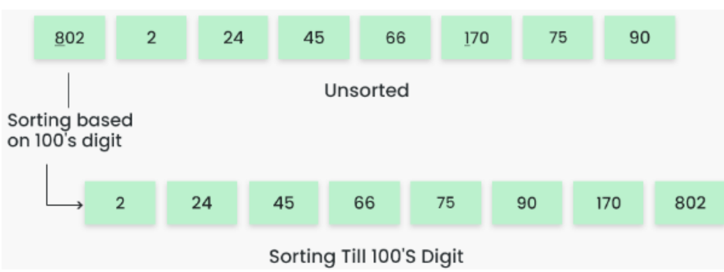
Step 3: Sort the elements based on the tens place digits.

Sorting based on the tens place:
Perform counting sort on the array based on the tens place digits.
The sorted array based on the tens place is [802, 2, 24, 45, 66, 170, 75, 90]



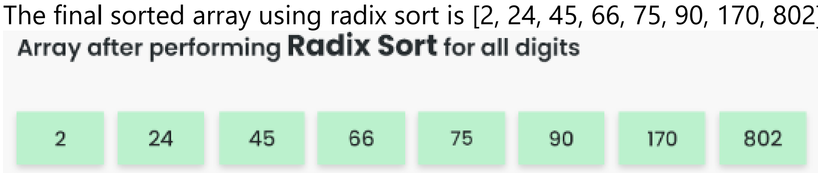
Step 4: Sort the elements based on the hundreds place digits.

Sorting based on the hundreds place:
Perform counting sort on the array based on the hundreds place digits.
The sorted array based on the hundreds place is [2, 24, 45, 66, 75, 90, 170, 802]



Step 5: The array is now sorted in ascending order.

The final sorted array using radix sort is [2, 24, 45, 66, 75, 90, 170, 802]




```
# Implementation of Radix Sort
# A function to do counting sort of arr[] according to the digit represented by exp.

def countingSort(arr, exp1):
    # write code here
    …
```

```
# Method to do Radix Sort
def radixSort(arr):
    # write code here
    …

# Driver code
arr = [170, 45, 75, 90, 802, 24, 2, 66]

# Function Call
radixSort(arr)

for i in range(len(arr)):
    print(arr[i],end=" ")
```

4.5 Shell Sort

Shell sort is mainly a variation of Insertion Sort. In insertion sort, we move elements only one position ahead. When an element has to be moved far ahead, many movements are involved. The idea of ShellSort is to allow the exchange of far items. In Shell sort, we make the array h-sorted for a large value of h. We keep reducing the value of h until it becomes 1. An array is said to be h-sorted if all sublists of every h'th element are sorted.

Shell Sort Procedure:

1. Initialize the value of gap size h
2. Divide the list into smaller sub-part. Each must have equal intervals to h
3. Sort these sub-lists using insertion sort
4. Repeat this step 1 until the list is sorted.
5. Print a sorted list.

```
Procedure Shell_Sort(Array, N)
  While Gap < Length(Array) /3 :
          Gap = ( Interval * 3 ) + 1
  End While Loop
  While Gap > 0 :
    For (Outer = Gap; Outer < Length(Array); Outer++):
       Insertion_Value = Array[Outer]
          Inner = Outer;
       While Inner > Gap-1 And Array[Inner – Gap] >= Insertion_Value:
          Array[Inner] = Array[Inner – Gap]
          Inner = Inner – Gap
        End While Loop
         Array[Inner] = Insertion_Value
    End For Loop
    Gap = (Gap -1) /3;
  End While Loop
End Shell_Sort
```

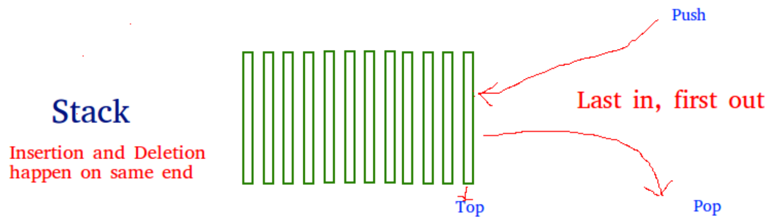
```
# Implementation of Shell Sort

def shellSort(arr, n):
    # write code here
    …

# Driver code
arr = [12, 34, 54, 2, 3]
```

```
print("input array:",arr)

shellSort(arr,len(arr))
print("sorted array",arr)
```

5. Stack

5.1 Stack implementation using List

A stack is a linear data structure that stores items in a Last-In/First-Out (LIFO) or First-In/Last-Out (FILO) manner. In stack, a new element is added at one end and an element is removed from that end only. The insert and delete operations are often called push and pop.



The functions associated with stack are:

- **empty()** – Returns whether the stack is empty
- **size()** – Returns the size of the stack
- **top() / peek()** – Returns a reference to the topmost element of the stack
- **push(a)** – Inserts the element ‘a’ at the top of the stack
- **pop()** – Deletes the topmost element of the stack

```
# Stack implementation using list
top=0
mymax=5
def createStack():
    stack=[]
    return stack
def isEmpty(stack):
    # write code here
    …
def Push(stack,item):
    # write code here
    …
def Pop(stack):
    # write code here
    …
# create a stack object
stack = createStack()
while True:
    print("1.Push")
```

```
    print("2.Pop")
    print("3.Display")
    print("4.Quit")
    # write code here
    …
```

5.2 Balanced Parenthesis Checking

Given an expression string, write a python program to find whether a given string has balanced parentheses or not.

Input: {[]{()}}

Output: Balanced

Input: [{}{}(]

Output: Unbalanced

Using stack One approach to check balanced parentheses is to use stack. Each time, when an open parentheses is encountered push it in the stack, and when closed parenthesis is encountered, match it with the top of stack and pop it. If stack is empty at the end, return Balanced otherwise, Unbalanced.

```
# Check for balanced parentheses in an expression
open_list = ["[","{","("]
close_list = ["]","}",")"]

# Function to check parentheses
def check(myStr):
    # write code here
    …
```

5.3 Evaluation of Postfix Expression

Given a postfix expression, the task is to evaluate the postfix expression. Postfix expression: The expression of the form "a b operator" (ab+) i.e., when a pair of operands is followed by an operator.

Input: str = "2 3 1 * + 9 -"

Output: -4

Explanation: If the expression is converted into an infix expression, it will be 2 + (3 * 1) – 9 = 5 – 9 = -4.

Input: str = "100 200 + 2 / 5 * 7 +"

Output: 757

Procedure for evaluation postfix expression using stack:

- Create a stack to store operands (or values).
- Scan the given expression from left to right and do the following for every scanned element.
    - If the element is a number, push it into the stack.
    - If the element is an operator, pop operands for the operator from the stack. Evaluate the operator and push the result back to the stack.
- When the expression is ended, the number in the stack is the final answer.

```python
# Evaluate value of a postfix expression

# Class to convert the expression
class Evaluate:

    # Constructor to initialize the class variables
    def __init__(self, capacity):
        self.top = -1
        self.capacity = capacity

        # This array is used a stack
        self.array = []

    # Check if the stack is empty
    def isEmpty(self):
        # write code here
        …
    def peek(self):
        # write code here
        …
    def pop(self):
        # write code here
        …
    def push(self, op):
        # write code here
        …
    def evaluatePostfix(self, exp):
        # write code here
        …
# Driver code
exp = "231*+9-"
obj = Evaluate(len(exp))

# Function call
print("postfix evaluation: %d" % (obj.evaluatePostfix(exp)))
```

5.4 Infix to Postfix Expression Conversion

For a given Infix expression, convert it into Postfix form.
Infix expression: The expression of the form "a operator b" (a + b) i.e., when an operator is in-between every pair of operands.
Postfix expression: The expression of the form "a b operator" (ab+) i.e., When every pair of operands is followed by an operator.

Infix to postfix expression conversion procedure:

1. Scan the infix expression from left to right.

2. If the scanned character is an operand, put it in the postfix expression.

3. Otherwise, do the following

- If the precedence and associativity of the scanned operator are greater than the precedence and associativity of the operator in the stack [or the stack is empty or the stack contains a '('], then push it in the stack. ['^' operator is right associative and other operators like '+','–','*' and '/' are left-associative].
- Check especially for a condition when the operator at the top of the stack and the scanned operator both are '^'. In this condition, the precedence of the scanned operator is higher due to its right associativity. So it will be pushed into the operator stack.
- In all the other cases when the top of the operator stack is the same as the scanned operator, then pop the operator from the stack because of left associativity due to which the scanned operator has less precedence.
- Else, Pop all the operators from the stack which are greater than or equal to in precedence than that of the scanned operator.
- After doing that Push the scanned operator to the stack. (If you encounter parenthesis while popping then stop there and push the scanned operator in the stack.)

4. If the scanned character is a '(', push it to the stack.
5. If the scanned character is a ')', pop the stack and output it until a '(' is encountered, and discard both the parenthesis.
6. Repeat steps 2-5 until the infix expression is scanned.
7. Once the scanning is over, Pop the stack and add the operators in the postfix expression until it is not empty.
8. Finally, print the postfix expression.

Input: A + B * C + D
Output: A B C * + D +

Input: ((A + B) – C * (D / E)) + F
Output: A B + C D E / * - F +

```
# Convert infix expression to postfix
# Class to convert the expression

class Conversion:

    # Constructor to initialize the class variables
    def __init__(self, capacity):
        self.top = -1
        self.capacity = capacity

        # This array is used a stack
        self.array = []
```

```
        # Precedence setting
        self.output = []
        self.precedence = {'+': 1, '-': 1, '*': 2, '/': 2, '^': 3}

    # Check if the stack is empty
    def isEmpty(self):
        # write code here

        …

    # Return the value of the top of the stack
    def peek(self):
        # write code here

        …

    # Pop the element from the stack
    def pop(self):
        # write code here

        …

    # Push the element to the stack
    def push(self, op):
        # write code here

        …

    # A utility function to check is the given character is operand
    def isOperand(self, ch):
        # write code here

        …

    # Check if the precedence of operator is strictly less than top of stack or not
    def notGreater(self, i):
        # write code here

        …

    # The main function that converts given infix expression
    # to postfix expression
    def infixToPostfix(self, exp):
       # write code here

        …

# Driver code
exp = "a+b*(c^d-e)^(f+g*h)-i"
obj = Conversion(len(exp))

# Function call
obj.infixToPostfix(exp)
```

5.5 Reverse a Stack

The stack is a linear data structure which works on the LIFO concept. LIFO stands for last in first out. In the stack, the insertion and deletion are possible at one end the end is called the top of the stack. Define two recursive functions BottomInsertion() and Reverse() to reverse a stack using Python. Define some basic function of the stack like push(), pop(), show(), empty(), for basic operation like respectively append an item in stack, remove an item in stack, display the stack, check the given stack is empty or not.

BottomInsertion(): this method append element at the bottom of the stack and BottomInsertion accept two values as an argument first is stack and the second is elements, this is a recursive method.

Reverse(): the method is reverse elements of the stack, this method accept stack as an argument Reverse() is also a Recursive() function. Reverse() is invoked BottomInsertion() method for completing the reverse operation on the stack.

Input: Elements = [1, 2, 3, 4, 5]
Output: Original Stack
5
4
3
2
1
Stack after Reversing
1
2
3
4
5

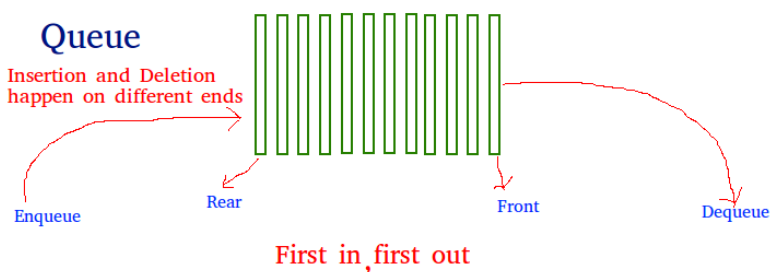
```
# create class for stack
class Stack:

    # create empty list
    def __init__(self):
        self.Elements = []

    # push() for insert an element
    def push(self, value):
        self.Elements.append(value)

    # pop() for remove an element
    def pop(self):
        return self.Elements.pop()

    # empty() check the stack is empty of not
    def empty(self):
        return self.Elements == []

    # show() display stack
    def show(self):
        for value in reversed(self.Elements):
            print(value)
 # Insert_Bottom() insert value at bottom
def BottomInsert(s, value):
   # write code here
```

```
    …
# Reverse() reverse the stack
def Reverse(s):
    # write code here
    …
# create object of stack class
stk = Stack()

stk.push(1)
stk.push(2)
stk.push(3)
stk.push(4)
stk.push(5)

print("Original Stack")
stk.show()

print("\nStack after Reversing")
Reverse(stk)
stk.show()
```

6. Queue

6.1 Linear Queue

Linear queue is a linear data structure that stores items in First in First out (FIFO) manner. With a queue the least recently added item is removed first. A good example of queue is any queue of consumers for a resource where the consumer that came first is served first.




```
# Static implementation of linear queue
front=0
rear=0
mymax=5
def createQueue():
    queue=[]   #empty list
    return queue
def isEmpty(queue):
    # write code here
    …
def enqueue(queue,item):  # insert an element into the queue
```

```
    # write code here
    …
def dequeue(queue):  #remove an element from the queue
    # write code here
    …
# Driver code
queue = createQueue()
while True:
    print("1.Enqueue")
    print("2.Dequeue")
    print("3.Display")
    print("4.Quit")
    # write code here
    …
```

6.2 Stack using Queues

Implement a last-in-first-out (LIFO) stack using only two queues. The implemented stack should support all the functions of a normal stack (push, top, pop, and empty).

- void push(int x) Pushes element x to the top of the stack.
- int pop() Removes the element on the top of the stack and returns it.
- int top() Returns the element on the top of the stack.
- boolean empty() Returns true if the stack is empty, false otherwise.

Input:

["MyStack", "push", "push", "top", "pop", "empty"]

[[], [1], [2], [], [], []]

Output:

[null, null, null, 2, 2, false]

```
class MyStack:

    def __init__(self):
       # write code here
       …
    def push(self, x: int) -> None:
       # write code here
       …
    def pop(self) -> int:
       # write code here
       …
    def top(self) -> int:
       # write code here
       …
```

```
    def empty(self) -> bool:
       # write code here
       …
# Your MyStack object will be instantiated and called as such:
# obj = MyStack()
# obj.push(x)
# param_2 = obj.pop()
# param_3 = obj.top()
# param_4 = obj.empty()
```

6.3 Queue using Stacks

Implement a first in first out (FIFO) queue using only two stacks. The implemented queue should support all the functions of a normal queue (push, peek, pop, and empty).

- void push(int x) Pushes element x to the back of the queue.
- int pop() Removes the element from the front of the queue and returns it.
- int peek() Returns the element at the front of the queue.
- boolean empty() Returns true if the queue is empty, false otherwise.

Input:

["MyQueue", "push", "push", "peek", "pop", "empty"]

[[], [1], [2], [], [], []]

Output:

[null, null, null, 1, 1, false]

```
class MyQueue:

    def __init__(self):
       # write code here
       …
    def push(self, x: int) -> None:
       # write code here
       …
    def pop(self) -> int:
       # write code here
       …
    def peek(self) -> int:
       # write code here
       …
    def empty(self) -> bool:
       # write code here
       …
# Your MyQueue object will be instantiated and called as such:
# obj = MyQueue()
# obj.push(x)
```

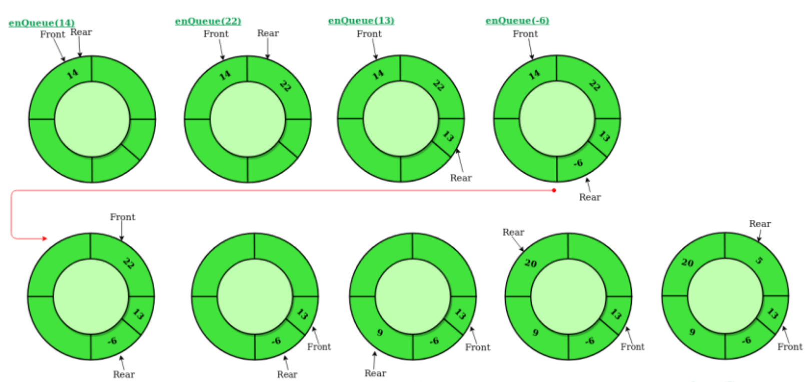
```
# param_2 = obj.pop()
# param_3 = obj.peek()
# param_4 = obj.empty()
```

6.4 Circular Queue

A Circular Queue is an extended version of a normal queue where the last element of the queue is connected to the first element of the queue forming a circle. The operations are performed based on FIFO (First In First Out) principle. It is also called 'Ring Buffer'.

Operations on Circular Queue:

- **Front:** Get the front item from the queue.
- **Rear:** Get the last item from the queue.
- **enQueue(value)** This function is used to insert an element into the circular queue. In a circular queue, the new element is always inserted at the rear position.
    - Check whether the queue is full – [i.e., the rear end is in just before the front end in a circular manner].
    - If it is full then display Queue is full.
        - If the queue is not full then, insert an element at the end of the queue.
- **deQueue()** This function is used to delete an element from the circular queue. In a circular queue, the element is always deleted from the front position.
    - Check whether the queue is Empty.
    - If it is empty then display Queue is empty.
        - If the queue is not empty, then get the last element and remove it from the queue.



Implement Circular Queue using Array:

1. Initialize an array queue of size **n**, where n is the maximum number of elements that the queue can hold.
2. Initialize two variables front and rear to -1.
3. **Enqueue:** To enqueue an element **x** into the queue, do the following:

- Increment rear by 1.
- If **rear** is equal to n, set **rear** to 0.
- If **front** is -1, set **front** to 0.
- Set queue[rear] to x.

4. **Dequeue:** To dequeue an element from the queue, do the following:
    - Check if the queue is empty by checking if **front** is -1.
    - If it is, return an error message indicating that the queue is empty.
    - Set **x** to queue [front].
    - If **front** is equal to **rear**, set **front** and **rear** to -1.
    - Otherwise, increment **front** by 1 and if **front** is equal to n, set **front** to 0.
    - Return x.

```
class CircularQueue():

    # constructor
    def __init__(self, size): # initializing the class
        self.size = size

        # initializing queue with none
        self.queue = [None for i in range(size)]
        self.front = self.rear = -1

    def enqueue(self, data):
         # Write code here
          …
                 def dequeue(self):
         # Write code here
          …

    def display(self):
       # Write code here
        …
# Driver Code
ob = CircularQueue(5)
ob.enqueue(14)
ob.enqueue(22)
ob.enqueue(13)
ob.enqueue(-6)
ob.display()
print ("Deleted value = ", ob.dequeue())
print ("Deleted value = ", ob.dequeue())
ob.display()
ob.enqueue(9)
ob.enqueue(20)
ob.enqueue(5)
ob.display()
```

6.5 Deque (Doubly Ended Queue)

In a Deque (Doubly Ended Queue), one can perform insert (append) and delete (pop) operations from both the ends of the container. There are two types of Deque:

1. **Input Restricted Deque:** Input is limited at one end while deletion is permitted at both ends.
2. **Output Restricted Deque:** Output is limited at one end but insertion is permitted at both ends.

Operations on Deque:

1. **append():** This function is used to insert the value in its argument to the right end of the deque.
2. **appendleft():** This function is used to insert the value in its argument to the left end of the deque.
3. **pop():** This function is used to delete an argument from the right end of the deque.
4. **popleft():** This function is used to delete an argument from the left end of the deque.
5. **index(ele, beg, end):** This function returns the first index of the value mentioned in arguments, starting searching from beg till end index.
6. **insert(i, a):** This function inserts the value mentioned in arguments(a) at index(i) specified in arguments.
7. **remove():** This function removes the first occurrence of the value mentioned in arguments.
8. **count():** This function counts the number of occurrences of value mentioned in arguments.
9. **len(dequeue):** Return the current size of the dequeue.
10. **Deque[0]:** We can access the front element of the deque using indexing with de[0].
11. **Deque[-1]:** We can access the back element of the deque using indexing with de[-1].
12. **extend(iterable):** This function is used to add multiple values at the right end of the deque. The argument passed is iterable.
13. **extendleft(iterable):** This function is used to add multiple values at the left end of the deque. The argument passed is iterable. Order is reversed as a result of left appends.
14. **reverse():** This function is used to reverse the order of deque elements.
15. **rotate():** This function rotates the deque by the number specified in arguments. If the number specified is negative, rotation occurs to the left. Else rotation is to right.

```
# importing "collections" for deque operations
import collections

# initializing deque
de = collections.deque([1, 2, 3])
print("deque: ", de)

# using append() to insert 4 at the end of deque
# Write code here

# Printing modified deque
# Write code here

# using appendleft() to insert 6 at the beginning of deque
# Write code here
```

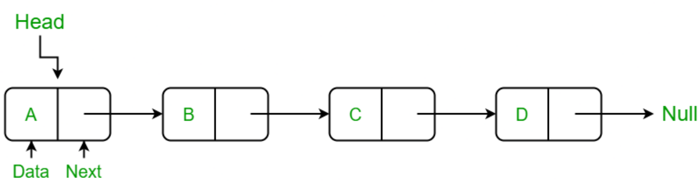
```
# Printing modified deque
# Write code here

# using pop() to delete 4 from the right end of deque
# Write code here

# Printing modified deque
# Write code here

# using popleft() to delete 6 from the left end of deque
# Write code here

# Printing modified deque
# Write code here

# using insert() to insert the value 3 at 5th position
# Write code here

# printing modified deque
# Write code here

# using count() to count the occurrences of 3
# Write code here

# using remove() to remove the first occurrence of 3
# Write code here

# Printing modified deque
# Write code here

# Printing current size of deque
# Write code here

# using pop() to delete 6 from the right end of deque
# Write code here

# Printing modified deque
# Write code here

# Printing current size of deque
# Write code here

# Accessing the front element of the deque
# Write code here

# Accessing the back element of the deque
# Write code here

# using extend() to add 4,5,6 to right end
# Write code here
```

```
# Printing modified deque
# Write code here

# using extendleft() to add 7,8,9 to left end
# Write code here

# Printing modified deque
# Write code here

# using rotate() to rotate the deque rotates by 3 to left
# Write code here

# Printing modified deque
# Write code here

# using reverse() to reverse the deque
# Write code here

# Printing modified deque
# Write code here
```

7. Linked List

7.1 Singly Linked List

A singly linked list is a linear data structure in which the elements are not stored in contiguous memory locations and each element is connected only to its next element using a pointer.



Creating a linked list involves the following operations:

1. Creating a Node class:
2. Insertion at beginning:
3. Insertion at end
4. Insertion at middle
5. Update the node
6. Deletion at beginning
7. Deletion at end
8. Deletion at middle
9. Remove last node
10. Linked list traversal
11. Get length

```python
# Create a Node class to create a node
class Node:
    def __init__(self, data):
        self.data = data
        self.next = None

# Create a LinkedList class
class LinkedList:
    def __init__(self):
        self.head = None

    # Method to add a node at begin of LL
    def insertAtBegin(self, data):
        # Write code here
        …
    # Method to add a node at any index, Indexing starts from 0.
    def insertAtIndex(self, data, index):
        # Write code here
        …
     # Method to add a node at the end of LL
    def insertAtEnd(self, data):
        # Write code here
        …
     # Update node of a linked list at given position
    def updateNode(self, val, index):
        # Write code here
        …
    # Method to remove first node of linked list
    def remove_first_node(self):
        # Write code here
        …
    # Method to remove last node of linked list
    def remove_last_node(self):
       # Write code here
        …
    # Method to remove at given index
    def remove_at_index(self, index):
        # Write code here
        …
     # Method to remove a node from linked list
```

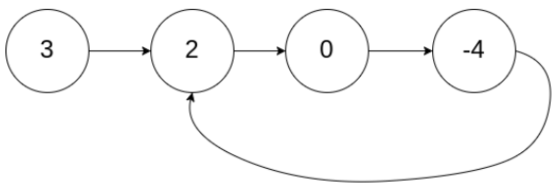
```
    def remove_node(self, data):
        # Write code here
        …
     # Print the size of linked list
    def sizeOfLL(self):
        # Write code here
        …
    # print method for the linked list
    def printLL(self):
        # Write code here
        …
# create a new linked list
llist = LinkedList()

# add nodes to the linked list
llist.insertAtEnd('a')
llist.insertAtEnd('b')
llist.insertAtBegin('c')
llist.insertAtEnd('d')
llist.insertAtIndex('g', 2)
# print the linked list
print("Node Data")
llist.printLL()
# remove a nodes from the linked list
print("\nRemove First Node")
llist.remove_first_node()
print("Remove Last Node")
llist.remove_last_node()
print("Remove Node at Index 1")
llist.remove_at_index(1)
# print the linked list again
print("\nLinked list after removing a node:")
llist.printLL()
print("\nUpdate node Value")
llist.updateNode('z', 0)
llist.printLL()
print("\nSize of linked list :", end=" ")
print(llist.sizeOfLL())
```

7.2 Linked List Cycle

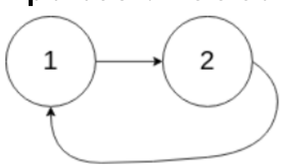
Given head, the head of a linked list, determine if the linked list has a cycle in it. There is a cycle in a linked list if there is some node in the list that can be reached again by continuously following the next pointer. Internally, pos is used to denote the index of the node that tail's next pointer is connected to.

Note that pos is not passed as a parameter.

Return true if there is a cycle in the linked list. Otherwise, return false.



Input: head = [3, 2, 0, -4], pos = 1
Output: true
Explanation: There is a cycle in the linked list, where the tail connects to the 1st node (0-indexed).



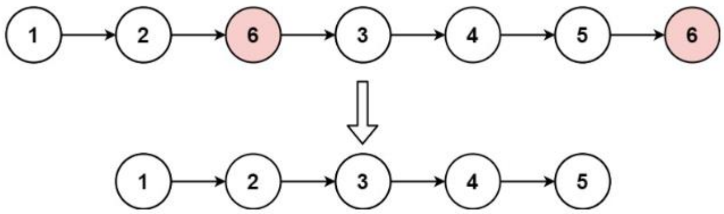
Input: head = [1, 2], pos = 0
Output: true
Explanation: There is a cycle in the linked list, where the tail connects to the 0th node.

Input: head = [1], pos = -1
Output: false
Explanation: There is no cycle in the linked list.

```
# Definition for singly-linked list.
class ListNode:
    def __init__(self, x):
        self.val = x
        self.next = None

class Solution:
    def hasCycle(self, head):
         # Write code here
         …
```

7.3 Remove Linked List Elements

Given the head of a linked list and an integer val, remove all the nodes of the linked list that has Node.val == val, and return the new head.



Input: head = [1, 2, 6, 3, 4, 5, 6], val = 6

Output: [1, 2, 3, 4, 5]

Input: head = [ ], val = 1

Output: [ ]

Input: head = [7, 7, 7, 7], val = 7

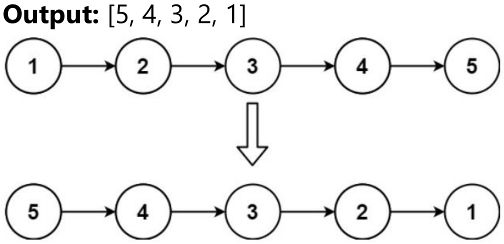
Output: [ ]

```
# Definition for singly-linked list.
class ListNode:
   def __init__(self, val=0, next=None):
       self.val = val
       self.next = next

class Solution:
    def removeElements(self, head, val):
        # Write code here
        …
```

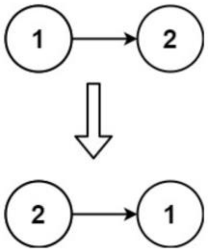
7.4 Reverse Linked List

Given the head of a singly linked list, reverse the list, and return the reversed list.

Input: head = [1, 2, 3, 4, 5]
Output: [5, 4, 3, 2, 1]



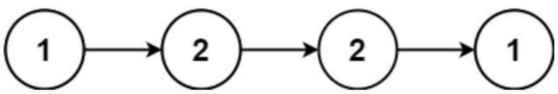
Input: head = [1, 2]
Output: [2, 1]




```python
# Definition for singly-linked list.
class ListNode:
   def __init__(self, val=0, next=None):
       self.val = val
       self.next = next

class Solution:
    def reverseList(self, head):
        # Write code here
         …
```

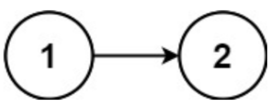
7.5 Palindrome Linked List

Given the head of a singly linked list, return true if it is a palindrome or false otherwise.



Input: head = [1, 2, 2, 1]

Output: true



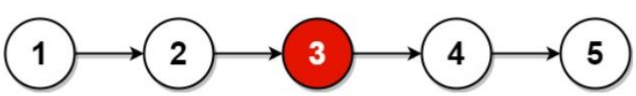
Input: head = [1, 2]

Output: false

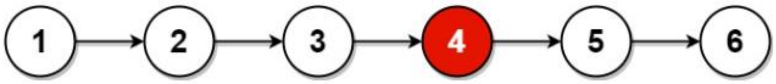
```python
# Definition for singly-linked list.
class ListNode:
   def __init__(self, val=0, next=None):
       self.val = val
       self.next = next

class Solution:
    def isPalindrome(self, head):
        # Write code here
         …
```

7.6 Middle of the Linked List

Given the head of a singly linked list, return the middle node of the linked list. If there are two middle nodes, return the second middle node.



Input: head = [1, 2, 3, 4, 5]
Output: [3, 4, 5]
Explanation: The middle node of the list is node 3.



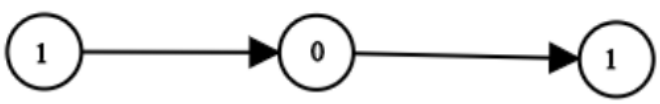
Input: head = [1, 2, 3, 4, 5, 6]
Output: [4, 5, 6]
Explanation: Since the list has two middle nodes with values 3 and 4, we return the second one.

```
# Definition for singly-linked list.
class ListNode:
   def __init__(self, val=0, next=None):
       self.val = val
       self.next = next

class Solution:
    def middleNode(self, head):
        # Write code here
        …
```

7.7 Convert Binary Number in a Linked List to Integer

Given head which is a reference node to a singly-linked list. The value of each node in the linked list is either 0 or 1. The linked list holds the binary representation of a number.

Return the decimal value of the number in the linked list. The most significant bit is at the head of the linked list.



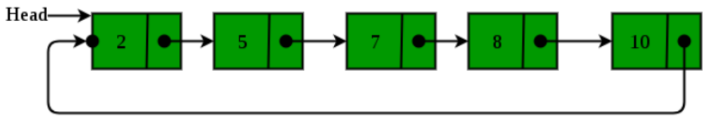
Input: head = [1, 0, 1]
Output: 5
Explanation: (101) in base 2 = (5) in base 10
Input: head = [0]
Output: 0

```
# Definition for singly-linked list.
class ListNode:
   def __init__(self, val=0, next=None):
       self.val = val
       self.next = next

class Solution:
    def getDecimalValue(self, head):
        # Write code here
        …
```

8. Circular Single Linked List and Doubly Linked List

8.1 Circular Linked List

The circular linked list is a linked list where all nodes are connected to form a circle. In a circular linked list, the first node and the last node are connected to each other which forms a circle. There is no NULL at the end.



Operations on the circular linked list:

1. Insertion at the beginning
2. Insertion at the end
3. Insertion in between the nodes
4. Deletion at the beginning
5. Deletion at the end
6. Deletion in between the nodes
7. Traversal

```
# Circular linked list operations

class Node:
    def __init__(self, data):
        self.data = data
        self.next = None

class CircularLinkedList:
    def __init__(self):
        self.last = None
    def addToEmpty(self, data):
       # Write code here
        …

    # add node to the front
    def addFront(self, data):
       # Write code here
        …

    # add node to the end
    def addEnd(self, data):
        # Write code here
        …

    # insert node after a specific node
    def addAfter(self, data, item):
       # Write code here
        …

    # delete a node
    def deleteNode(self, last, key):
       # Write code here
        …
```

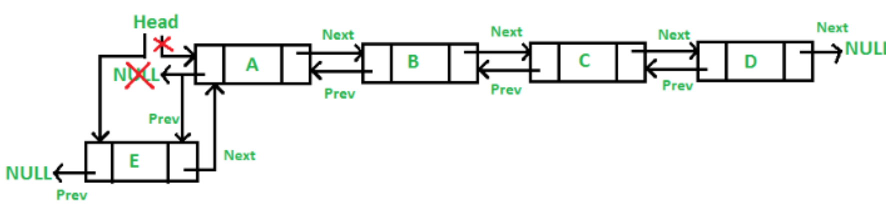
```
    def traverse(self):
        # Write code here
        …
# Driver Code
cll = CircularLinkedList()

last = cll.addToEmpty(6)
last = cll.addEnd(8)
last = cll.addFront(2)
last = cll.addAfter(10, 2)

cll.traverse()
last = cll.deleteNode(last, 8)
print()
cll.traverse()
```

8.2 Doubly Linked List

The A doubly linked list is a type of linked list in which each node consists of 3 components:

1. *prev - address of the previous node
2. data - data item
3. *next - address of next node.

Double Linked List Node



Operations on the Double Linked List:

1. Insertion at the beginning
2. Insertion at the end
3. Insertion in between the nodes
4. Deletion at the beginning
5. Deletion at the end
6. Deletion in between the nodes
7. Traversal

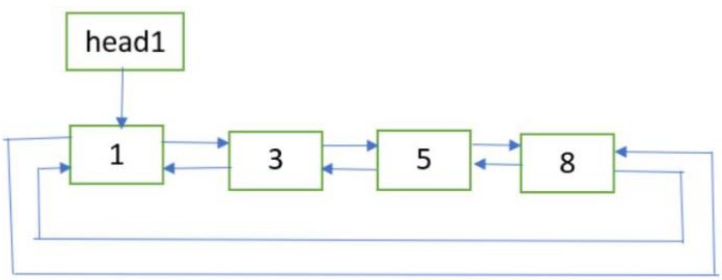
```
# Implementation of doubly linked list
class Node:
    def __init__(self,data):
        self.data=data
        self.next=self.prev=None

class DLinkedList:
    def __init__(self):
        self.head=None
        self.ctr=0
    def insert_beg(self,data):
        # Write code here
        …
    def insert_end(self,data):
        # Write code here
        …
    def delete_beg(self):
        # Write code here
        …
    def delete_end(self):
        # Write code here
        …
    def insert_pos(self,pos,data):
        # Write code here
        …
    def delete_pos(self,pos):
        # Write code here
        …
    def traverse_f(self):
        # Write code here
        …
    def traverse_r(self):
        # Write code here
        …

def menu():
    print("1.Insert at beginning")
    print("2.Insert at position")
    print("3.Insert at end")
    print("4.Delete at beginning")
    print("5.Delete at position")
    print("6.Delete at end")
    print("7.Count no of nodes")
    print("8.Traverse forward")
    print("9.Traverse reverse")
    print("10.Quit")
    ch=eval(input("Enter choice:"))
    return ch

print("******************Double linked list**************")
d=DLinkedList()
while True :
    ch=menu()
    if ch==1:
        data=eval(input("Enter data:"))
        d.insert_beg(data)

    elif ch==2:
```

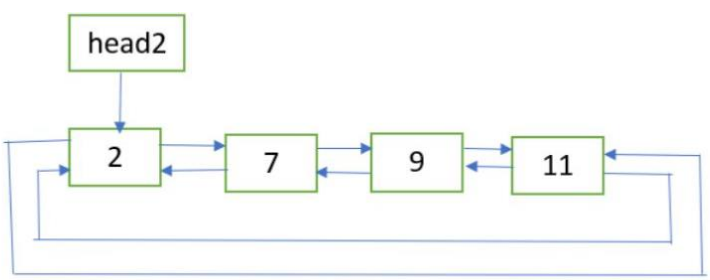
```
        data=eval(input("Enter data:"))
        pos=int(input("Enter position:"))
        d.insert_pos(pos,data)

    elif ch==3:
        data=eval(input("Enter data:"))
        d.insert_end(data)

    elif ch==4:
        d.delete_beg()

    elif ch==5:
        pos=int(input("Enter position:"))
        d.delete_pos(pos)

    elif ch==6:
        d.delete_end()

    elif ch==7:
        print("Number of nodes",d.ctr)

    elif ch==8:
        d.traverse_f()
    elif ch==9:
        d.traverse_r()

    else:
        print("Exit")
        break
```

8.3 Sorted Merge of Two Sorted Doubly Circular Linked Lists

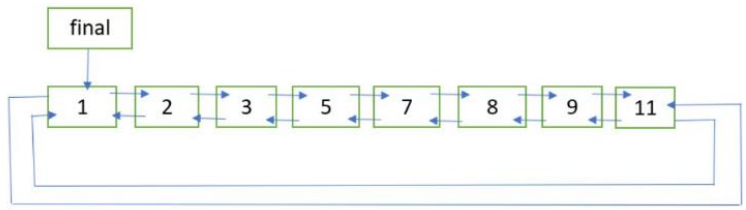
Given two sorted Doubly circular Linked List containing n1 and n2 nodes respectively. The problem is to merge the two lists such that resultant list is also in sorted order.

Input: List 1 and List 2





Output: Merged List



Procedure for Merging Doubly Linked List:

1. If head1 == NULL, return head2.

2. If head2 == NULL, return head1.

3. Let **last1** and **last2** be the last nodes of the two lists respectively. They can be obtained with the help of the previous links of the first nodes.

4. Get pointer to the node which will be the last node of the final list. If last1.data < last2.data, then **last_node** = last2, Else **last_node** = last1.

5. Update last1.next = last2.next = NULL.

6. Now merge the two lists as two sorted doubly linked list are being merged. Refer **merge** procedure of this post. Let the first node of the final list be **finalHead**.

7. Update finalHead.prev = last_node and last_node.next = finalHead.

8. Return **finalHead**.

```
# Implementation for Sorted merge of two sorted doubly circular linked list

import math

class Node:
    def __init__(self, data):
        self.data = data
        self.next = None
        self.prev = None

# A utility function to insert a new node at the beginning
# of doubly circular linked list
def insert(head_ref, data):
     # Write code here
     …
# function for Sorted merge of two sorted doubly linked list
def merge(first, second):
    # Write code here
    …
# function for Sorted merge of two sorted doubly circular linked list
def mergeUtil(head1, head2):
    # Write code here
    …
# function to print the list
def printList(head):
```

```
    # Write code here
    …
# Driver Code
head1 = None
head2 = None
# list 1:
head1 = insert(head1, 8)
head1 = insert(head1, 5)
head1 = insert(head1, 3)
head1 = insert(head1, 1)
# list 2:
head2 = insert(head2, 11)
head2 = insert(head2, 9)
head2 = insert(head2, 7)
head2 = insert(head2, 2)

newHead = mergeUtil(head1, head2)

print("Final Sorted List: ", end = "")
printList(newHead)
```

8.4 Delete all occurrences of a given key in a Doubly Linked List

Given a doubly linked list and a key x. The problem is to delete all occurrences of the given key x from the doubly linked list.

Input: 2 <-> 2 <-> 10 <-> 8 <-> 4 <-> 2 <-> 5 <-> 2
x = 2
Output: 10 <-> 8 <-> 4 <-> 5

Algorithm:
delAllOccurOfGivenKey (head_ref, x)
    if head_ref == NULL
        return
    Initialize **current** = head_ref
    Declare **next**
    while current != NULL
        if current->data == x
            next = current->next
            deleteNode(head_ref, current)
            current = next
        else
            current = current->next

```
# Implementation to delete all occurrences of a given key in a doubly linked list
import math

# a node of the doubly linked list
class Node:
    def __init__(self,data):
        self.data = data
        self.next = None
        self.prev = None

# Function to delete a node in a Doubly Linked List.
# head_ref --> pointer to head node pointer.
# del --> pointer to node to be deleted.
```

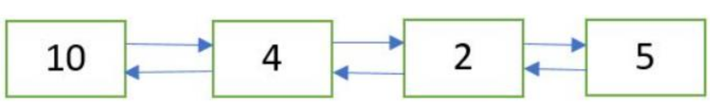
```
def deleteNode(head, delete):
    # Write code here
    …

# function to delete all occurrences of the given key 'x'
def deleteAllOccurOfX(head, x):
    # Write code here
    …

# Function to insert a node at the beginning of the Doubly Linked List
def push(head,new_data):
    # Write code here
    …

# Function to print nodes in a given doubly linked list
def printList(head):
    # Write code here
    …

# Driver Code
# Start with the empty list
head = None
# Create the doubly linked list:
head = push(head, 2)
head = push(head, 5)
head = push(head, 2)
head = push(head, 4)
head = push(head, 8)
head = push(head, 10)
head = push(head, 2)
head = push(head, 2)
print("Original Doubly linked list:")
printList(head)
x = 2
# delete all occurrences of 'x'
head = deleteAllOccurOfX(head, x)
print("\nDoubly linked list after deletion of ",x,":")
printList(head)
```

8.5 Delete a Doubly Linked List Node at a Given Position

Given a doubly linked list and a position n. The task is to delete the node at the given position n from the beginning.

Input: Initial doubly linked list

Output: Doubly Linked List after deletion of node at position n = 2



Procedure:

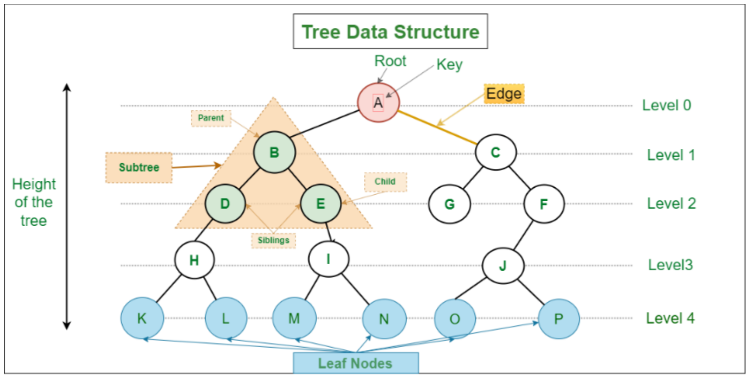
1. Get the pointer to the node at position n by traversing the doubly linked list up to the nth node from the beginning.
2. Delete the node using the pointer obtained in Step 1.

```
# Python implementation to delete a doubly Linked List node
# at the given position

# A node of the doubly linked list
class Node:

    # Constructor to create a new node
    def __init__(self, data):
        self.data = data
        self.next = None
        self.prev = None

# Function to delete a node in a Doubly Linked List.
# head_ref -. pointer to head node pointer.
# del -. pointer to node to be deleted.
def deleteNode(head_ref, del_):
    # Write code here
    …

# Function to delete the node at the given position
# in the doubly linked list
def deleteNodeAtGivenPos(head_ref, n):
    # Write code here
    …

# Function to insert a node at the beginning of the Doubly Linked List
def push(head_ref, new_data):
    # Write code here
    …

# Function to print nodes in a given doubly linked list
def printList(head):
    # Write code here
    …
# Driver Code
# Start with the empty list
head = None
head = push(head, 5)
head = push(head, 2)
head = push(head, 4)
head = push(head, 8)
head = push(head, 10)
print("Doubly linked list before deletion:")
printList(head)

n = 2

# delete node at the given position 'n'
head = deleteNodeAtGivenPos(head, n)
print("\nDoubly linked list after deletion:")
printList(head)
```

9. Trees

9.1 Tree Creation and Basic Tree Terminologies

A tree data structure is a hierarchical structure that is used to represent and organize data in a way that is easy to navigate and search. It is a collection of nodes that are connected by edges and has a hierarchical relationship between the nodes.



Basic Terminologies in Tree:

1. **Parent Node:** The node which is a predecessor of a node is called the parent node of that node. {B} is the parent node of {D, E}.
2. **Child Node:** The node which is the immediate successor of a node is called the child node of that node. Examples: {D, E} are the child nodes of {B}.
3. **Root Node:** The topmost node of a tree or the node which does not have any parent node is called the root node. {A} is the root node of the tree. A non-empty tree must contain exactly one root node and exactly one path from the root to all other nodes of the tree.
4. **Leaf Node or External Node:** The nodes which do not have any child nodes are called leaf nodes. {K, L, M, N, O, P} are the leaf nodes of the tree.
5. **Ancestor of a Node:** Any predecessor nodes on the path of the root to that node are called Ancestors of that node. {A, B} are the ancestor nodes of the node {E}
6. **Descendant:** Any successor node on the path from the leaf node to that node. {E, I} are the descendants of the node {B}.
7. **Sibling:** Children of the same parent node are called siblings. {D, E} are called siblings.
8. **Level of a node:** The count of edges on the path from the root node to that node. The root node has level 0.
9. **Internal node:** A node with at least one child is called Internal Node.
10. **Neighbour of a Node:** Parent or child nodes of that node are called neighbors of that node.
11. **Subtree:** Any node of the tree along with its descendant.

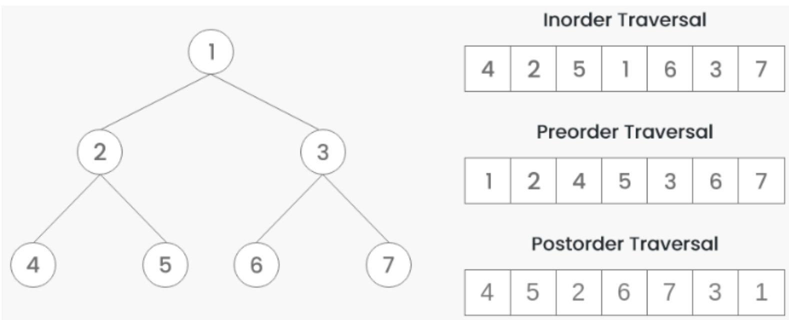
```
# Demonstration of Tree Basic Terminologies
# Function to add an edge between vertices x and y

# Function to print the parent of each node
def printParents(node, adj, parent):
```

```
    # Write code here
    …

# Function to print the children of each node
def printChildren(Root, adj):
    # Write code here
    …

# Function to print the leaf nodes
def printLeafNodes(Root, adj):
    # Write code here
    …

# Function to print the degrees of each node
def printDegrees(Root, adj):
    # Write code here
    …

# Driver code
# Number of nodes
N = 7
Root = 1

# Adjacency list to store the tree
adj = []
for i in range(0, N+1):
    adj.append([])

# Creating the tree
adj[1].append(2)
adj[2].append(1)

adj[1].append(3)
adj[3].append(1)

adj[1].append(4)
adj[4].append(1)

adj[2].append(5)
adj[5].append(2)

adj[2].append(6)
adj[6].append(2)

adj[4].append(7)
adj[7].append(4)

# Printing the parents of each node
print("The parents of each node are:")
printParents(Root, adj, 0)
# Printing the children of each node
print("The children of each node are:")
printChildren(Root, adj)

# Printing the leaf nodes in the tree
print("The leaf nodes of the tree are:")
printLeafNodes(Root, adj)
```

```
# Printing the degrees of each node
print("The degrees of each node are:")
printDegrees(Root, adj)
```

9.2 Binary Tree Traversal Techniques

A binary tree data structure can be traversed in following ways:
1. Inorder Traversal
2. Preorder Traversal
3. Postorder Traversal
4. Level Order Traversal



Algorithm Inorder (tree)

1. Traverse the left subtree, i.e., call Inorder(left->subtree)
2. Visit the root.
3. Traverse the right subtree, i.e., call Inorder(right->subtree)

Algorithm Preorder (tree)

1. Visit the root.
2. Traverse the left subtree, i.e., call Preorder(left->subtree)
3. Traverse the right subtree, i.e., call Preorder(right->subtree)

Algorithm Postorder (tree)

1. Traverse the left subtree, i.e., call Postorder(left->subtree)
2. Traverse the right subtree, i.e., call Postorder(right->subtree)
3. Visit the root.

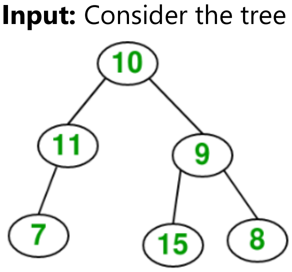
```
# Program to create a binary tree and print traversal orders
class Node:
    def __init__(self,data):
        self.data=data
        self.l=None
        self.r=None

class BT:
    def __init__(self):
        self.root=None

    def insert(self,n):
        # Write code here
        …
```

```
        def postorder(self,root):
            # Write code here
            …

    def preorder(self,root):
        # Write code here
        …

    def inorder(self,root):
        # Write code here
        …

# Driver code
b=BT()
print("******************TREE USING DOUBLE LINKED LIST************************")
while True:
    print("1.Insert data to tree")
    print("2.Post Order Traversal")
    print("3.Pre Order Traversal")
    print("4.In Order Traversal")
    print("5.Exit")
    ch=int(input("Enter choice:"))
    if ch==1:
        n=int(input("Enter number of nodes:"))
        b.insert(n)
    elif ch==2:
        b.postorder(b.root)
    elif ch==3:
        b.preorder(b.root)
    elif ch==4:
        b.inorder(b.root)
    else:
        print("Exit")
        break
```

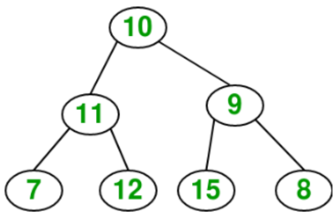
9.3 Insertion in a Binary Tree in Level Order

Given a binary tree and a key, insert the key into the binary tree at the first position available in level order.

Input: Consider the tree given below



Output:



After inserting 12

The idea is to do an iterative level order traversal of the given tree using queue. If we find a node whose left child is empty, we make a new key as the left child of the node. Else if we find a node whose right child is empty, we make the new key as the right child. We keep traversing the tree until we find a node whose either left or right child is empty.

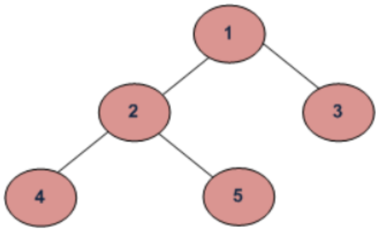
```
# Insert element in binary tree
class newNode():
    def __init__(self, data):
        self.key = data
        self.left = None
        self.right = None

# Inorder traversal of a binary tree
def inorder(temp):
    # Write code here
    …

# function to insert element in binary tree
def insert(temp,key):
   # Write code here
   …

# Driver code
root = newNode(10)
root.left = newNode(11)
root.left.left = newNode(7)
root.right = newNode(9)
root.right.left = newNode(15)
root.right.right = newNode(8)
print("Inorder traversal before insertion:", end = " ")
inorder(root)

key = 12
insert(root, key)

print()
print("Inorder traversal after insertion:", end = " ")
inorder(root)
```

9.4 Finding the Maximum Height or Depth of a Binary Tree

Given a binary tree, the task is to find the height of the tree. The height of the tree is the number of edges in the tree from the root to the deepest node.

Note: The height of an empty tree is 0.

Input: Consider the tree below



Recursively calculate the height of the left and the right subtrees of a node and assign height to the node as max of the heights of two children plus 1.

maxDepth('1') = max(maxDepth('2'), maxDepth('3')) + 1 = 2 + 1
because recursively
maxDepth('2') = max (maxDepth('4'), maxDepth('5')) + 1 = 1 + 1 and (as height of both '4' and '5' are 1)
maxDepth('3') = 1

Procedure:

- Recursively do a Depth-first search.
- If the tree is empty then return 0
- Otherwise, do the following
    - Get the max depth of the left subtree recursively i.e. call maxDepth(tree->left-subtree)
    - Get the max depth of the right subtree recursively i.e. call maxDepth(tree->right-subtree)
    - Get the max of max depths of left and right subtrees and add 1 to it for the current node.

$$max_depth = max(maxdeptofleftsubtree, maxdepthofrightsubtree) + 1$$

    - Return max_depth.

```
# Find the maximum depth of tree
# A binary tree node
class Node:
    # Constructor to create a new node
    def __init__(self, data):
        self.data = data
        self.left = None
        self.right = None

# Compute the "maxDepth" of a tree -- the number of nodes
# along the longest path from the root node down to the farthest leaf node

def maxDepth(node):
    # Write code here
    …

# Driver program to test above function
root = Node(1)
```

```
root.left = Node(2)
root.right = Node(3)
root.left.left = Node(4)
root.left.right = Node(5)
print("Height of tree is %d" % (maxDepth(root)))
```

9.5 Deletion in a Binary Tree

Given a binary tree, delete a node from it by making sure that the tree shrinks from the bottom (i.e. the deleted node is replaced by the bottom-most and rightmost node).

Input: Delete 10 in below tree

```
      10
    /   \
  20     30
```

Output:

```
      30
    /
 20
```

Input: Delete 20 in below tree

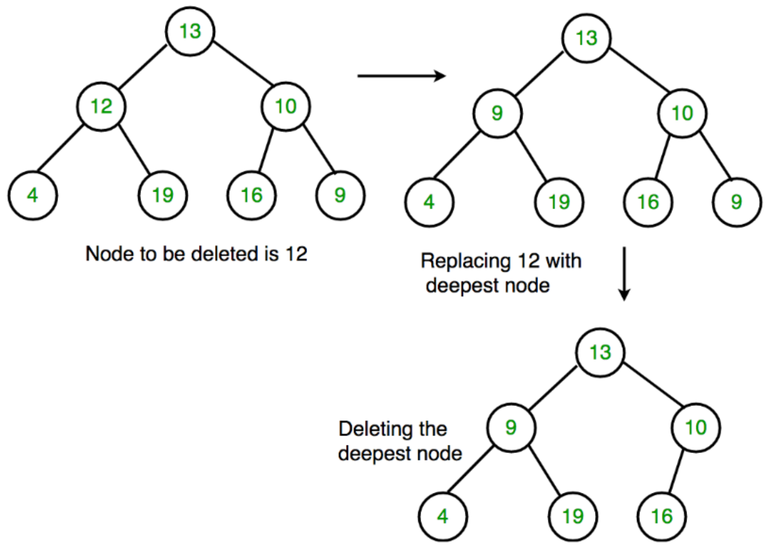
```
      10
    /   \
 20     30
          \
           40
```

Output:

```
      10
   /     \
40        30
```

Algorithm:

1. Starting at the root, find the deepest and rightmost node in the binary tree and the node which we want to delete.
2. Replace the deepest rightmost node’s data with the node to be deleted.
3. Then delete the deepest rightmost node.




```python
# Deletion in a Binary Tree

# Create a node with data, left child and right child.

class Node:
    def __init__(self, data):
        self.data = data
        self.left = None
        self.right = None

# Inorder traversal of a binary tree
def inorder(temp):
    # Write code here
    …

# function to delete the given deepest node (d_node) in binary tree
def deleteDeepest(root, d_node):
    # Write code here
    …

# function to delete element in binary tree
def deletion(root, key):
    # Write code here
    …

# Driver code
root = Node(10)
root.left = Node(11)
root.left.left = Node(7)
root.left.right = Node(12)
root.right = Node(9)
root.right.left = Node(15)
root.right.right = Node(8)
print("The tree before the deletion: ", end = "")
inorder(root)
key = 11
root = deletion(root, key)
print();
print("The tree after the deletion: ", end = "")
inorder(root)
```

10. Binary Search Tree (BST)

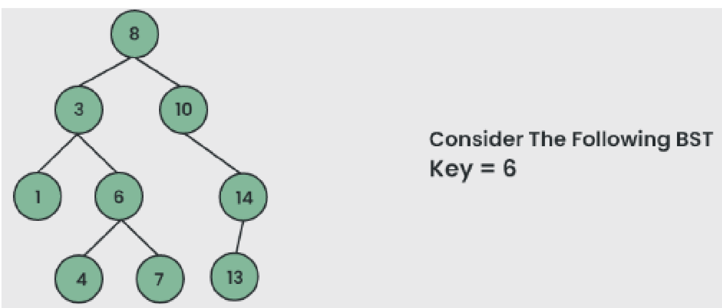
10.1 Searching in Binary Search Tree

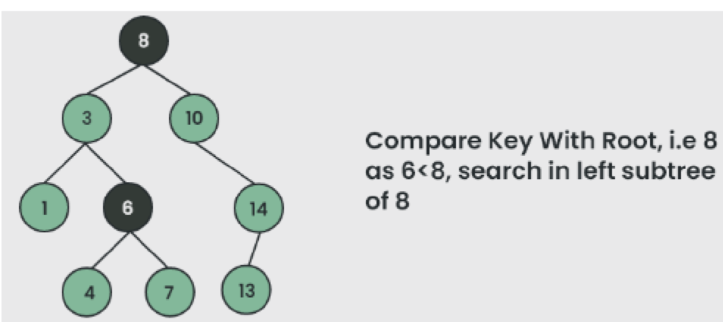
Given a BST, the task is to delete a node in this BST. For searching a value in BST, consider it as a sorted array. Perform search operation in BST using Binary Search Algorithm.

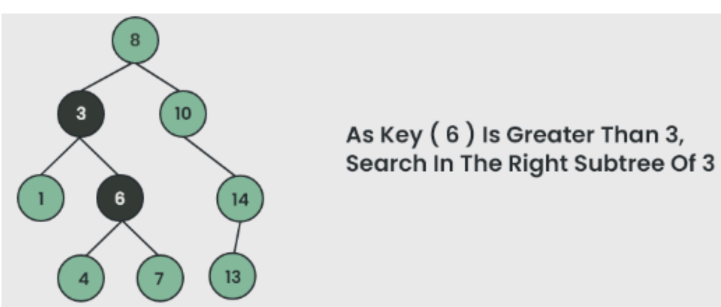
Algorithm to search for a key in a given Binary Search Tree:

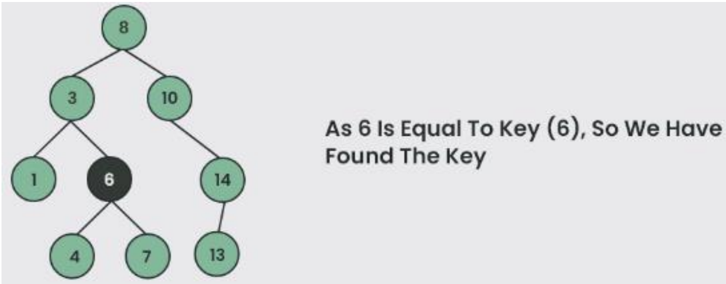
Let's say we want to search for the number **X,** We start at the root. Then:

- We compare the value to be searched with the value of the root.
- If it's equal we are done with the search if it's smaller we know that we need to go to the left subtree because in a binary search tree all the elements in the left subtree are smaller and all the elements in the right subtree are larger.
- Repeat the above step till no more traversal is possible
- If at any iteration, key is found, return True. Else False.







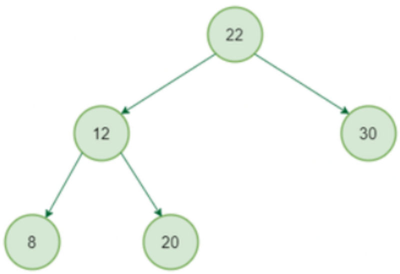



```
# Search a given key in a given BST

class Node:
    # Constructor to create a new node
    def __init__(self, key):
        self.key = key
        self.left = None
        self.right = None

# A utility function to insert
# a new node with the given key in BST
def insert(node, key):
    # Write code here
    …

# Utility function to search a key in a BST
def search(root, key):
    # Write code here
    …

# Driver Code
root = None
root = insert(root, 50)
insert(root, 30)
insert(root, 20)
insert(root, 40)
insert(root, 70)
insert(root, 60)
insert(root, 80)
# Key to be found
key = 6

# Searching in a BST
if search(root, key) is None:
    print(key, "not found")

else:
    print(key, "found")

key = 60

# Searching in a BST
if search(root, key) is None:
    print(key, "not found")
else:
    print(key, "found")
```

10.2 Find the node with Minimum Value in a BST

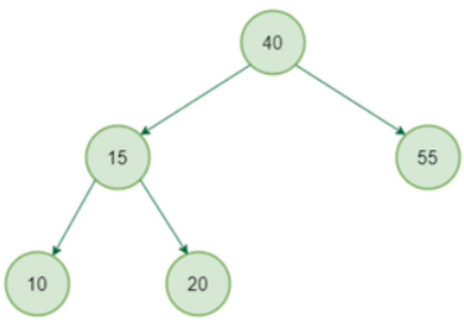
Write a function to find the node with minimum value in a Binary Search Tree.

Input: Consider the tree given below



Output: 8

Input: Consider the tree given below



Output: 10

```
from typing import List
class Node:
    def __init__(self, data):
        self.data = data
        self.left = None
        self.right = None

# Give a binary search tree and a number, inserts a new node with the given number
# in the correct place in the tree. Returns the new root pointer
def insert(node: Node, data: int) -> Node:
    # Write code here
    …
# Given a non-empty binary search tree, inorder traversal for
# the tree is stored in the list sorted_inorder. Inorder is LEFT, ROOT, RIGHT.

def inorder(node: Node, sorted_inorder: List[int]) -> None:
    # Write code here
    …
# Driver Code
root = None
root = insert(root, 4)
insert(root, 2)
insert(root, 1)
insert(root, 3)
insert(root, 6)
```

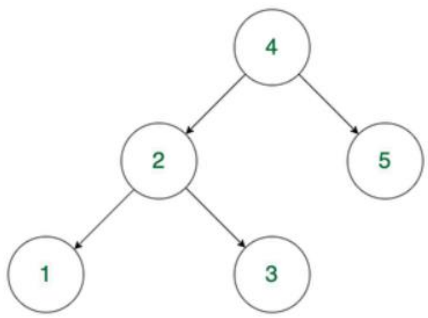
```
insert(root, 4)
insert(root, 5)
sorted_inorder = []
inorder(root, sorted_inorder)  # calling the recursive function

# Values of all nodes will appear in sorted order in the list sorted_inorder
print(f"Minimum value in BST is {sorted_inorder[0]}")
```

10.3 Check if a Binary Tree is BST or not

A binary search tree (BST) is a node-based binary tree data structure that has the following properties.

1. The left subtree of a node contains only nodes with keys less than the node's key.
2. The right subtree of a node contains only nodes with keys greater than the node's key.
3. Both the left and right subtrees must also be binary search trees.
4. Each node (item in the tree) has a distinct key.

Input: Consider the tree given below



Output: Check if max value in left subtree is smaller than the node and min value in right subtree greater than the node, then print it "Is BST" otherwise "Not a BST"

Procedure:

1. If the current node is null then return true
2. If the value of the left child of the node is greater than or equal to the current node then return false
3. If the value of the right child of the node is less than or equal to the current node then return false
4. If the left subtree or the right subtree is not a BST then return false
5. Else return true

```
# Program to check if a binary tree is BST or not
# A binary tree node has data, pointer to left child and a pointer to right child

class Node:
     def __init__(self, data):
        self.data = data
        self.left = None
        self.right = None

def maxValue(node):
    # Write code here
    …

def minValue(node):
    # Write code here
    …
```

```
# Returns true if a binary tree is a binary search tree
def isBST(node):
    # Write code here
    …

# Driver code
root = Node(4)
root.left = Node(2)
root.right = Node(5)
# root.right.left = Node(7)
root.left.left = Node(1)
root.left.right = Node(3)

# Function call
if isBST(root) is True:
    print("Is BST")
else:
    print("Not a BST")
```

10.4 Second Largest Element in BST

Given a Binary search tree (BST), find the second largest element.

Input: Root of below BST

```
      10
     /
    5
```

Output: 5

Input: Root of below BST

```
       10

      /  \

    5     20

            \

             30
```

Output: 20

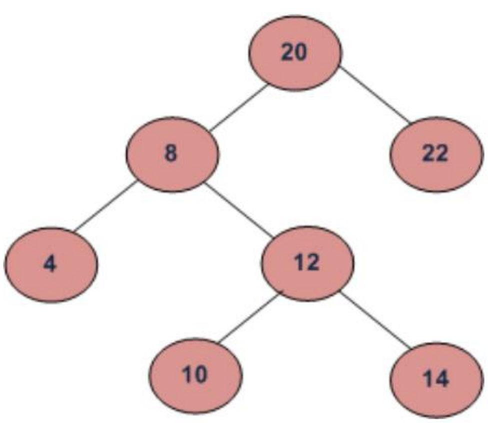
Procedure: The second largest element is second last element in inorder traversal and second element in reverse inorder traversal. We traverse given Binary Search Tree in reverse inorder and keep track of counts of nodes visited. Once the count becomes 2, we print the node.

```
# Find the second largest element in
class Node:

    # Constructor to create a new node
    def __init__(self, data):
        self.key = data
```

```
        self.left = None
        self.right = None

# A function to find 2nd largest element in a given tree.
def secondLargestUtil(root, c):
    # Write code here
    …
# Function to find 2nd largest element
def secondLargest(root):
    # Write code here
    …

# A utility function to insert a new node with given key in BST
def insert(node, key):

# Driver Code
# Let us create following BST
#       50
#     /    \
#    30     70
#   / \     / \
#  20  40  60  80

root = None
root = insert(root, 50)
insert(root, 30)
insert(root, 20)
insert(root, 40)
insert(root, 70)
insert(root, 60)
insert(root, 80)
secondLargest(root)
```

Try:

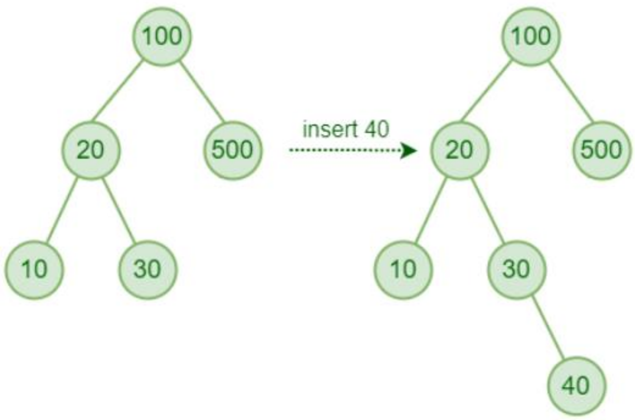
1. **Kth largest element in BST when modification to BST is not allowed:** Given a Binary Search Tree (BST) and a positive integer k, find the k'th largest element in the Binary Search Tree. For a given BST, if k = 3, then output should be 14, and if k = 5, then output should be 10.



10.5 Insertion in Binary Search Tree (BST)

Given a Binary search tree (BST), the task is to insert a new node in this BST.

Input: Consider a BST and insert the element 40 into it.



Procedure for inserting a value in a BST:

A new key is always inserted at the leaf by maintaining the property of the binary search tree. We start searching for a key from the root until we hit a leaf node. Once a leaf node is found, the new node is added as a child of the leaf node. The below steps are followed while we try to insert a node into a binary search tree:

- Check the value to be inserted (say X) with the value of the current node (say val) we are in:
  - If X is less than val move to the left subtree.
  - Otherwise, move to the right subtree.
  - Once the leaf node is reached, insert X to its right or left based on the relation between X and the leaf node's value.

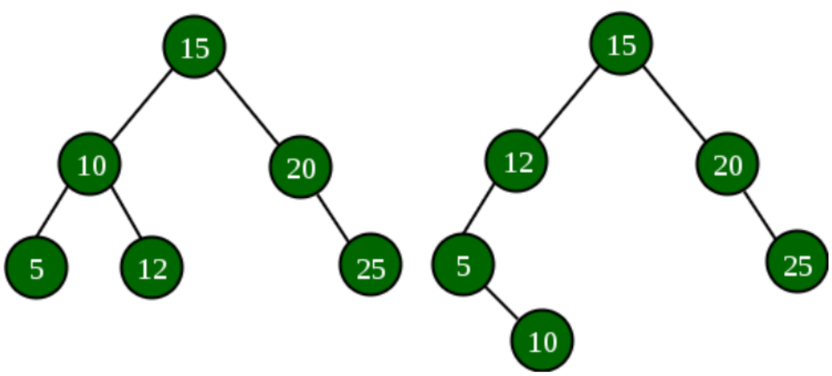
```
# insert operation in binary search tree
# A utility class that represents an individual node in a BST
class Node:
    def __init__(self, key):
        self.left = None
        self.right = None
        self.val = key

 # A utility function to insert a new node with the given key
def insert(root, key):
    # Write code here
    …

 # A utility function to do inorder tree traversal
def inorder(root):
    # Write code here
    …

# Driver code
```

```
# Let us create the following BST
#       50
#     /     \
#    30     70
#   / \     / \
#  20 40   60 80
r = Node(50)
r = insert(r, 30)
r = insert(r, 20)
r = insert(r, 40)
r = insert(r, 70)
r = insert(r, 60)
r = insert(r, 80)

# Print inorder traversal of the BST
inorder(r)
```

Try:

1. **Check if two BSTs contain same set of elements:** Given two Binary Search Trees consisting of unique positive elements, we have to check whether the two BSTs contain the same set of elements or not.

Input: Consider two BSTs which contains same set of elements {5, 10, 12, 15, 20, 25}, but the structure of the two given BSTs can be different.



11. AVL Tree

11.1 Insertion in an AVL Tree

AVL tree is a self-balancing Binary Search Tree (BST) where the difference between heights of left and right subtrees cannot be more than one for all nodes. To make sure that the given tree remains AVL after every insertion, we must augment the standard BST insert operation to perform some re-balancing. Following are two basic operations that can be performed to balance a BST without violating the BST property (keys(left) < key(root) < keys(right)).

- Left Rotation
- Right Rotation

T1, T2 and T3 are subtrees of the tree, rooted with y (on the left side) or x (on the right side)

```
     y                               x
    / \     Right Rotation          /  \
   x   T3   - - - - - - - >        T1   y
  / \       < - - - - - - -            / \
 T1  T2     Left Rotation            T2  T3
```

Keys in both of the above trees follow the following order

keys(T1) < key(x) < keys(T2) < key(y) < keys(T3)

So BST property is not violated anywhere.

Procedure for inserting a node into an AVL tree

Let the newly inserted node be w

- Perform standard BST insert for w.
- Starting from w, travel up and find the first unbalanced node. Let z be the first unbalanced node, y be the child of z that comes on the path from w to z and x be the grandchild of z that comes on the path from w to z.
- Re-balance the tree by performing appropriate rotations on the subtree rooted with z. There can be 4 possible cases that need to be handled as x, y and z can be arranged in 4 ways.
- Following are the possible 4 arrangements:
  - y is the left child of z and x is the left child of y (Left Left Case)
  - y is the left child of z and x is the right child of y (Left Right Case)
  - y is the right child of z and x is the right child of y (Right Right Case)
  - y is the right child of z and x is the left child of y (Right Left Case)

```
# Insert a node in AVL tree

# Generic tree node class
class TreeNode(object):
    def __init__(self, val):
        self.val = val
        self.left = None
        self.right = None
        self.height = 1

# AVL tree class which supports the insert operation
class AVL_Tree(object):

    # Recursive function to insert key in subtree rooted with node and returns
    # new root of subtree.
    def insert(self, root, key):
        # Write code here
        …

    def leftRotate(self, z):
        # Write code here
        …

    def rightRotate(self, z):
        # Write code here
        …

    def getHeight(self, root):
        # Write code here
        …

    def getBalance(self, root):
        # Write code here
        …

    def preOrder(self, root):
        # Write code here
        …

# Driver code
myTree = AVL_Tree()
root = None

root = myTree.insert(root, 10)
root = myTree.insert(root, 20)
root = myTree.insert(root, 30)
root = myTree.insert(root, 40)
root = myTree.insert(root, 50)
root = myTree.insert(root, 25)

"""The constructed AVL Tree would be
            30
           /  \
         20   40
        /  \     \
       10  25    50"""
```

```
# Preorder Traversal
print("Preorder traversal of the",
      "constructed AVL tree is")
myTree.preOrder(root)
print()
```

11.2 Deletion in an AVL Tree

Given an AVL tree, make sure that the given tree remains AVL after every deletion, we must augment the standard BST delete operation to perform some re-balancing. Following are two basic operations that can be performed to re-balance a BST without violating the BST property (keys(left) < key(root) < keys(right)).

1. Left Rotation
2. Right Rotation

T1, T2 and T3 are subtrees of the tree rooted with y (on left side)
or x (on right side)

```
     y                               x
    / \     Right Rotation          /  \
   x   T3   - - - - - - - >        T1   y
  / \       < - - - - - - -            / \
T1   T2     Left Rotation            T2  T3
```

Keys in both of the above trees follow the following order
   keys(T1) < key(x) < keys(T2) < key(y) < keys(T3)
So BST property is not violated anywhere.

Procedure to delete a node from AVL tree:

Let w be the node to be deleted

1. Perform standard BST delete for w.

2. Starting from w, travel up and find the first unbalanced node. Let z be the first unbalanced node, y be the larger height child of z, and x be the larger height child of y. Note that the definitions of x and y are different from insertion here.

3. Re-balance the tree by performing appropriate rotations on the subtree rooted with z. There can be 4 possible cases that needs to be handled as x, y and z can be arranged in 4 ways. Following are the possible 4 arrangements:

   i. y is left child of z and x is left child of y (Left Left Case)

   ii. y is left child of z and x is right child of y (Left Right Case)

   iii. y is right child of z and x is right child of y (Right Right Case)

   iv. y is right child of z and x is left child of y (Right Left Case)

```
# delete a node in AVL tree

class TreeNode(object):
    def __init__(self, val):
        self.val = val
        self.left = None
        self.right = None
        self.height = 1

# AVL tree class which supports insertion, deletion operations
class AVL_Tree(object):

    def insert(self, root, key):
        # Write code here
        …

    # Recursive function to delete a node with given key from subtree
    # with given root. It returns root of the modified subtree.
    def delete(self, root, key):
        # Write code here
        …

    def leftRotate(self, z):
        # Write code here
        …

    def rightRotate(self, z):
        # Write code here
        …

    def getHeight(self, root):
        # Write code here
        …

    def getBalance(self, root):
        # Write code here
        …

    def getMinValueNode(self, root):
        # Write code here
        …

    def preOrder(self, root):
        # Write code here
        …

myTree = AVL_Tree()
root = None
nums = [9, 5, 10, 0, 6, 11, -1, 1, 2]

for num in nums:
    root = myTree.insert(root, num)


# Preorder Traversal
print("Preorder Traversal after insertion -")
myTree.preOrder(root)
```

```
print()

# Delete
key = 10
root = myTree.delete(root, key)

# Preorder Traversal
print("Preorder Traversal after deletion -")
myTree.preOrder(root)
print()
```

11.3 Count Greater Nodes in AVL Tree

Given an AVL tree, calculate number of elements which are greater than given value in AVL tree.

Input: x = 5

Root of below AVL tree

```
       9
      / \
     1   10
    / \    \
   0   5    11
  /   / \
-1   2   6
```

Output: 4

Explanation: There are 4 values which are greater than 5 in AVL tree which are 6, 9, 10 and 11.

```
# Count greater nodes in an AVL tree

class Node:
    def __init__(self, key):
        self.key = key
        self.left = None
        self.right = None
        self.height = 1
        self.desc = 0

 def height(N):
    if N is None:
        return 0
    return N.height

# A utility function to get maximum of two integers

def max(a, b):
    if a > b:
        return a
    return b

def newNode(key):
    # Write code here
```

```
    …

# A utility function to right rotate subtree rooted with y

def rightRotate(y):
    # Write code here
    …

def leftRotate(x):
    # Write code here
    …
def getBalance(N):
    # Write code here
    …

def insert(root, key):
    # Write code here
    …

def minValueNode(node):
    # Write code here
    …

# Recursive function to delete a node with given key # from subtree with given root. It returns root of the modified subtree.

def deleteNode(root, key):
    # Write code here
    …

def preOrder(root):
    # Write code here
    …

def CountGreater(root, x):
    # Write code here
    …

# Driver program to test above function
root = None
root = insert(root, 9)
root = insert(root, 5)
root = insert(root, 10)
root = insert(root, 0)
root = insert(root, 6)
root = insert(root, 11)
root = insert(root, -1)
root = insert(root, 1)
root = insert(root, 2)

print("Preorder traversal of the constructed AVL tree is")
preOrder(root)

print("Number of elements greater than 9 are")
print(CountGreater(root, 9))

root = deleteNode(root, 10)
```

```
print("Preorder traversal after deletion of 10")
preOrder(root)
print('Number of elements greater than 9 are')
print(CountGreater(root, 9))
```

11.4 Minimum Number of Nodes in an AVL Tree with given Height

Given the height of an AVL tree 'h', the task is to find the minimum number of nodes the tree can have.

Input: H = 0

Output: N = 1

Only '1' node is possible if the height
of the tree is '0' which is the root node.

Input: H = 3

Output: N = 7

Recursive approach:
In an AVL tree, we have to maintain the height balance property, i.e. difference in the height of the left and the right subtrees cannot be other than -1, 0 or 1 for each node.

We will try to create a recurrence relation to find minimum number of nodes for a given height, n(h).

- For height = 0, we can only have a single node in an AVL tree, i.e. n(0) = 1
- For height = 1, we can have a minimum of two nodes in an AVL tree, i.e. n(1) = 2
- Now for any height 'h', root will have two subtrees (left and right). Out of which one has to be of height h-1 and other of h-2. [root node excluded]
- So, n(h) = 1 + n(h-1) + n(h-2) is the required recurrence relation for h>=2 [1 is added for the root node]

```
# Function to find minimum number of nodes

def AVLnodes(height):
    # Write code here
    …
# Driver Code
H = 3
print(AVLnodes(H))
```

12. Graph Traversal

12.1 Breadth First Search

The **Breadth First Search (BFS)** algorithm is used to search a graph data structure for a node that meets a set of criteria. It starts at the root of the graph and visits all nodes at the current depth level before moving on to the nodes at the next depth level.
For a given graph G, print BFS traversal from a given source vertex.

```
# BFS traversal from a given source vertex.

from collections import defaultdict
```

```python
 # This class represents a directed graph using adjacency list representation
class Graph:

    # Constructor
    def __init__(self):
        # Default dictionary to store graph
        self.graph = defaultdict(list)

    # Function to add an edge to graph
    def addEdge(self, u, v):
        self.graph[u].append(v)

    # Function to print a BFS of graph
    def BFS(self, s):
      # Write code here
      …

# Create a graph given in the above diagram
g = Graph()
g.addEdge(0, 1)
g.addEdge(0, 2)
g.addEdge(1, 2)
g.addEdge(2, 0)
g.addEdge(2, 3)
g.addEdge(3, 3)

print("Following is Breadth First Traversal" " (starting from vertex 2)")
g.BFS(2)
```

Output: Following is Breadth First Traversal (starting from vertex 2)
2 0 3 1

12.2 Depth First Search

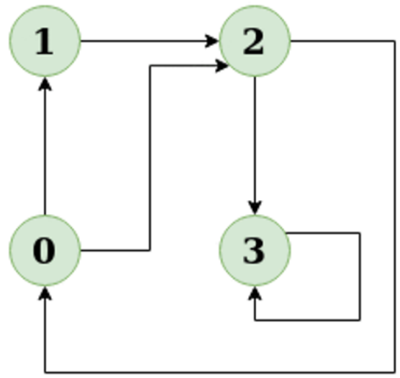
Depth First Traversal (or DFS) for a graph is similar to Depth First Traversal of a tree. The only catch here is, that, unlike trees, graphs may contain cycles (a node may be visited twice). To avoid processing a node more than once, use a boolean visited array. A graph can have more than one DFS traversal.

For a given graph G, print DFS traversal from a given source vertex.

Input: n = 4, e = 6
0 -> 1, 0 -> 2, 1 -> 2, 2 -> 0, 2 -> 3, 3 -> 3

Output: DFS from vertex 1: 1 2 0 3

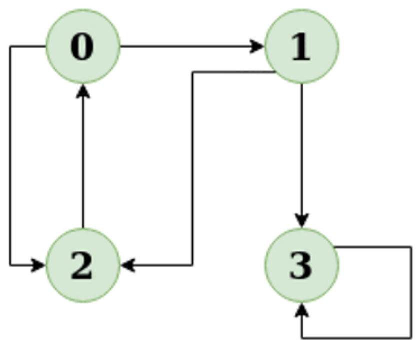
Explanation:
DFS Diagram:



Input: n = 4, e = 6
2 -> 0, 0 -> 2, 1 -> 2, 0 -> 1, 3 -> 3, 1 -> 3

Output: DFS from vertex 2: 2 0 1 3

Explanation:
DFS Diagram:




```
# DFS traversal from a given graph
from collections import defaultdict

# This class represents a directed graph using adjacency list representation
class Graph:
    # Constructor
    def __init__(self):
        # Default dictionary to store graph
        self.graph = defaultdict(list)

    # Function to add an edge to graph
    def addEdge(self, u, v):
        self.graph[u].append(v)
    # A function used by DFS
    def DFSUtil(self, v, visited):
        # Write code here
        …

    # The function to do DFS traversal. It uses recursive DFSUtil()

    def DFS(self, v):
       # Write code here
       …
```

```
# Driver's code
g = Graph()
g.addEdge(0, 1)
g.addEdge(0, 2)
g.addEdge(1, 2)
g.addEdge(2, 0)
g.addEdge(2, 3)
g.addEdge(3, 3)
print("Following is Depth First Traversal (starting from vertex 2)")
# Function call
g.DFS(2)
```

12.3 Best First Search (Informed Search)

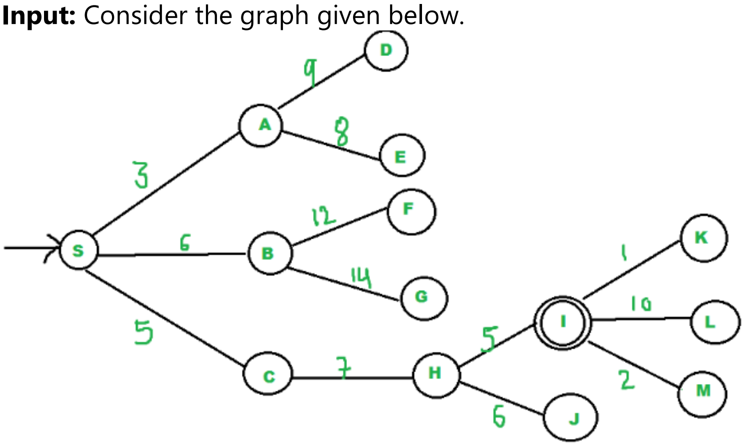
The idea of Best First Search is to use an evaluation function to decide which adjacent is most promising and then explore. Best First Search falls under the category of Heuristic Search or Informed Search.

Implementation of Best First Search:
We use a priority queue or heap to store the costs of nodes that have the lowest evaluation function value. So the implementation is a variation of BFS, we just need to change Queue to PriorityQueue.

Algorithm:
Best-First-Search(Graph g, Node start)

```
1) Create an empty PriorityQueue
   PriorityQueue pq;
2) Insert "start" in pq.
   pq.insert(start)
3) Until PriorityQueue is empty
      u = PriorityQueue.DeleteMin
      If u is the goal
         Exit
      Else
         Foreach neighbor v of u
            If v "Unvisited"
                Mark v "Visited"
                pq.insert(v)
         Mark u "Examined"
End procedure
```

Input: Consider the graph given below.



- We start from source "S" and search for goal "I" using given costs and Best First search.
- pq initially contains S
  - We remove S from pq and process unvisited neighbors of S to pq.
  - pq now contains {A, C, B} (C is put before B because C has lesser cost)
- We remove A from pq and process unvisited neighbors of A to pq.
  - pq now contains {C, B, E, D}
- We remove C from pq and process unvisited neighbors of C to pq.
  - pq now contains {B, H, E, D}
- We remove B from pq and process unvisited neighbors of B to pq.
  - pq now contains {H, E, D, F, G}
- We remove H from pq.
- Since our goal "I" is a neighbor of H, we return.

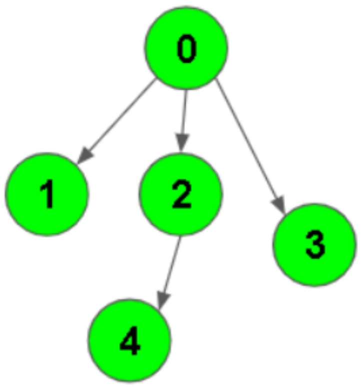
```
from queue import PriorityQueue
v = 14
graph = [[] for i in range(v)]

# Function For Implementing Best First Search
# Gives output path having lowest cost

def best_first_search(actual_Src, target, n):
    # Write code here
    …
# Function for adding edges to graph
def addedge(x, y, cost):
    # Write code here
    …
# The nodes shown in above example(by alphabets) are
# implemented using integers addedge(x,y,cost);
addedge(0, 1, 3)
addedge(0, 2, 6)
addedge(0, 3, 5)
addedge(1, 4, 9)
addedge(1, 5, 8)
addedge(2, 6, 12)
addedge(2, 7, 14)
addedge(3, 8, 7)
addedge(8, 9, 5)
addedge(8, 10, 6)
addedge(9, 11, 1)
addedge(9, 12, 10)
addedge(9, 13, 2)

source = 0
```

```
target = 9
best_first_search(source, target, v)
```

12.4 Breadth First Traversal of a Graph

Given a directed graph. The task is to do Breadth First Traversal of this graph starting from 0.
One can move from node u to node v only if there's an edge from u to v. Find the BFS traversal of the graph starting from the 0th vertex, from left to right according to the input graph. Also, you should only take nodes directly or indirectly connected from Node 0 in consideration.

Input: Consider the graph given below where V = 5, E = 4, edges = {(0,1), (0,2), (0,3), (2,4)}



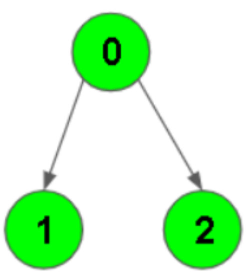
Output: 0 1 2 3 4

Explanation:

0 is connected to 1, 2, and 3.

2 is connected to 4.
So starting from 0, it will go to 1 then 2 then 3. After this 2 to 4, thus BFS will be 0 1 2 3 4.

Input: Consider the graph given below where V = 3, E = 2, edges = {(0, 1), (0, 2)}



Output: 0 1 2
Explanation:
0 is connected to 1, 2. So starting from 0, it will go to 1 then 2, thus BFS will be 0 1 2.
Your task is to complete the function **bfsOfGraph()** which takes the integer V denoting the number of vertices and adjacency list as input parameters and returns a list containing the BFS traversal of the graph starting from the 0th vertex from left to right.

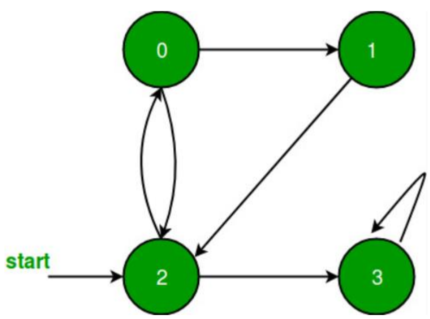
```
from typing import List
from queue import Queue
class Solution:

    # Function to return Breadth First Traversal of given graph.
```

```
    def bfsOfGraph(self, V: int, adj: List[List[int]]) -> List[int]:
        # Write code here
        …
# Driver Code
T=int(input())
for i in range(T):
      V, E = map(int, input().split())
      adj = [[] for i in range(V)]
      for _ in range(E):
            u, v = map(int, input().split())
            adj[u].append(v)
      ob = Solution()
      ans = ob.bfsOfGraph(V, adj)
      for i in range(len(ans)):
               print(ans[i], end = " ")
      print()
```

12.5 Depth First Search (DFS) for Disconnected Graph

Given a Disconnected Graph, the task is to implement DFS or Depth First Search Algorithm for this Disconnected Graph.

Input: Consider the graph given below.



Output: 0 1 2 3

Procedure for DFS on Disconnected Graph:
Iterate over all the vertices of the graph and for any unvisited vertex, run a DFS from that vertex.

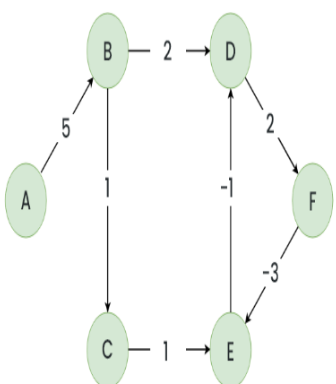
```
# DFS traversal for complete graph
from collections import defaultdict

# This class represents a directed graph using adjacency list representation
class Graph:
    # Constructor
    def __init__(self):
        # Default dictionary to store graph
        self.graph = defaultdict(list)

    # Function to add an edge to graph
    def addEdge(self, u, v):
        # Write code here
        …

    # A function used by DFS
    def DFSUtil(self, v, visited):
        # Write code here
        …
```

```
    # The function to do DFS traversal.
    # It uses recursive DFSUtil
    def DFS(self):
        # Write code here
        …
# Driver's code
print("Following is Depth First Traversal")
g = Graph()
g.addEdge(0, 1)
g.addEdge(0, 2)
g.addEdge(1, 2)
g.addEdge(2, 0)
g.addEdge(2, 3)
g.addEdge(3, 3)

# Function call
g.DFS()
```

Try:

1. **Detect a negative cycle in a Graph (Bellman Ford):** A Bellman-Ford algorithm is also guaranteed to find the shortest path in a graph, similar to Dijkstra's algorithm. Although Bellman-Ford is slower than Dijkstra's algorithm, it is capable of handling graphs with negative edge weights, which makes it more versatile. The shortest path cannot be found if there exists a negative cycle in the graph. If we continue to go around the negative cycle an infinite number of times, then the cost of the path will continue to decrease (even though the length of the path is increasing).

Consider a graph G and detect a negative cycle in the graph using Bellman Ford algorithm.



13. Minimum Spanning Tree (MST)

13.1 Kruskal's Algorithm

In Kruskal's algorithm, sort all edges of the given graph in increasing order. Then it keeps on adding new edges and nodes in the MST if the newly added edge does not form a cycle. It picks the minimum weighted edge at first and the maximum weighted edge at last.

MST using Kruskal's algorithm:

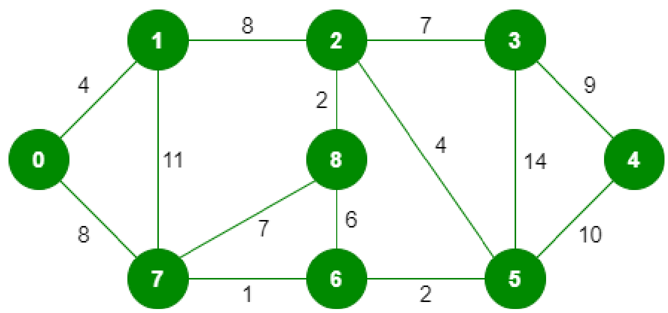
1. Sort all the edges in non-decreasing order of their weight.

2. Pick the smallest edge. Check if it forms a cycle with the spanning tree formed so far. If the cycle is not formed, include this edge. Else, discard it.

3. Repeat step#2 until there are (V-1) edges in the spanning tree.

Kruskal's algorithm to find the minimum cost spanning tree uses the greedy approach. The Greedy Choice is to pick the smallest weight edge that does not cause a cycle in the MST constructed so far.

Input: For the given graph G find the minimum cost spanning tree.



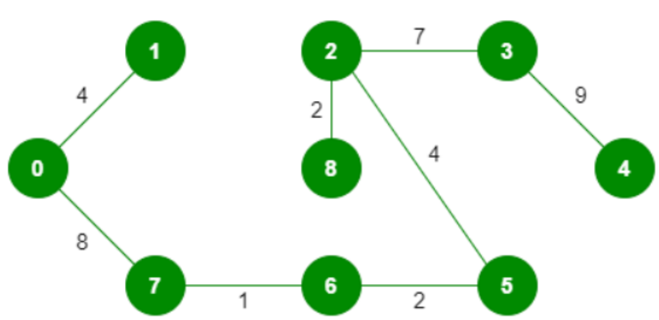
The graph contains 9 vertices and 14 edges. So, the minimum spanning tree formed will be having (9 – 1) = 8 edges.

After sorting:

Weight	Source	Destination
1	7	6
2	8	2
2	6	5
4	0	1
4	2	5
6	8	6
7	2	3
7	7	8
8	0	7
8	1	2
9	3	4
10	5	4
11	1	7
14	3	5

Now pick all edges one by one from the sorted list of edges.

Output:



```python
# Kruskal's algorithm to find minimum Spanning Tree of a given connected,
# undirected and weighted graph

# Class to represent a graph
class Graph:
    def __init__(self, vertices):
        self.V = vertices
        self.graph = []

    # Function to add an edge to graph
    def addEdge(self, u, v, w):
        self.graph.append([u, v, w])

    def find(self, parent, i):
        …

    def union(self, parent, rank, x, y):
        …

    def KruskalMST(self):
      # write your code here
      …

# Driver code
g = Graph(4)
g.addEdge(0, 1, 10)
g.addEdge(0, 2, 6)
g.addEdge(0, 3, 5)
g.addEdge(1, 3, 15)
g.addEdge(2, 3, 4)

# Function call
g.KruskalMST()
```

Output: Following are the edges in the constructed MST
2 -- 3 == 4

0 -- 3 == 5

0 -- 1 == 10

Minimum Cost Spanning Tree: 19

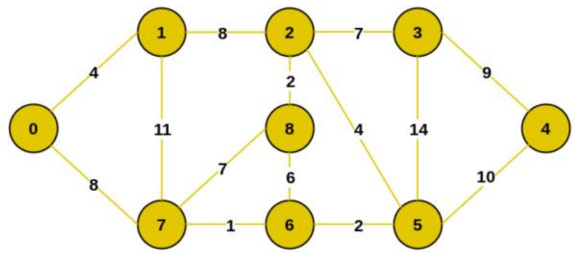
13.2 Prim's Algorithm

The Prim's algorithm starts with an empty spanning tree. The idea is to maintain two sets of vertices. The first set contains the vertices already included in the MST, and the other set contains the vertices not yet included. At every step, it considers all the edges that connect the two sets and picks the minimum weight edge from these edges. After picking the edge, it moves the other endpoint of the edge to the set containing MST.

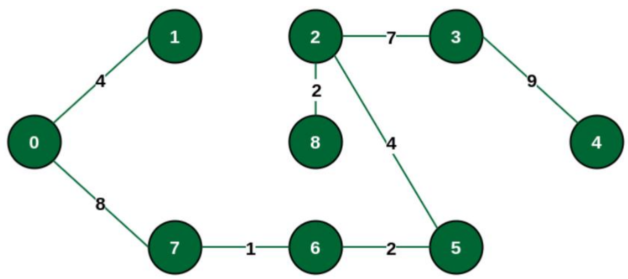
Prim's Algorithm:
The working of Prim's algorithm can be described by using the following steps:
1. Determine an arbitrary vertex as the starting vertex of the MST.
2. Follow steps 3 to 5 till there are vertices that are not included in the MST (known as fringe vertex).
3. Find edges connecting any tree vertex with the fringe vertices.

4. Find the minimum among these edges.
5. Add the chosen edge to the MST if it does not form any cycle.
6. Return the MST and exit

Input: For the given graph G find the minimum cost spanning tree.



Output: The final structure of the MST is as follows and the weight of the edges of the MST is (4 + 8 + 1 + 2 + 4 + 2 + 7 + 9) = 37.




```
# Prim's Minimum Spanning Tree (MST) algorithm.
# The program is for adjacency matrix representation of the graph

# Library for INT_MAX
import sys

class Graph():
    def __init__(self, vertices):
        self.V = vertices
        self.graph = [[0 for column in range(vertices)]
                      for row in range(vertices)]

    # A utility function to print
    # the constructed MST stored in parent[]
    def printMST(self, parent):
        print("Edge \tWeight")
        for i in range(1, self.V):
            print(parent[i], "-", i, "\t", self.graph[i][parent[i]])

    # A utility function to find the vertex with
    # minimum distance value, from the set of vertices
    # not yet included in shortest path tree
    def minKey(self, key, mstSet):
        # write your code here
        …

    def primMST(self):
       # write your code here
        …
```

```
# Driver's code
g = Graph(5)
g.graph = [[0, 2, 0, 6, 0],
           [2, 0, 3, 8, 5],
           [0, 3, 0, 0, 7],
           [6, 8, 0, 0, 9],
           [0, 5, 7, 9, 0]]

g.primMST()
```

Output:

Edge Weight

0 - 1 2

1 - 2 3

0 - 3 6

1 - 4 5

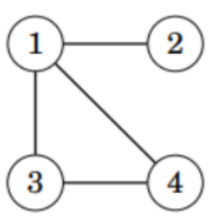
13.3 Total Number of Spanning Trees in a Graph

If a graph is a complete graph with n vertices, then total number of spanning trees is $n^{(n-2)}$ where n is the number of nodes in the graph. In complete graph, the task is equal to counting different labeled trees with n nodes for which have Cayley's formula.

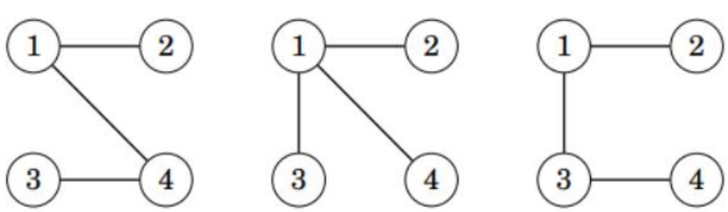
Laplacian matrix:

A Laplacian matrix L, where L[i, i] is the degree of node i and L[i, j] = −1 if there is an edge between nodes i and j, and otherwise L[i, j] = 0.

Kirchhoff's theorem provides a way to calculate the number of spanning trees for a given graph as a determinant of a special matrix. Consider the following graph,



All possible spanning trees are as follows:



In order to calculate the number of spanning trees, construct a Laplacian matrix L, where L[i, i] is the degree of node i and L[i, j] = −1 if there is an edge between nodes i and j, and otherwise L[i, j] = 0.
for the above graph, The Laplacian matrix will look like this

$$L = \begin{bmatrix} 3 & -1 & -1 & -1 \\ -1 & 1 & 0 & 0 \\ -1 & 0 & 2 & -1 \\ -1 & 0 & -1 & 2 \end{bmatrix}$$

The number of spanning trees equals the determinant of a matrix.

The Determinant of a matrix that can be obtained when we remove any row and any column from L.
For example, if we remove the first row and column, the result will be,

$$\det\left(\begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix}\right) = 3.$$

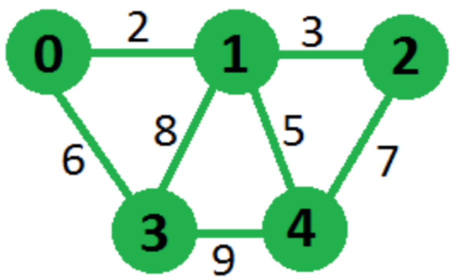
The determinant is always the same, regardless of which row and column we remove from L.

```
# Finds the number of spanning trees in a graph using Matrix Chain Multiplication.
MAX = 100
MOD = 1000000007

# Matrix Multiplication
def multiply(A, B, C):
    # write your code here
    …

# Function to find Nth power of A
def power(A, N, result):
    # write your code here
    …
# Function to find number of Spanning Trees in a Graph
# using Matrix Chain Multiplication.
def numOfSpanningTree(graph, V):
    # write your code here
    …

# Driver program
V = 4 # Number of vertices in graph
E = 5 # Number of edges in graph
graph = [[0, 1, 1, 1],
         [1, 0, 1, 1],
         [1, 1, 0, 1],
         [1, 1, 1, 0]]
print(numOfSpanningTree(graph, V))
```

13.4 Minimum Product Spanning Tree

A minimum product spanning tree for a weighted, connected, and undirected graph is a spanning tree with a weight product less than or equal to the weight product of every other spanning tree. The weight product of a spanning tree is the product of weights corresponding to each edge of the spanning tree. All weights of the given graph will be positive for simplicity.

Input:



Output: Minimum Product that we can obtain is 180 for above graph by choosing edges 0-1, 1-2, 0-3 and 1-4

This problem can be solved using standard minimum spanning tree algorithms like Kruskal and prim's algorithm, but we need to modify our graph to use these algorithms. Minimum spanning tree algorithms tries to minimize the total sum of weights, here we need to minimize the total product of weights. We can use the property of logarithms to overcome this problem.

log(w1* w2 * w3 * …. * wN) = log(w1) + log(w2) + log(w3) ….. + log(wN)

We can replace each weight of the graph by its log value, then we apply any minimum spanning tree algorithm which will try to minimize the sum of log(wi) which in turn minimizes the weight product.

```
# Minimum product spanning tree
import math

# Number of vertices in the graph
V = 5

# A utility function to find the vertex with minimum key value, from the set
# of vertices not yet included in MST
def minKey(key, mstSet):
    # write your code here
    …

# A utility function to print the constructed MST stored in parent[] and
# print Minimum Obtainable product
def printMST(parent, n, graph):
    # write your code here
    …

# Function to construct and print MST for a graph represented using adjacency
# matrix representation inputGraph is sent for printing actual edges and
# logGraph is sent for actual MST operations
def primMST(inputGraph, logGraph):
    # write your code here
    …

# Method to get minimum product spanning tree
def minimumProductMST(graph):
    # write your code here
    …

# Driver code
graph = [ [ 0, 2, 0, 6, 0 ],
          [ 2, 0, 3, 8, 5 ],
          [ 0, 3, 0, 0, 7 ],
```

```
          [ 6, 8, 0, 0, 9 ],
          [ 0, 5, 7, 9, 0 ], ]

# Print the solution
minimumProductMST(graph)
```

13.5 Reverse Delete Algorithm for Minimum Spanning Tree

In Reverse Delete algorithm, we sort all edges in decreasing order of their weights. After sorting, we one by one pick edges in decreasing order. We include current picked edge if excluding current edge causes disconnection in current graph. The main idea is delete edge if its deletion does not lead to disconnection of graph.

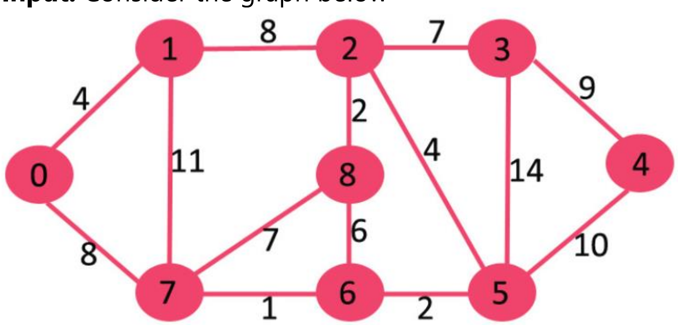
Algorithm:

1. Sort all edges of graph in non-increasing order of edge weights.

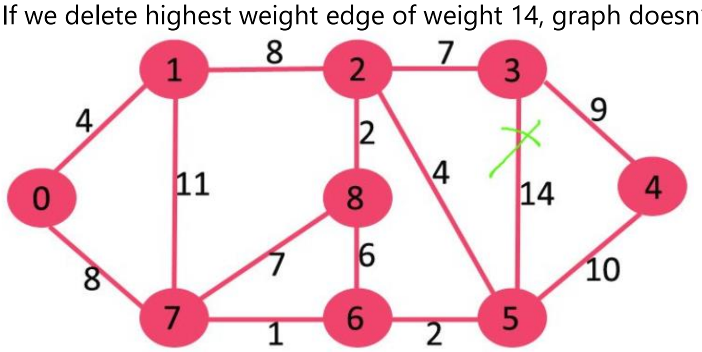
2. Initialize MST as original graph and remove extra edges using step 3.

3. Pick highest weight edge from remaining edges and check if deleting the edge disconnects the graph or not.
   If disconnects, then we don't delete the edge.
   Else we delete the edge and continue.

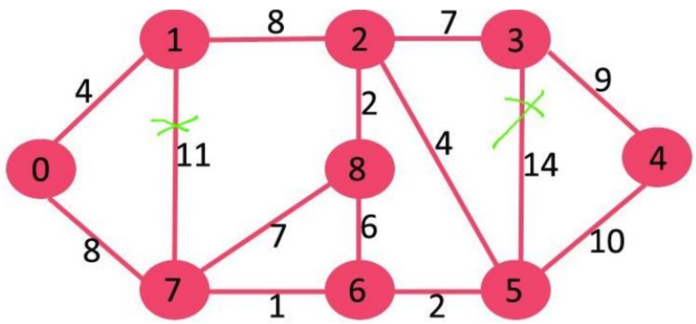
Input: Consider the graph below



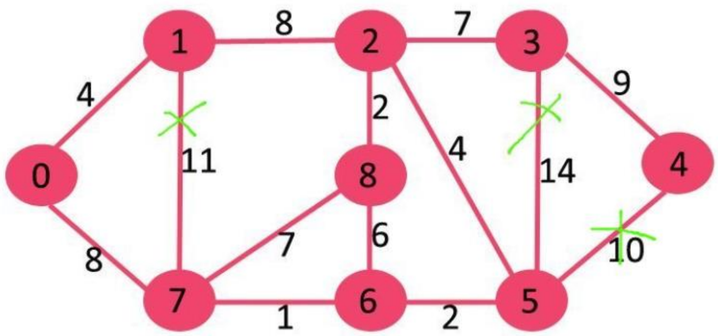
If we delete highest weight edge of weight 14, graph doesn't become disconnected, so we remove it.



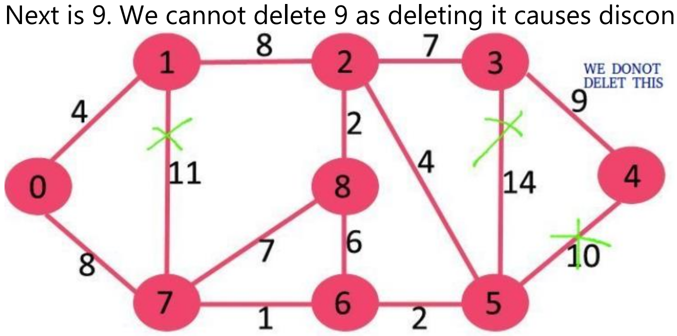
Next we delete 11 as deleting it doesn't disconnect the graph.



Next we delete 10 as deleting it doesn't disconnect the graph.



Next is 9. We cannot delete 9 as deleting it causes disconnection.



We continue this way and following edges remain in final MST.

Edges in MST

(3, 4)
(0, 7)
(2, 3)
(2, 5)
(0, 1)
(5, 6)
(2, 8)
(6, 7)

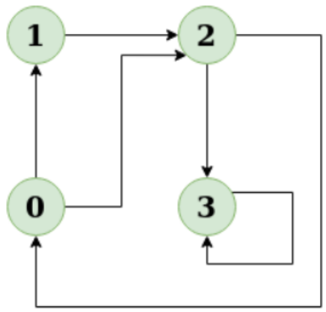
```
# Find Minimum Spanning Tree of a graph using Reverse Delete Algorithm

# Graph class represents a directed graph using adjacency list representation
class Graph:
    def __init__(self, v):

        # No. of vertices
```

```
        self.v = v
        self.adj = [0] * v
        self.edges = []
        for i in range(v):
            self.adj[i] = []

    # function to add an edge to graph
    def addEdge(self, u: int, v: int, w: int):
        # write code here
        …

    def dfs(self, v: int, visited: list):
       # write code here
        …

    # Returns true if graph is connected
    # Returns true if given graph is connected, else false
    def connected(self):
       # write code here
       …

    # This function assumes that edge (u, v) exists in graph or not
    def reverseDeleteMST(self):
        # write code here
        …

# Driver Code
# create the graph given in above figure
V = 9
g = Graph(V)

# making above shown graph
g.addEdge(0, 1, 4)
g.addEdge(0, 7, 8)
g.addEdge(1, 2, 8)
g.addEdge(1, 7, 11)
g.addEdge(2, 3, 7)
g.addEdge(2, 8, 2)
g.addEdge(2, 5, 4)
g.addEdge(3, 4, 9)
g.addEdge(3, 5, 14)
g.addEdge(4, 5, 10)
g.addEdge(5, 6, 2)
g.addEdge(6, 7, 1)
g.addEdge(6, 8, 6)
g.addEdge(7, 8, 7)

g.reverseDeleteMST()
```

Try:

1. **Detect Cycle in a Directed Graph:** Given the root of a Directed graph, The task is to check whether the graph contains a cycle or not.

Input: N = 4, E = 6



Output: Yes
Explanation: The diagram clearly shows a cycle 0 -> 2 -> 0

14. Final Notes

The only way to learn programming is program, program and program on challenging problems. The problems in this tutorial are certainly NOT challenging. There are tens of thousands of challenging problems available – used in training for various programming contests (such as International Collegiate Programming Contest (ICPC), International Olympiad in Informatics (IOI)). Check out these sites:

- The ACM - ICPC International collegiate programming contest (https://icpc.global/)
- The Topcoder Open (TCO) annual programming and design contest (https://www.topcoder.com/)
- Universidad de Valladolid's online judge (https://uva.onlinejudge.org/).
- Peking University's online judge (http://poj.org/).
- USA Computing Olympiad (USACO) Training Program @ http://train.usaco.org/usacogate.
- Google's coding competitions (https://codingcompetitions.withgoogle.com/codejam, https://codingcompetitions.withgoogle.com/hashcode)
- The ICFP programming contest (https://www.icfpconference.org/)
- BME International 24-hours programming contest (https://www.challenge24.org/)
- The International Obfuscated C Code Contest (https://www0.us.ioccc.org/main.html)
- Internet Problem Solving Contest (https://ipsc.ksp.sk/)
- Microsoft Imagine Cup (https://imaginecup.microsoft.com/en-us)
- Hewlett Packard Enterprise (HPE) Codewars (https://hpecodewars.org/)
- OpenChallenge (https://www.openchallenge.org/)

Coding Contests Scores

Students must solve problems and attain scores in the following coding contests:

Name of the contest	Minimum number of problems to solve	Required score
• CodeChef	20	200
• Leetcode	20	200
• GeeksforGeeks	20	200
• SPOJ	5	50
• InterviewBit	10	1000
• Hackerrank	25	250
• Codeforces	10	100
• BuildIT	50	500
	Total score need to obtain	2500

Student must have any one of the following certifications:

1. HackerRank - Problem Solving Skills Certification (Basic and Intermediate)
2. GeeksforGeeks – Data Structures and Algorithms Certification
3. CodeChef - Learn Data Structures and Algorithms Certification
4. Interviewbit – DSA pro / Python pro
5. Edx – Data Structures and Algorithms
5. NPTEL – Programming, Data Structures and Algorithms
6. NPTEL – Introduction to Data Structures and Algorithms
7. NPTEL – Data Structures and Algorithms
8. NPTEL – Programming and Data Structure

V. TEXT BOOKS:

1. Rance D. Necaise, "Data Structures and Algorithms using Python", Wiley Student Edition.
2. Benjamin Baka, David Julian, "Python Data Structures and Algorithms", Packt Publishers, 2017.

VI. REFERENCE BOOKS:

1. S. Lipschutz, "Data Structures", Tata McGraw Hill Education, 1st edition, 2008.
2. D. Samanta, "Classic Data Structures", PHI Learning, 2nd edition, 2004.

VII. ELECTRONICS RESOURCES:

1. https://www.tutorialspoint.com/data_structures_algorithms/algorithms_basics.htm
2. https://www.codechef.com/certification/data-structures-and-algorithms/prepare
3. https://www.cs.auckland.ac.nz/software/AlgAnim/dsToC.html
4. https://online-learning.harvard.edu/course/data-structures-and-algorithms

VIII. MATERIALS ONLINE

1. Course Content
2. Lab manual

ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

<table>
<tr><td colspan="10">III Semester: Common for all branches</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">AHSC10</td><td rowspan="2">Mandatory</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Contact Classes: Nil</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: Nil</td></tr>
<tr><td colspan="9">Prerequisite: No Prerequisites</td></tr>
</table>

COURSE OBJECTIVES:

The course should enable the students to:

I. Understand the concept of Traditional knowledge and its importance
II. Know the need and importance of protecting traditional knowledge.
III. Know the various enactments related to the protection of traditional knowledge.
IV. Understand the concepts of Intellectual property to protect the traditional knowledge

MODULE-I	INTRODUCTION TO TRADITIONAL KNOWLEDGE

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge

MODULE-II	PROTECTION OF TRADITIONAL KNOWLEDGE

Protection of traditional knowledge: The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

MODULE-III	LEGAL FRAMEWORK AND TK

A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001(PPVFR Act);

B: The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indicators act 2003.

MODULE-IV	TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

MODULE-V	TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS:

Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK. 139.

Text Books:

1. Traditional Knowledge System in India, by Amit Jha, 2009.
2. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh Pratibha Prakashan 2012.

Reference Books:

1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2

THEORY OF STRUCTURES

IV Semester: CE								
Course Code	Category	Hours/Week			Credits	Maximum Marks		
ACEC07	Core	L	T	P	C	CIA	SEE	Total
		3	1	0	4	30	70	100
Contact Classes:45	Tutorial Classes:15	Practical Classes: Nil				Total Classes:60		
Prerequisite: Strength of Materials								

I. COURSEOVERVIEW

Theory of Structures, deals with deformable solids, requires basic knowledge and principles of mechanics from Mechanics of Solids course and acts as a pre-requisite to the advanced courses on Structural Analysis and Design. This course introduces study of indeterminate beams and focuses on the deflections of determinate beams and simple trusses by energy methods. It also introduces the study of columns and struts. Eventually, through this course content, engineers can analyze the response of various structural members under different loading conditions and design the same, satisfying the safety and serviceability conditions.

II. COURSEOBJECTIVES

The Students will try to learn:

I. The behavior of different type of beams for their movement and protection under different loading conditions.
II. The concepts and applications of differential equations of various types of beams using different methods.
III. The analysis of forces in various members of steel roof trusses for different spans.
IV. Concepts of shear force and bending moment diagrams for beams subjected to point load and uniformly distributed load.

III. COURSESYLLABUS

MODULE-I:PROPPED CANTILEVERS AND FIXED BEAMS (12)

Analysis of propped cantilever and fixed beams using the method of consistent deformation, including the beams with varying moments of inertia, subjected to uniformly distributed load, central point load, eccentric point load, number of point loads, uniformly varying load and combination of loads, shear force and bending moment diagrams for propped cantilever and fixed beams, effect of sinking of support, effect of rotation of a support.

MODULE–II:CONTINUOUS BEAMS (12)

Introduction, Continuous beams, Clapeyron's theorem of three moments, analysis of continuous beams with constant and variable moments of inertia with one or both ends fixed, continuous beams with overhang; effects of sinking of supports.

MODULE–III:DEFLECTION OF BEAMS (12)

Introduction, Differential equation of deflected beam, Slope and deflection at a point, double integration and Macaulay's methods, determination of slope and deflection for cantilever and simply supported beams subjected to point loads.

Uniformly distributed load and uniformly varying load- Mohr's theorems, moment area method, application to simple cases, conjugate beam method, application to simple cases.

MODULE–IV:ANALYSIS OF TRUSSES AND ENERGY METHODS (12)

ANALYSIS OF TRUSSES: Definition – Perfect, Deficient and Redundant frames – Methods of Analysis - Analysis of simple trusses by method of joints and method of sections.

ENERGY METHODS: Introduction-Strain energy in linear elastic system, expression of strain energy due to axial load, bending moment and shear forces, Castigliano's first theorem, deflections of simple beams and pin jointed trusses.

MODULE–V:COLUMNS AND STRUTS (12)

Introduction, slenderness ratio, equivalent length, Euler's formulae for long columns with different end conditions, Rankine's and I.S. Code formulae, combined direct and bending stresses, eccentric loading, Limit of eccentricity and core of section.

IV. TEXT BOOKS

1. R. K. Bansal, "A Textbook of Strength of Materials", Laxmi publications Pvt. Ltd., New Delhi, 2^{nd} Edition, 2007.
2. F. Beer, E. R. Johnston, J. DeWolf, "Mechanics of Materials", Tata McGraw-Hill Publishing Company Ltd., New Delhi, India, 1st Edition, 2008.
3. S. S. Bhavikatti, "Strength of Materials", Vikas Publishing House Pvt. Ltd., New Delhi, 5^{th}Edition, 2013.

V. REFERENCE BOOKS

1. B. C. Punmia, Ashok K Jain and Arun K Jain, "Mechanics of Materials", Laxmi Publications Pvt. Ltd., New Delhi, 12^{th} Edition, 2007.
2. R. Subramanian, "Strength of Materials", Oxford University Press, 2^{nd}Edition, 2010.
3. Hibbeler, R. C., "Mechanics of Materials", East Rutherford, NJ: Pearson Prentice Hall, 6^{th} Edition 2004.

VI. WEB REFERENCES

1. http://www.nptelvideos.in/2012/11/strength-of-materials- prof.html
2. http://ocw.mit.edu/courses/civil-and-environmental-engineering/1-050-solid-mechanics-fall-2004/lecturenotes/
3. https://www.youtube.com/watch?v=coRgpxG2pyY&list=PLLbvVfERDon3oDfCYxkwRct1Q6YeOzi9g

VII. E-TEXTBOOKS:

1. http://www.freeengineeringbooks.com/Civil/Strength-of-Material-Books.php
2. http://royalmechanicalbuzz.blogspot.in/2015/04/strength-of-materials-book-by-r-k-bansal.html
3. https://books.google.co.in/books?id=I8gg0Q4OQ4C&printsec=frontcover&dq=STRENGTH+OF+MATERIALS&hl=en&sa=X&ved=0ahUKEwjpveCD44HgAhWBad4KHacUAgYQ6AEIMDAB#v=onepage&q=STRENGTH%20OF%20MATERIALS&f=false.

PROBABILITY AND STATISTICS

<table>
<tr><td colspan="10">II Semester: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT

III Semester: AE | ME | IV Semester: CE</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">AHSC08</td><td rowspan="2">Foundation</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: 15</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 60</td></tr>
<tr><td colspan="10">Prerequisite: Fundamentals of statistics</td></tr>
</table>

I. COURSE OVERVIEW:

Probability theory is the branch of mathematics that deals with modelling uncertainty. Inferential Statistics and regression analysis together with random variate distributions are playing an exceptional role in designing data driven technology which is familiarly known as data centric engineering. They also have wide variety applications in telecommunications and other engineering disciplines. The course covers advanced topics of probability and statistics with applications. The course includes: random variables, probability distributions, hypothesis testing, confidence intervals, and linear regression. There is an emphasis placed on real-world applications to engineering problems.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The theory of random variables, basic random variate distributions and their applications.
II. The Methods and techniques for quantifying the degree of closeness among two or more variables and linear regression analysis.
III. The Estimation statistics and Hypothesis testing which play a vital role in the assessment of the quality of the materials, products and ensuring the standards of the engineering process.
IV. The statistical tools which are essential for translating an engineering problem into probability model.

III. COURSE SYLLABUS:

MODULE-I: RANDOM VARIABLES (12)

Random variables: Basic definitions, discrete and continuous random variables; Probability distribution: Probability mass function and probability density functions.

MODULE –II: PROBABILITY DISTRIBUTION (12)

Binomial distribution; Mean and variances of Binomial distribution, Poisson distribution: Poisson distribution as a limiting case of Binomial distribution, mean and variance of Poisson distribution, Normal distribution; Mean, Variance, Mode, Median of Normal distribution.

MODULE –III: CORRELATIONS AND REGRESSION (12)

Correlation: Karl Pearson's Coefficient of correlation, Rank correlation, Repeated Ranks.

Regression: Lines of regression, Regression coefficient, Angle between two lines of regression.

MODULE –IV: TEST OF HYPOTHESIS - I (12)

Sampling: Population, Sampling, standard error; Test of significance: Null hypothesis, alternate hypothesis; Large sample tests: Test of hypothesis for single mean, difference between means, single proportion and difference between proportions.

MODULE –V: TEST OF HYPOTHESIS - II (12)

Small sample tests: Student t-distribution, F-distribution and Chi-square distribution.

IV. TEXT BOOKS:

1. ErwinKreyszig, "AdvancedEngineering Mathematics", John Wiley & Sons Publishers, 9th Edition, 2014.
2. B.S. Grewal, "HigherEngineeringMathematics", Khanna Publishers, 42nd Edition, 2012.

V. REFERENCE BOOKS:

1. S. C. Gupta,V.K.Kapoor, "Fundamentals of Mathematical Statistics", S. Chand & Co., 10th Edition, 2000.
2. N. P. Bali, "Engineering Mathematics", Laxmi Publications, 9th Edition, 2016.

3. Richard Arnold Johnson, Irwin Millerand John E. Freund, "Probability and Statistics for Engineers", Prentice Hall, 8th Edition, 2013.

VI. WEB REFERENCES:

1. http://www.efunda.com/math/math_home/math.cfm
2. http://www.ocw.mit.edu/resourcs/#Mathematics
3. http://www.sosmath.com
4. http://www.mathworld.wolfram.com

VII. E-TEXT BOOKS:

1. http://www.keralatechnologicaluniversity.blogspot.in/2015/06/erwin-kreyszig-advanced-engineering- mathematics-ktu-ebook-download.html
2. http://www.faadooengineers.com/threads/13449-Engineering-Maths-II-eBooks

HYDRAULICS AND HYDRAULIC MACHINERY

IV Semester: CE								
Course Code	Category	Hours/Week			Credits	Maximum Marks		
ACEC08	Core	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes:45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisite: Fluid Mechanics								

I. COURSE OVERVIEW

This course is intended to introduce basic principles of fluid mechanics. It is further extended to cover the application of fluid mechanics by the inclusion of fluid machinery especially water turbine and water pumps. Now days the principles of fluid mechanics find wide applications in many situations directly or indirectly. The use of fluid machinery, turbines pumps in general and in power stations in getting as accelerated fill up. Thus, there is a great relevance for this course for mechanical technicians. The Mechanical technicians have to deal with large variety of fluids like water, air, steam, ammonia and even plastics. The major emphasis is given for the study of water. However, the principle dealt with in this course will be applicable to all incompressible fluids.

II. COURSE OBJECTIVES

The Students will try to learn:

1. The importance of study of open channel flow, to give brief description on different types of flows and channels and hydraulic design principles of channels.
2. The fundamentals of Uniform and Non-Uniform flow in open channels and importance of specific energy, critical flow and their applications.
3. The gradually varied flow and rapidly varied flow and their equations and computations and the concepts of momentum principles.
4. The working principles, functions and applications of pumps and turbines.

III. COURSESYLLABUS

MODULE – I: OPEN CHANNEL FLOW (09)

Types of flows, types of channels, channel characteristics, velocity distribution, determination of velocity using empherical methods, economical sections, critical flow, critical depth, specific energy, hydraulic jump.

MODULE – II: BOUNDARY LAYER THEORY (09)

Viscous fluid flow – Boundary conditions – Development of boundary layer – Estimation of boundary layer thickness – Displacement thickness, momentum and energy thickness Characteristics of boundary layer along a thin flat plate, Vonkarmon momentum integral equation, laminar and turbulent Boundary layers separation of BL, control of BL, flow around submerged objects.

MODULE – III: IMPACT OF JETS AND HYDRAULIC TURBINES (09)

IMPACT OF JETS: Hydrodynamic force of jets on stationary, moving plates, jet striking centrally and at tip of symmetrical and unsymmetrical vanes, jet striking on series of straight and curved vanes. Velocity triangles at inlet and outlet, principle of angular momentum.

HYDRAULIC TURBINES: Classification of hydraulic turbines, selection of hydraulic turbines, working, design principles of impulse and reaction turbines, draft tube, theory and function efficiency, layout of hydropower plant, types of heads and efficiencies.

MODULE – IV: CENTRIFUGAL PUMPS (09)

Classification of pumps, work done, manometric head, minimum starting speed, losses and efficiency, specific speed, multistage pump, pumps in parallel, performance of pumps, design of centrifugal pumps, NPSH, cavitation in pumps.

MODULE – V: DIMENSIONAL ANALYSIS (09)

Dimensional Analysis, dimensionless numbers, methods of dimensional analysis (Buckingham's π-Theorem). Concept of similitude – model and prototype.

IV. TEXT BOOKS

1. Subramanya K. "Open Channel Flow", Tata McGraw Hill Publications, New Delhi, 2008.
2. Modi,Seth, "Fluid Mechanics Hydraulic and Hydraulic Machines", Standard Book House, 2011.
3. Pillai Narayan,Rama KrishnaCR, Universities press,2006.

V. REFERENCE BOOKS

1. Ojha CSP, Chandramouli P. N., Berndtsson R., "Fluid Mechanics and Machinery", Oxford University Press, 2010.
2. Chow V.T., "Open Channel Hydraulics", Blackburn Press, 2009.
3. Rajput R.K., "A Text Book of Fluid Mechanics", S.Chand Publications, 1998.
4. Franck N. White, "Fluid Mechanics", Tata McGraw Hill Publications, 8th Edition, 2015.

VI.WEB REFERENCES

1. http://nptel.ac.in/courses/112104117/
2. http://nptel.ac.in/courses/105103096/
3. http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/TOC.htm

VII.E-TEXTBOOKS

1. https://drive.google.com/file/d/0B9_2yANiGJ12aWJrSGJZVjlxbHM/view
2. https://books.google.co.in/books?id=mLpf6YjHM5AC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

BUILDING MATERIALS – PLANNING AND CONSTRUCTION

IV Semester: CE							
Course Code	Category	Hours/Week			Credits	Maximum Marks		
ACEC09	Core	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes:45	Tutorial Classes: Nil	Practical Classes: Nil				TotalClasses:45		
Prerequisite: No prerequisites required								

I. COURSEOVERVIEW

The construction materials course introduces students to materials used in different construction projects from building materials to ground and foundation make-up. Specific materials studied include soil, metals, concrete and wood. This course also covers finishes and materials for the exterior and interior of buildings. Skills are developed to assess the effect materials have on a building projects related to structure, fire safety, building codes as well as market demand. A large part of construction management has to do with overseeing entire building projects or multiple construction projects. This course helps to develop students' skills in managing projects and people. This course may be taken at different times in a construction management program with an emphasis on residential or commercial construction.

II. COURSEOBJECTIVES

The Students will try to learn:

1. The basics of material science and behavior of various building materials used in construction.
2. The construction materials required for the assigned work.
3. The procedural knowledge of the simple testing methods of cement, lime and concrete etc.
4. The requirements and different types of stairs.

III. COURSESYLLABUS

MODULE – I: STONES, BRICKS AND AGGREGATES (09)

Properties of building stones, relation to their structural requirements. Classification of stones, stone quarrying, precautions in blasting, dressing of stone, composition of good brick earth, various methods of manufacture of bricks, Comparison between clamp burning and kiln burning; Fine aggregate: Natural and manufactured: Sieve analysis, specify gravity, bulking, moisture content, deleterious materials; Coarse aggregate: Natural and manufactured: Importance of size, shape and texture.

MODULE – II: CEMENT AND ADMIXTURES (09)

Various types of cement and their properties; Various file and laboratory tests for cement; Various ingredients of cement concrete and their importance, various tests for concrete-Field tests, admixtures- mineral and chemical admixture.

MODULE – III: ALTERNATIVE MATERIALS AND MASONRY (09)

Wood - structure, properties, seasoning of timber; Classification of wood, defects in timber; Alternative materials for wood - galvanized iron, fiber reinforced plastics, steel, aluminum and glass.

Masonry - types of masonry, English and Flemish bonds, rubble and ashlars masonry.

MODULE – IV: BUILDING COMPONENTS (09)

Lintels, arches, different types of floors-concrete, mosaic, terrazzo floors; Roofs - pitched, flat and curved roofs, lean-to-roof, coupled roofs, RCC roofs, madras terrace and shell roofs. Trussed roofs- king and queen post trusses; Foundations: Shallow foundations, spread, combined, strap and mat footings. Stair case: Definitions, technical terms and types of stairs, requirements of good stairs, introduction to geometrical design of stairs, lifts, ramps, elevators and escalators – types and purpose.

MODULE – V: BUILDING PLANNING (09)

Building planning - significance, scope, principles of building planning, classification of buildings and building by laws, Introduction to National Building Codes (NBC) – guidelines and regulations.

IV. TEXT BOOKS

1. S. K. Duggal, "Building Materials", New Age International (P) Limited, 4th Edition, 2016, National Building Code (NBC) of India.
2. Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, "Building Construction, Laxmi Publications (P) ltd., New Delhi.
3. Rangawala S. C. "Engineering Materials", Charter Publishing House, Anand, India.

V. REFERENCE BOOKS

1. Sushil Kumar "Building Materials and construction", Standard Publishers, 20th Edition, reprint, 2015.
2. P C Vergese, "Building Materials", PHI Learning Pvt. Ltd, 2nd Edition, 2015.
3. Building Materials and Components, CBRI, India, 1990.
4. Jagadish. K.S, "Alternative Building Materials Technology", New Age International, 2007.
5. M. S. Shetty, "Concrete Technology", S. Chand & Co. New Delhi, 2005.

VI. WEB REFERENCES

1. http://nptel.ac.in/courses/105102088/
2. http://nptel.ac.in/courses/105101088/

VII.E-TEXTBOOKS

1. http://www.freeengineeringbooks.com/civil-books-download/building-materials-construction.php
2. http://www.freeengineeringbooks.com/civil-books-download/building-materials.php

CONCRETE TECHNOLOGY

IV Semester: CE								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
ACEC10	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	30	70	100
Contact Classes:45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes:45**		
Prerequisite: No prerequisites required								

I. COURSEOVERVIEW

The course Concrete Technology focuses on concrete making materials including supplementary cementitious materials. Concrete production process also forms a part of the discussion. Going through the course one would develop first-hand knowledge on concrete production process and properties and uses of concrete as a modern material of construction. The courses will enable one to make appropriate decision regarding ingredient selection and use of concrete.

II. COURSEOBJECTIVES

The Students will try to learn:

1. The physical and chemical properties of cement and admixtures
2. The workability of concrete, manufacturing processes of concrete and the behavior of the hardened concrete.
3. Identify, formulate and solve problems in concrete mix design.
4. The practical knowledge on mix design principles, concepts and methods.

.

III. COURSESYLLABUS

MODULE – I: CEMENT, ADMIXTURES AND AGGREGATES (09)

Portland cement: Manufacturing of cement, chemical composition, hydration, setting of cement, structure of hydrated cement, test on physical properties, different grades of cement. Admixtures: Mineral and chemical admixtures, properties, dosage, effects, usage. Aggregates: Classification of aggregate, particle shape & texture bond, strength & other mechanical properties of aggregate, specific gravity, bulk density, porosity, adsorption & moisture content of aggregate, bulking of sand, deleterious substances in aggregate, soundness of aggregate, alkali aggregate reaction, thermal properties, sieve analysis, fineness modulus, grading curves, grading of fine & coarse aggregates, gap graded aggregate.

MODULE – II: FRESH CONCRETE (09)

Workability: Factors affecting workability, measurement of workability by different tests, setting times of concrete, the effect of time and temperature on workability, segregation & bleeding, mixing and vibration of concrete, steps in manufacture of concrete, quality of mixing water.

MODULE – III: HARDENED CONCRETE AND TESTING (09)

Water / Cement ratio: Abram's Law, Gel space ratio, Nature of strength of concrete, maturity concept, strength in tension and compression, factors affecting strength, relation between compression and tensile strength, curing.

Testing of hardened concrete: compression tests, tension tests, flexure tests, split tests, Non-Destructive Testing methods, codal provisions for NDT; Elasticity: modulus of elasticity, dynamic modulus of elasticity, Poisson's ratio, Creep - factors influencing creep, relation between creep and time, nature of creep, effects of creep. Shrinkage - types of shrinkage.

MODULE – IV: MIX DESIGN (09)

Factors in the choice of mix proportions, durability of concrete, quality control of concrete, statistical methods, acceptance criteria, BIS method of mix design.

MODULE – V: SPECIAL CONCRETES (09)

Light weight aggregate concrete - cellular concrete, No-fines concrete; Fiber Reinforced Concrete: different types of fibers, factors affecting properties of F.R.C, applications. Polymer concrete - types of polymer concrete, properties of polymer concrete, applications, high-Performance concrete, high strength concrete, high-density concrete, Self-Consolidating Concrete, SIFCON.

IV. TEXT BOOKS

1. Shetty, M.S., "Concrete Technology, Theory & Practice", S.Chand and Co, 2004.
2. Gambhir, M.L., "Concrete Technology", Tata McGraw Hill, 2004.
3. Nevile, "Properties of Concrete", Longman Publishers, 2004.

V. REFERENCE BOOKS

1. V.N.Vazirani & S.P.Chandola, Ed. by Vineet Kumar," Concrete Technology", 6th Edition reprint.
2. Santakumar A.R., "Concrete Technology", Oxford University Press, New Delhi, 2007

VI. WEB REFERENCES

1. http://nptel.ac.in/courses/105102012/
2. http://nptel.ac.in/courses/105104030/

VII. E-TEXTBOOKS

1. http://www.freeengineeringbooks.com/civilbooksdownload/ConcreteTechnology.php
2. http://www.faadooengineers.com/threads/10428Concretetechnologyebookfreedownload
3. https://books.google.com.au/books/about/Concrete_Technology.html?id...

EXPERIENTIAL ENGINEERING EDUCATION (EXEED) – FABRICATION / MODEL DEVELOPMENT

IV Semester: Common for all branches							
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACSC14	Foundation	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		2	0	0	1	30	70	100
Contact Classes: 28	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 28**		
Prerequisite: There are no prerequisites to take this course								

I. COURSE OVERVIEW:

This course provide the environment to develop high-tech, ecological and socially responsible products from concept and design to production. The course covers hands-on learning in product and industrial design and product development with product lifecycle management.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The design thinking process and Identify opportunities through customer needs analysis.
II. Product specifications based on customer needs that are desirable, feasible, and viable through applied creativity.
III. The Implementation techniques for planning and executing a prototype design services.

WEEK NO	TOPIC
WEEK – I	Introduction To Product Design
WEEK – II	Design Thinking Skills
WEEK – III	Identifying Customer Needs
WEEK – IV	Product Specifications
WEEK – V	Applied Creativity
WEEK – VI	Prototyping
WEEK – VII	Design Of Services
WEEK –VIII	Product Architecture
WEEK - IX	Financial Analysis
WEEK - X	Design For Environment
WEEK - XI	Product Development Process
WEEK - XII	Reverse Engineering
WEEK - XIII	Value Engineering
WEEK - XIV	Assessment

CONCRETE TECHNOLOGY LABORATORY

III SEMESTER: CE									
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACEC11	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		0	0	2	1	30	70	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 24**				**Total Classes: 24**		
Prerequisite: **No prerequisites required**								

I. COURSEOVERVIEW

Concrete production process also forms a part of the discussion. Going through the course one would develop first-hand knowledge on concrete production process and properties and uses of concrete as a modern material of construction. The courses will enable one to make appropriate decision regarding ingredient selection and use of concrete.

II. COURSE OBJECTIVES

The students will try to learn:

1. The practical knowledge regarding concrete testing equipment and their operation.
2. The demonstration tests on cement, aggregates and concrete.
3. The observation of the behavior of concrete materials and their properties.
4. The knowledge and application of safety regulations.

III. COURSE SYLLABUS

Week-l: INTRODUCTION TO CONCRETE TECHNOLOGY

Introduction to concrete technology laboratory

Week-2: FINENESS OF CEMENT

Fineness of cement.

Week-3: NORMAL CONSISTENCY OF CEMENT

Normal consistency of cement.

Week-4: INITIAL AND FINAL SETTING TIMES OF CEMENT

Initial and final setting times of cement

Week-5: SPECIFIC GRAVITY OF CEMENT

Specific gravity of cement

Week-6: COMPRESSIVE STRENGTH OF CEMENT

Compressive strength of cement

Week-7: SOUNDNESS OF CEMENT

Soundness of cement

Week-8: FINENESS MODULUS OF FINE AND COARSE AGGREGATE

Fineness modulus of fine and Coarse Aggregate

Week-9: BULKING OF SAND

Bulking of sand

Week-10: WORKABILITY TESTS ON FRESH CONCRETE

Workability tests on fresh concrete

Week-11: TEST FOR COMPRESSIVE STRENGTH OF CEMENT CONCRETE

Test for compressive strength of cement concrete.

Week-12: STUDIES ON NON-DESTRUCTIVE TESTING OF CONCRETE

Introduction to Non-destructive test methods.

IV. TEXT BOOK

1. Humanhood and LN Mittal, "Laboratory Manual on Concrete Technology", CBS Publishers Pvt. Ltd., New Delhi, 2nd Edition, 2013.
2. Khanna S.K and Justo C.E.G., "Pavement Materials and Testing" Tata McGraw Hill Education, 2012.

V. WEB REFERENCES

1. https://nptel.ac.in/courses/105102012/

HYDRAULICS AND HYDRAULIC MACHINERY LABORATORY

IV SEMESTER: CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC12	Core	L	T	P	C	CIA	SEE	Total
		0	0	3	1.5	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 36				Total Classes: 36		
Prerequisite: No prerequisites required								

I. COURSEOVERVIEW

The Hydraulics Laboratory course is an indispensable supplement to the theory. It covers measuring devices and techniques, error analysis in experimental works and analysis of assumptions in the theory of fluid mechanics. Hydraulics and fluid mechanics, or the study of liquids, is an important area for civil engineers. Whether designing a steam engine, or working on a pump or turbine, civil engineers need to know how the water or liquid is going to move or operate. This allows them to create and maintain important machines that power our everyday world.

II. COURSE OBJECTIVES

The students will try to learn:

I. The concept of fluid mechanics and hydraulic machines.
II. The demonstration on the classical experiments in fluid mechanics and hydraulic machinery.
III. The mechanism flow measuring devices such as Venturi meter, orifice meter and notches etc.
IV. The performance characteristics of turbines and pumps.

III. COURSE SYLLABUS

Week-l: INTRODUCTION TO FLUID MECHANICS AND HYDRAULIC MACHINES LAB

Introduction to Fluid Mechanics and Hydraulic Machinery laboratory

Week-2: CALIBRATION OF VENTURIMETER AND ORIFICE METER

Determination of Co-efficient of discharge through Venturi meter and Orifice meter.

Week-3: VERIFICATION OF BERNOULLI'S EQUATION FOR HORIZONTAL AND INCLINED PIPE

Verification of Bernoulli 's equation for horizontal and inclined pipes

Week-4: DETERMINATION OF FRICTION FACTOR OF CIRCULAR AND NON – CIRCULAR PIPES

Determination of friction factor of pipe of circular and non – circular pipes

Week-5: DETERMINATION OF HEAD LOSS DUE TO MINOR LOSSES IN A PIPE

Determination of head losses in a pipe due to sudden contraction and sudden expansion

Week-6: CALIBRATION OF RECTANGULAR, TRIANGULAR AND TRAPEZOIDAL NOTCH

Determination of Co-efficient of discharge through rectangular, triangular and trapezoidal notches

Week-7: IMPACT OF JET ON VANES (FLAT, CURVED VANES)

Determination of Co-efficient of impact due to jet on flat, curved vanes.

Week-8: PERFORMANCE TEST ON PELTON TURBINE

Determination of the efficiency of Pelton Wheel turbine

Week-9: PERFORMANCE TEST ON REACTION TURBINE

Determination of the efficiency of either Francis or Kaplan turbine

Week-10: PERFORMANCE TEST ON SINGLE STAGE CENTRIFUGAL PUMP

Determination of the maximum efficiency of multi stage centrifugal pump

Week-11: PERFORMANCE TEST ON MULTI STAGE CENTRIFUGAL PUMP

Determination of the maximum efficiency of multi stage centrifugal pump

Week-12: PERFORMANCE TEST ON SINGLE ACTING RECIPROCATING PUMP

Determination of the maximum efficiency of single acting reciprocating pump

IV. TEXT BOOKS

1. C.S.P.Ojha, R. Berndtsson and P. N. Chadramouli, ‘Fluid Mechanics and Machinery’, Oxford University Press, 2010
2. P M Modi and S M Seth, ‘Hydraulics and Fluid Mechanics’, Standard Book House.
3. K. Subramanya, ‘Theory and Applications of Fluid Mechanics’, Tata McGraw Hill.
4. R.L. Daugherty, J.B. Franzini and E.J. Finnemore, ‘Fluid Mechanics with Engineering Applications’, International, Student Edition, Mc Graw Hill.

V. WEB REFERENCES

1. http://site.iugaza.edu.ps/mymousa/files/Fluid-Mechanics-and-Hydraulics-Lab-Manual-2015-.pdf
2. http://www.public.asu.edu/~lwmays/classes/cee341/manual.pdf
3. https://issuu.com/loisburchette4023/docs/fluid-mechanics-lab-manual-for-mech

STRENGTH OF MATERILAS LABORATORY

IV SEMESTER: CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC13	Core	L	T	P	C	CIA	SEE	Total
		0	0	3	1.5	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 36				Total Classes: 36		
Prerequisite: No prerequisites required								

I. COURSE OVERVIEW

Students will be able to understand the theoretical concepts of solid mechanics course and enable them to apply it practically in this laboratory. Different types of tests are conducted in this laboratory as per standards (ASTM and IS) to know the various mechanical properties of a material such as young's modulus, shear modulus, hardness, toughness, deflection, fatigue strength etc.

II. COURSE OBJECTIVES

The students will try to learn:

I. The mechanical properties of different solid engineering materials.
II. The behavior of various material samples under different loads and equilibrium conditions.
III. The experiments with materials subjected to tension, compression, shear, torsion, bending and impact.
IV. The material testing data and its interpretation.

III. COURSE SYLLABUS

Week-l: DIRECT TENSION TEST

Direct Tension test: To evaluate the tensile strength, the elastic limits and the young „s modulus of a mild steel bar in tension using the universal testing machine.

Week-2: BENDING TEST ON CANTILEVER BEAM

To evaluate the deflections of the beam made of wood and steel.

Week-3: BENDING TEST ON SIMPLY SUPPORTED BEAM

To evaluate the deflections of the beam made of wood and steel.

Week-4: TORSION TEST

To conduct torsion test on mild steel or cast iron specimen to determine modulus of rigidity.

Week-5: HARDNESS TEST

To conduct hardness test on mild steel, carbon steel, brass and aluminum specimens using Brinell's Hardness Testand Rockwell's Hardness Test

Week-6: SPRING TEST

To determine the stiffness and modulus of rigidity of a spring wire.

Week-7: COMPRESSION TEST

To perform compression test on UTM for Wooden block and Concrete block.

Week-8: IMPACT TEST

To evaluate the impact strength of steel specimen using Izod test and Charpy Test

Week-9: SHEAR TEST

To evaluate the shear strength of the given specimens using universal testing machine.

Week-10: BEAM DEFLECTIONS

To verify the Maxwell's reciprocal theorem for beam deflections.

Week-11: STRAIN MEASUREMENT
Use of electrical resistance strain gauges.

Week-12: DEFLECTION OF CONTINUOUS BEAM
To evaluate deflections on a continuous beam.

IV. REFERENCE BOOKS

1. Hibbeler, R. C. Mechanics of Materials. 6th ed. East Rutherford, NJ: Pearson Prentice Hall, 2004
2. Crandall, S. H., N. C. Dahl, and T. J. Lardner. An Introduction to the Mechanics of Solids. 2nd Edition. New York, NY: McGraw Hill, 1979.
3. William Kendrick Hatt, "Laboratory Manual of Testing Materials", Andesite Press, 2017.

V. WEB REFERENCES

1. https://home.iitm.ac.in/kramesh/Strength%20of%20Materials%20Laboratory%20Manual.pdf
2. http://www.atri.edu.in/images/pdf/departments/SOM%20LAB%20MANUAL.pdf
3. https://www.iitg.ac.in/mech/lab_sml.php

FUNDAMENTALS OF DATABASE SYSTEMS

IV Semester: CE / EEE / ME / ECE / AE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACSC18	SKILL	L	T	P	C	CIA	SEE	Total
		-	-	-	-	-	-	-
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: Nil		

I. COURSE OVERVIEW

The fundamentals of Database systems are vital components of modern information systems. Database applications all pervasive and range in size from small in-memory databases to terabytes or even larger in various applications domains. The course focuses and the fundamentals of knowledgebase and relational database management systems, and the current developments in database theory and their practices.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The role of database management system in an organization and learn the database concepts.
II. The design databases using data modeling and data normalization techniques.
III. Construct database queries using relational algebra and calculus.
IV. The concept of a database transaction and related database facilities.

III. COURSE SYLLABUS:

MODULE: I CONCEPTUAL MODELING (10)

Introduction to file and database systems: Database system structure, data models: entity relationship model, relational model.

MODULE: II RELATIONAL APPROACH (08)

Relational algebra and calculus: Relational algebra, selection and projection, set operations, renaming, joins, division, examples of algebra queries, relational calculus, tuple relational calculus.

MODULE : III BASIC SQL QUERY AND NORMALIZATION (10)

SQL data definition; Queries in SQL: updates, views, integrity and security, relational database design.

Normal Forms: 1NF, 2NF, 3NF and BCNF.

MODULE : IV TRANSACTION MANAGEMENT (09)

Transaction processing: Introduction, need for concurrency control, desirable properties of transaction, schedule and recoverability, Serializability and schedules

MODULE : V CONCURRENCY CONTROL (08)

Concurrency control; Types of locks: Two phases locking, deadlock, timestamp based concurrency control, recovery techniques, concepts, immediate update, deferred update, shadow paging.

IV. TEXT BOOKS:

Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw-Hill, 4thEdition, 2002.

V. REFERENCE BOOKS:

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamental Database Systems", Pearson Education, 3rdEdition, 2003.
2. Raghu Ramakrishnan, "Database Management System", Tata McGraw-Hill Publishing Company, 3rd Edition, 2003.

3. Hector Garcia Molina, Jeffrey D. Ullman, Jennifer Widom, "Database System Implementation", Pearson Education, United States, 1st Edition, 2000.
4. Peter Rob, Corlos Coronel, "Database System, Design, Implementation and Management", Thompson Learning Course Technology, 5th Edition, 2003.

VI. WEB REFERENCES:

1. https://www.youtube.com/results?search_query=DBMS+onluine+classes
2. http://www.w3schools.in/dbms/
3. http://beginnersbook.com/2015/04/dbms-tutorial/

VII. E-TEXT BOOKS

1. http://www.e-booksdirectory.com/details.php?ebook=10166
2. http://www.e-booksdirectory.com/details.php?ebook=7400re

ANALYSIS OF STRUCTURES

V Semester: CE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC14	Core	L	T	P	C	CIA	SEE	Total
		3	1	0	4	30	70	100
Contact Classes: 45	Tutorial Classes:15	Practical Classes: Nil				Total Classes: 60		
Prerequisite: Theory of Structures								

I. COURSE OVERVIEW:

The course of Structural Engineering comprises a set of fundamental theorems of mechanics that obey physical laws required to study and predict the behavior of structures for computation of deformations, internal forces and stresses. This course mainly discusses the energy, force and displacement methods for the analysis of arches, determinate and indeterminate beams and trusses. This course also includes the effects of rolling loads on bridge girders and truss girders. Through this course content engineers can analyze the response of various structural members under different loading conditions for design, safety and serviceability.

II. COURSE OBJECTIVES:

The Students will try to learn:

I. The behavior of arches under the action of uniformly distributed loads and concentrated loads.
II. The concepts of energy methods for analyzing the components of various industrial structures.
III. The analysis of indeterminate beams and rigid frames by displacement methods for designing framed structures.
IV. The concept of rolling loads and influence lines for analyzing the bridge girders and truss girders in complex structures.

III. COURSE SYLLABUS:

MODULE –I: ARCHES (9)

Introduction, types of arches, comparison between three-hinged and two hinged arches; Normal thrust and radial shear in an arch; Geometrical properties of parabolic and circular arch; Three hinged circular arch at different levels; Absolute maximum bending moment diagram for a three-hinged arch; Two hinged arches: Introduction, classification of two hinged arches, analysis of two hinged parabolic arches, secondary stresses in two hinged arches due to temperature and elastic shortening of rib.

MODULE -II: ANALYSIS OF INDETERMINATE STRUCTURES (9)

Indeterminate Structural Analysis –Determination of static and kinematic indeterminacies – Analysis of trusses with up to two degrees of internal and external indeterminacies using Castigliano's theorem.

MODULE -III: SLOPE-DEFLECTION AND MOMENT DISTRIBUTION METHOD (9)

Introduction- Derivation of slope deflection equation-Application to continuous beams with and without settlement of supports - Analysis of single-bay, single-storey, portal frame including side sway.

Introduction to moment distribution method - Application to continuous beams with and without settlement of supports - Analysis of single-bay, single-storey, portal frame including side sway.

MODULE -IV: KANI'S METHOD (9)

Introduction to Kani's method – Rotation factor- Application to continuous beams with and without settlement of supports.

MODULE -V: MOVING LOADS AND INFLUENCE LINES (9)

Introduction - maximum SF and BM at a given section and absolute maximum S.F. and B.M due to single concentrated load, UDL longer than the span, UDL shorter than the span, two-point loads with fixed distance between them and several point loads. Definition of influence line for SF, Influence line for BM – load position for maximum SF at a section – Load position for maximum BM at a section Point loads, UDL longer than the span, UDL shorter than the span.

IV. TEXT BOOKS:

1. B.C. Punmia, A.K Jain &A.K.Jain, “Theory of Structures”, Laxmi Publications 12th Edition, 2004.
2. C.S.Reddy, “Basic Structural Analysis”, Tata McGraw Hill, 3rd Edition, 2010.

V. REFERENCE BOOKS:

1. S.S.Bhavikatti, “Structural Analysis - Vol. 1&2”,Vikas Publications, 4th Edition, 2011
2. Vazirani and Ratwani, “Analysis of Structures–Vol.II”, Khanna Publishers, 16th Edition, 2015.
3. Ramamrutham, “Theory of Structures”, Dhanpat Rai Publications, 9th Edition, 2014.
4. C.K.Wang, “Intermediate Structural Analysis”, Standard Publication, 1st Edition, 2010.

VI. WEB REFERENCES:

1. https://nptel.ac.in/courses/105105166/
2. https://www.youtube.com/watch?v=qhEton-EEOw&list=PL83821B43A558F579

VII. E-TEXT BOOKS:

1. https://www.kopykitab.com/Structural-Analysis-I-by-S-S-Bhavikatti
2. https://www.pdfdrive.com/fundamental-structural-analysis-e25550099.html

HYDROLOGY AND WATER RESOURCES ENGINEERING

<table>
<tr><td colspan="9">V Semester: CE</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">ACECI5</td><td rowspan="2">Core</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: 15</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 60</td></tr>
<tr><td colspan="9">Prerequisite: Fluid Mechanics</td></tr>
</table>

I. COURSE OVERVIEW:

Hydrology and water resources engineering is concerned with quantitative study of the hydrological cycle on and below the earth surface. This course deals with supply and feed for surface, sub-surface water bodies, methods of irrigation and their challenges in water table management and improving crop production. Further, the knowledge of the course is useful for designing innovative systems and equipment for planning, development and management of water resources.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The fundamentals of hydrological cycle on and below the surface of the earth.
II. The concept of ground water engineering and analytical techniques in ground water flow.
III. The principles of irrigation types, methods and design-discharge required based on canal networks.
IV. The construction of hydraulic structures based on data from design-flood flow.

III.COURSE SYLLABUS:

MODULE –I: HYDROLOGICAL CYCLE AND PRECIPITATION (9)

Introduction to hydrologic cycle, Water – budgetequation. Precipitation - forms of precipitation, characteristics of precipitation in India,measurement of precipitation, rain gauge network, mean precipitation over an area, Depth-Area-Duration (DAD) relationships, maximum intensity/depth-duration-frequency relationship, Probable Maximum Precipitation (PMP), rainfall data in India.

MODULE -II: ABSTRACTIONS FROM PRECIPITATION (9)

Evaporation process, evaporimeters, analytical methods of evaporation estimation, reservoir evaporation and methods for its reduction, evapotranspiration, measurement of evapotranspiration, evapotranspiration equations, Potential evapotranspiration, actual evapotranspiration, infiltration, infiltration capacity, measurement of infiltration.

MODULE -III: SURFACE AND SUB – SURFACE RUNOFF (9)

Surface Runoff - Runoff volume, SCS – CN method of estimating runoff volume, flow – duration curve, flow- mass curve, hydrograph, factors affecting runoff hydrograph, components of hydrograph, base flow separation, effective rainfall, and unit hydrograph.

Sub – surface runoff - forms of subsurface water, saturated formation, aquifer properties, geologic formations of aquifers, well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifers, aquifer tests.

MODULE -IV: WATER WITHDRAWLS AND DISTRIBUTION SYSTEMS (9)

Water requirement of crops-Crops and crop seasons in India, cropping pattern, duty and delta; Quality of irrigation water; Soil-water relationships, root zone soil water, consumptive use, irrigation requirement, frequency of irrigation; Methods of applying water to the fields: surface, sub-surface, sprinkler and trickle /drip irrigation. Canal systems – Design of channels – Kennedy’s and Lacey’s theory of regime channels.

MODULE -V:DAMS AND SPILLWAYS (9)

Dams - Gravity dams - forces on gravity dams, causes of failure, stress analysis, elementary and practical profile. Embankment of dams - Classification, design considerations. Arch and buttress dams. Spillways - components of spillways, types of gates for spillway crests. Reservoirs - Types, capacity of reservoirs, yield of reservoir, selection of suitable site for reservoirs.

IV. TEXTBOOKS:

1. Jayarami Reddy, "Engineering hydrology", McGraw Hill Education, 4th Edition, 2017.
2. B.C.Punmia, Ashok Kumar Jain, Arun Kumar Jain, Pande Brij Basi Lal, "Irrigation and Water Power Engineering", Laxmi publications Pvt. Ltd., New Delhi, 16th Edition, 2016.

V. REFERENCE BOOKS:

1. V. P. Singh, "Elementary Hydrology", PH1 publications, 1st Edition, 1991.
2. Dr.G.Venkata Ramana, "Water Resources Engineering-I", Academic Publishing Company, 1st Edition, 2012.
3. D.K.Majumdar, "Irrigation Water Management – Principles and Practice", Prentice Hall of India, 2ndEdition, 2014.

VI. WEB REFERENCES:

1. guides.lib.vt.edu/subject, guides/cee/environmental, water engineering
2. https://en.wikipedia.org/wiki/Water_resources
3. https://www.nae.edu/.../Expansion of Frontiers of Engineering /Water, Resource
4. https://books.google.co.in/books?isbn=0470460644

VII. E-TEXT BOOKS:

1. https://www.civilenggforall.com/p/water,resources,engineering.html
2. https://books.askvenkat.com/water,resources,engineering,1,textbook,pdf
3. https://www.amazon.in/Water,Resources,Engineering,Larry,Mays/dp/047
4. https://www.respwritunac.hatenablog.com/entry/2016/05/20/044146

REINFORCED CONCRETE STRUCTURES DESIGN AND DRAWING

V Semester: CE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACECI6	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	1	0	4	30	70	100
Contact Classes: 45	**Tutorial Classes: 15**	**Practical Classes: Nil**				**Total Classes: 60**		
Prerequisite: Strength of Materials								

I. COURSE OVERVIEW:

Reinforced Concrete Structures Design and Drawings an introductory design course in civil engineering. This course covers the structural design of reinforced concrete beams like singly reinforced, doubly reinforced, T & L beam sections, columns like short and long columns with biaxial bending, slabs like one way, two way, continuous and cantilever and footings like isolated, combined, strip, etc. Different methods of design will be briefly described before introducing the limit state of design. The design will be done as per IS 456:2000. In this course, basic elements governed by bending, shear, axial forces or combination of them are identified and are considered for structural analysis of the whole structure.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The basic design concepts for reinforced concrete structures starting with historical development to the latest limit state theory.
II. The Indian Standard codal provisions and refreshing the bending and shear theory.
III. The behavior of reinforced concrete components and systems subjected to gravity as well as lateral loads, designing of different structural members like beam, slab, column and footing.

III.COURSE SYLLABUS:

MODULE –I: INTRODUCTION TO LIMIT STATE DESIGN (9)

Concepts of reinforced concrete design, design Load, limit state method, material Stress, strain curves, safety factors, characteristic values; Stress block parameters, modes of failure - IS – 456: 2000 - working stress method; Beams: Limit state analysis and design of singly reinforced, doubly reinforced, T and L beam sections.

MODULE -II: SHEAR, TORSION AND BOND (9)

Shear, torsion and bond: Limit state analysis and design of section for shear and torsion, concept of bond, anchorage and development length, I.S. code provisions; Design examples in simply supported and continuous beams, detailing; Limit state design for serviceability for deflection, cracking and codal provision; General aspects of serviceability, deflection limits in IS: 456–2000, calculation of deflection (theoretical method), cracking in structural concrete members, calculation of deflections and crack width.

MODULE -III: DESIGN OF SLABS (9)

Design of one-way and two-way slab.

Design of continuous slab using IS coefficients, cantilever slab / canopy slab.

MODULE -IV: DESIGN OF COLUMNS (9)

Short and long columns, axial loads, uniaxial and biaxial bending IS Code provisions.

MODULE -V: DESIGN OF FOOTINGS AND STAIRCASE (9)

Design of footing: Isolated (square and rectangular) and combined footings. Design of staircase.

IV. TEXTBOOKS:

1. Neelam Sharma, “Reinforced Cement Concrete Design, S.K. Kataria & Sons, New Delhi, 2002.
2. Dr. B.C Punmia, “Reinforced Concrete Structures, Volume I”, Laxmi Publications (P) LTD, New Delhi, 2002.

V. REFERENCE BOOKS:

1. M.L. Gambhir, “Fundamentals of Reinforced Concrete Design, Print ice Hall of India Pvt. Ltd, New Delhi, 2006.
2. P. Purushotham, “Reinforced Concrete Structural Elements – Behavior, Analysis and Design’’, Tata McGraw Hill, 1994.
3. P.C. Varghese, “Limit State Design of Reinforced Concrete”, Prentice Hall of India, New Delhi, 2008.
4. N. Krishna Raju and R.N. Pranesh, “Reinforced Concrete Design”, New Age International Publishers, New Delhi,2007.

VI. WEB REFERENCES:

1. http://www.nptel.ac.in/courses/105105105/
2. http://www.nptel.ac.in/courses/105105104/

VII. E-TEXT BOOKS:

1. http://weccivilians.weebly.com/uploads/2/4/6/2/24623713/design_of_reinforced_concrete_9th_edition_-_jack_c._mccormac.pdf

BUSINESS ECONOMICS AND FINANCIAL ANALYSIS

IV Semester: CSE / CSIT / CSE(DS), CSE(CS)

V Semester: AE / CE / EEE | **VI Semester:** ECE / ME / IT / CSE(AI&ML)

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AHSC13	Foundation	L	T	P	C	CIA	SEE	Total
		3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisite: There is no prerequisite is required to this course								

I. COURSE OVERVIEW:

The course is designed in such a way that it gives an overview of concepts of Economics. Managerial Economics enables students to understand micro environment in which markets operate how price determination is done under different kinds of competitions. Financial Analysis gives clear idea about concepts, conventions and accounting procedures along with introducing students to fundamentals of ratio analysis and interpretation of financial statements. Break Even Analysis is very helpful to the Business Concern for Decision Making, controlling and forward Strategic Planning. Ratio analysis gives an idea about financial forecasting, financial planning, controlling the business and decision making.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The concepts of business economics and demand analysist o helps in optimal decision making in business environment**.**

II. The functional relationship between Production and factors of production and able to compute breakeven point to illustrate the various uses of breakeven analysis.

III. The features, merits and demerits of different forms of business organizations existing in the modern business environment and market structures.

IV. The concept of capital budgeting and allocations of the resources through capital budgeting methods and compute simple problems for project management.

V. Various accounting concepts and different types of financial ratios for knowing financial positions of business concern.

III. COURSE OBJECTIVES:

MODULE – I: INTRODUCTION AND DEMAND ANALYSIS (07)

Definition, nature and scope of business economics; Demand analysis; Demand determinants, law of demand and its exceptions; Elasticity of demand: Definition, types, measurement and significance of elasticity of demand, demand forecasting, factors governing demand forecasting.

MODULE – II: PRODUCTION AND COST ANALYSIS (10)

Production function; Isoquants and isocosts, MRTS, least cost combination of inputs, Cobb-Dougles production function, internal and external economies of scale, cost analysis; Cost concepts: Break even analysis (BEA), determination of break-even point (simple problems), managerial significance.

MODULE – III: MARKETS AND NEW ECONOMIC ENVIRONMENT (08)

Types of competition and markets, features of perfect competition, monopoly and monopolistic competition, price-output determination in case of perfect competition and monopoly business.

Features and evaluation of different forms of business organizations: Sole proprietorship, partnership, joint stock company, public enterprises and their types.

MODULE – IV: CAPITAL BUDGETING (10)

Capital and its significance, types of capital, estimation of fixed and working capital requirements, methods and sources of raising capital, capital budgeting: features of capital budgeting proposals; Methods of capital budgeting: Payback period, accounting rate of return(ARR), net present value method and internal rate of return method (simple problems).

MODULE – V: INTRODUCTION TO FINANCIAL ACCOUNTING AND FINANCIAL ANALYSIS (10)

Financial accounting objectives, functions, importance; Accounting concepts and accounting conventions -double-entry book keeping, journal, ledger, trial balance; Final accounts: Trading account, profit and loss account and balance sheet with simple adjustments; Financial analysis: Analysis and interpretation of liquidity ratios, activity ratios, capital structure ratios and profitability ratios (simple problems), Du Pont chart.

IV. TEXT BOOKS:

1. Aryasri, "Managerial Economics and Financial Analysis", TMH publications, 4th Edition, 2012.
2. M. Kasi Reddy, Saraswathi, "Managerial Economics and Financial Analysis", PHI Publications, New Delhi, 2nd Edition, 2012.
3. Varshney, Maheswari, "Managerial Economics", Sultan Chand Publications, 11th Edition, 2009.

V. REFERENCE BOOKS:

1. S. A. Siddiqual, A. S. Siddiqual, "Managerial Economics and Financial Analysis", New Age International Publishers, Hyderabad, Revised 1st Edition, 2013.
2. S. N. Maheswari, S. K. Maheswari, "Financial Accounting", Vikas publications, 3rd Edition, 2012.
3. J. V. Prabhakar Rao, P. V. Rao, "Managerial Economics and Financial Analysis", Maruthi Publishers, Reprinted Edition, 2011.
4. Vijay Kumar, Appa Rao, "Managerial Economics and Financial Analysis", Cengage Publications, 1st Edition, Paperback, 2011.

VI. WEB REFERENCES:

1. https:// www.slideshare.net/glory1988/managerial-economics-and- financial analysis
2. https:// thenthata.web4kurd.net/mypdf/managerial-economics-and- financial analysis
3. https:// bookshallcold.link/pdfread/managerial-economics-and-financial analysis
4. https:// www.gvpce.ac.in/syllabi/Managerial Economics and financial analysis

REMOTE SENSING AND GIS

V Semester: CE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC17	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisite: No prerequisites required								

I. COURSE OVERVIEW:

GIS and remote sensing techniques have become indispensable and potential tools for solving problems in civil engineering. Data from remote sensing mostly correlate spatial data to their attributes making them useful in this field. Different themes such as geology, terrain, drainage, and hydrology can be extracted by the use of remote sensing. Places, where remote sensing in technology is mostly used, include sanitation, urban growth, new road alignment, and irrigation project design. GIS and remote sensing data are mostly used to develop models by integrating socio-economic, demographic and information on natural resources.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The Photogrammetric techniques, concepts and components of Photogrammetry.
II. The basic concepts and principles of various components of remote sensing and its applications.
III. The concept of Geographical Information System (GIS), coordinate system, GIS Data and its types.
IV. The data management systems in GIS and its practical applications in the field of Civil Engineering.

III.COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO PHOTOGRAMMETRY (09)

Principles& types of aerial photograph, geometry of vertical aerial photograph, Scale & Height measurement on single vertical aerial photograph, Height measurement based on relief displacement, Fundamentals of stereoscopy, fiducially points, parallax measurement using fiducially line.

MODULE-II: REMOTE SENSING (09)

Basic concepts and foundation of remote sensing – elements involved in remote sensing, electromagnetic spectrum, remote sensing terminology and units. Energy resources, energy interactions with earth surface features and atmosphere, resolution, sensors and satellite visual interpretation techniques, basic elements, converging evidence, interpretation for terrain evaluation, spectral properties of water bodies, introduction to digital data analysis.

MODULE-III: GEOGRAPHIC INFORMATION SYSTEM AND TYPES OF DATA REPRESENTATION (09)

Introduction, History of GIS, GIS definition and terminology, GIS categories, components of GIS, fundamental operations of GIS, A theoretical framework for GIS.

Data collection and input overview, data input and output. Keyboard entry and coordinate geometry procedure, manual digitizing and scanning, Raster GIS, Vector GIS.

MODULE-IV: GIS DATA MANAGEMENT (09)

Introduction, Data base management systems, functions and components of data base management system, GIS data file management, Database Models - Hierarchical Database Models, Network

Systemsand Relational Database Models. Storage of GIS data.

MODULE-V: WATER RESOURCES APPLICATIONS (09)

Land use/Land cover in water resources, Surface water mapping and inventory, Rainfall – Runoff relations and runoff potential indices of watersheds, Flood and Drought impact assessment and monitoring, Watershed management for sustainable development and Watershed characteristics.

IV.TEXT BOOKS:

1. B.Bhatta, "Remote Sensing and GIS", Oxford University Press, New Delhi, 2008.
2. Gorge Joseph, "Fundamentals of Remote Sensing, Universities Press, Hyderabad.

V. REFERENCE BOOKS:

1. RA Narayana, "Remote Sensing and its Applications", University Press 1999.
2. Kumar, "Basics of Remote Sensing & GIS", Laxmi Publications, 2004.
3. Anji Reddy, "Remote Sensing and GIS", B.S. Publications, New Delhi
4. Sung Chang, "GIS", TMH Publications & Co.

VI. WEB REFERENCES:

1. https://nptel.ac.in/courses/105103193/
2. https://nptel.ac.in/courses/121107009/
3. https://nptel.ac.in/courses/105108077/

VII. E-TEXT BOOKS:

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/105107160/lec20.pdf

VISUAL INTERPETATION

V Semester: CE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC18	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisite: No prerequisites required								

I. COURSE OVERVIEW:

This course mainly deals in various fields such as geography, geology, agriculture, forestry, environment, ocean studies, wetlands, conservation of natural resources, urban and regional planning, defense and many other purposes. Visual perception is the ability to interpret information and surroundings from the effects of visible light reaching the eye. Interpretation is the process of extraction of qualitative and quantitative information of objects from aerial photographs or satellite images. Interpretation technique requires extensive training and it is labour intensive. To translate images into information, one should be well versed with both the subject knowledge and also the image interpretation basics. For example, interpretation of geological features requires expertise in geology along with image interpretation skill.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental knowledge on digital image interpretation via vector and raster data analysis in GIS environment.
II. The construction and manipulation of raster data sets and broad appreciation of spatial analysis techniques and application areas.
III. The importance of exploring and solving spatial problems using GIS techniques and develop skills in the creation, management and delivery of spatial data in an online GIS environment.
IV. The structure, advantages and limitations of raster datasets to interpret and present the results of spatial data analysis through high quality reports.

III.COURSE SYLLABUS:

MODULE –I: DIGITAL SATELLITE IMAGE INTERPRETATION (9)

Elements of image interpretation, Digital image enhancement techniques for lithological discrimination. Application of Remote Sensing in Geological Mapping (both Lithological and Structural).

MODULE -II: DIGITAL IMAGE PROCESSING (9)

Concepts about digital image and its characteristics, Spectral, Spatial, Radiometric and Temporal resolution, Visual vs. Digital methods, Image data storage and retrieval, Types of image displays and FCC.

MODULE -III: RASTER ANALYSIS (9)

Raster mask and No Data cells, Local raster operators, Raster zones and regions.

Raster operators, calculating NDVI, Raster Boolean overlay.

MODULE -IV: SPECTRAL SIGNATURES (9)

Spectral Signature and its Response: of Soil, Vegetation and Water, Basics of visual interpretation of satellite Images.

MODULE -V: DIGITAL CARTOGRAPHY (9)
Visualization of geospatial data- 2D and 3D visualization.

IV.TEXT BOOKS:

1. Bhatta, B., "Remote Sensing and GIS", Oxford University Press, New Delhi, 2010.
2. Curran, P.J., "The Semivariogram in Remote Sensing: An Introduction, Remote Sensing of Environment", 1998.

V.REFERENCE BOOKS:

1. Davis, W.A. and Peet, F.G, "A Method of Smoothing Digital Thematic Maps. Remote Sensing of Environment", 1977.
2. Rao, D.P, Remote Sensing Application in Geomorphology. Tropical Ecology, 2002.

VI.WEB REFERENCES:

1. http://airphotos.nrcan.gc.ca
2. http://ccrs.nrcan.gc.ca

VII.E-TEXT BOOKS:

1. http://changematters.esri.com/compare
2. https://egyankosh.ac.in/bitstream/123456789/39535/1/Unit-7.pdf

ADVANCED GEOGRAPHICAL INFORMATION SYSTEM

V Semester: CE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC19	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisite: No prerequisites required								

I. COURSE OVERVIEW:

This course builds upon the foundation GIS knowledge and skills acquired at the introductory level and guides students in the development of increasingly sophisticated spatial analysis capabilities. Theory will include detail of the principles that underpin the spatial modeling and analysis techniques employed in the practical exercises. The course has a strong practical focus, and students will gain experience in field data collection; network analysis; and the construction, manipulation and interpretation of raster data sets in a GIS environment. Students will learn how to interpret and present the results of spatial data analysis through high-quality reports.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The data capture and management using different spatial relationship and query by graphics.
II. The basic concepts of spatial analysis modeling and network modeling.
III. The concept of spatial statistical modeling, linear directional modeling, OLS and GWR
IV. The collection of GCP and mobile based survey open data kit.

III.COURSE SYLLABUS:

MODULE-I: DATA CAPTURE AND MANAGEMENT (9)

Scanning of hardcopy maps, geo referencing and projection, data encoding, feature and geo database creation (point, line and area), digitization, coverage editing, topology, annotations; attribute data – joining, editing and integration, field calculation, query by attribute, query by spatial relationship and query by graphics, class interval selection, thematic mapping and output.

MODULE-II: SPATIAL ANALYSIS MODELING (9)

Proximity analysis; Topography - Digital Elevation Model, Slope, Aspect, Hillshade, and View shed; Watershed and Morphometric – Stream order, Flow Direction, Flow Accumulation, Watershed delineation, bifurcation ratio.

MODULE III: NETWORK ANALYSIS (9)

Network analysis – shortest path, service area, closest facility, location and allocation;

Interpolation and Extrapolation – Kriging, IDW, Spline, Trend, Natural neighbor, Thiesson polygon, topo to raster.

MODULE IV: SPATIAL STATISTICAL MODELING (9)

Identification of Central feature, directional distribution, mean center, median center, linear directional mean, standard distance, hot-spot analysis, correlation, raster calculator and Boolean operation. Exploring spatial relations using Ordinary least square (OLS), Geographical weighted regression(GWR), Spatial autocorrelation.

MODULE V: GNSS/GPS SURVEY (9)

Collection of Ground Control Points (GCP), Way Points, and transformation of GNSS/GPS data into GIS; Ground Truth Verification of GIS data; Precision, Vertical and Horizontal Accuracy, inputting GPS data into computer. Mobile based survey using Open data kit (form building, XML generation, data collection, and mapping).

IV.TEXT BOOKS:

1. Bolstad, Paul, "Fundamentals of GIS", Atlas Books, 2nd Edition, 2005.
2. Lillesand, Thomas M., Ralph W. Kiefer and Jonathan W.Chipman, "Remote Sensing and Image Interpretation", Wiley, New York, 5th Edition, 2004.

V. REFERENCE BOOKS:

1. LRA Narayana, "Remote Sensing and its Applications", University Press 1999.
2. S.Kumar, "Basics of Remote Sensing & GIS", Laxmi Publications, 2004.
3. M.Anji Reddy, "Remote Sensing and GIS", B.S. Publications, New Delhi, 2008.
4. Tsung Chang, "GIS", TMH Publications & Co, 2007.

VI. WEB REFERENCES:

1. https://nptel.ac.in/courses/105103193/
2. https://nptel.ac.in/courses/121107009/
3. https://nptel.ac.in/courses/105108077/

VII. E-TEXT BOOKS:

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/105107160/lec20.pdf

SATELLITE IMAGERY IN GIS

V Semester: CE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACEC20	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: No prerequisites required								

I. COURSE OVERVIEW:

This course deals with processing of images which are digital in nature. Study of the subject is motivated by three major applications. The first application is in improvement of pictorial information for human perception i.e. enhancing the quality of the image so that the image will have a better look. The second is for autonomous machine applications which have wider applications in industries, particularly for quality control in assembly automation and many similar applications. This course will introduce various image processing techniques, algorithms and their applications.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The image acquisition, satellite data acquisition and image display system.
II. The basic concepts of image distortion and rectification.
III. The concept of Image enhancement and spatial statistics
IV. The image classification and image analysis using ANN and integration with GIS.

III.COURSE SYLLABUS:

MODULE I: IMAGE ACQUISITION AND FORMAT (9)

Satellite data acquisition, DN characters-kernels- storage devices, CC, CDisk, Optical disk. Data retrieval. Export and import, Data formats, BSQ, BIL, BIP, Run length encoding, Image Compression Data products, hard copy, digital products, Image display system, requirement.

MODELU II: IMAGE DISTORTION AND RECTIFICATION (9)

Introduction-Sensor model, Preprocessing and Post processing Geometric distortion, sources and causes for distortion, rectification, GCP, Resampling, Image registration, transformation, radiometric distortion, sources and causes, Computation of radiance, Computation of reflectance, cosmetic operations, Noise removal, atmospheric correction.

MODULE III: IMAGE ENHANCEMENT (9)

Satellite image statistics, Univariate and multi-variate statistics. Basics of Histogram, noise models, image quality, contrast manipulation, grey level thresholding, level slicing.

Contrast stretching- Spatial feature manipulations, spatial filtering, convolution Low pass, high pass, edge enhancement, edge detection, Fourier analysis.

MODULE IV: IMAGE CLASSIFICATION (9)

Introduction, Classification techniques, feature extraction, Supervised, training stage, classification stage, scatterogram, minimum distance to mean classifier, Parallelepiped classifier, Gaussian maximum Likelihood classifier, unsupervised classification, Hybrid classifier, classification of mixed pixel-fuzzy classification, output stage, classification accuracy , error matrix.

MODULE V: IMAGE ANALYSIS (9)

Digital Image interpretation ,Pattern recognition, shape analysis, Textural analysis, Decision concepts, fuzzy sets and Evidential reasoning, Change detection, multitemporal data merging, multi sensor image merging-merging image data with ancillary data, Expert system, Artificial Neural

Network; Integration with GIS.

IV.TEXT BOOKS:

1. Bolstad, Paul, "Fundamentals of GIS", Atlas Books, 2nd Edition, 2005.
2. Lillesand, Thomas M., Ralph W. Kiefer and Jonathan W.Chipman, "Remote Sensing and Image Interpretation", Wiley, New York, 5th Edition, 2004.

V. REFERENCE BOOKS:

1. LRA Narayana, "Remote Sensing and its applications", University Press 1999.
2. S.Kumar, "Basics of Remote Sensing & GIS", Laxmi Publications, 2004.
3. M.Anji Reddy, "Remote Sensing and GIS", B.S. Publications, New Delhi, 2008
4. Tsung Chang, "GIS", TMH Publications & Co, 2007.

VI. WEB REFERENCES:

1. https://nptel.ac.in/courses/105103193/
2. https://nptel.ac.in/courses/121107009/
3. https://nptel.ac.in/courses/105108077/

VII. E-TEXT BOOKS:

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/105107160/lec20.pdf

V Semester: **Common for all branches**

Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACSC20	Foundation	L	T	P	C	CIA	SEE	Total
		2	-	-	1	30	70	100
Contact Classes: 36	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 36		

Prerequisite: **There are no prerequisites to take this course**

I. COURSE OVERVIEW:

Project-based learning (PBL) is collaborative, learner-centered instructional approach where students work in groups to construct their knowledge using modern tools. It often requires students to collaborate, design, revise, and share their ideas and experiences with authentic audiences and supportive peer groups rather than collect resources, organize work, and manage long-term activities. Project-Based Learning begins with the assignment of tasks that will lead to the problem identification, modeling, simulation and analyzing the results.

II. COURSE OBJECTIVES:

The students will try to learn:

I. To emphasize learning activities that is long-term, interdisciplinary and student-centric.
II. To inculcate independent learning by problem solving with social context.
III. To engages students in rich and authentic learning experiences.
IV. To provide every student the opportunity to get involved either individually or as a group so as to develop team skills and learn professionalism.

III. COURSE SYLLABUS

I. Defining the Problem
II. Gathering requirements
III. Design / *Mode*ling
IV. Implementation
V. Testing
VI. Report

ADVANCED SURVEYING LABORATORY

V SEMESTER: CE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACEC21	Core	L	T	P	C	CIA	SEE	Total
		-	-	3	1.5	30	70	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 36**				**Total Classes: 36**		
Prerequisite: Surveying and Geomatics								

I. COURSE OVERVIEW:

The Advanced surveying Laboratory is equipped with the instruments and tools students use throughout the surveying course. Students learn techniques for gathering field data with both traditional and modern instruments. A set of traditional and modern instruments are used, including theodolite, total station, level rods, tripods, tape measures, chaining pins, and other common surveying tools and ancillary equipment.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The principles in theory of errors for correction of measurement.
II. The application of operating principles for solving civil engineering problems.
III. The differentiation of heights and distances using trigonometric method.
IV. The utilization of total station and other modern survey instruments.

III. COURSE SYLLABUS:

Week- l: INTRODUCTION TO ADVANCED SURVEYING LABORATORY

Introduction to surveying laboratory. Do's and Don'ts in surveying lab

Week- 2: STUDY OF THEODOLITE IN DETAIL-PRACTICE FOR MEASUREMENT OF HORIZONTAL AND VERTICAL ANGLES.

Batch I: Study of theodolite
Batch II: Study of theodolite

Week-3: MEASUREMENT OF HORIZONTAL ANGLES BY METHOD OF REPETITION AND REITERATION.

Batch I: Measurement of horizontal angles
Batch II: Measurement of horizontal angles

Week-4: TRIGONOMETRIC LEVELING- HEIGHTS AND DISTANCE PROBLEMS

Batch I: Trigonometric leveling- heights and distance problems
Batch II: Trigonometric leveling- heights and distance problems

Week-5:CURVE SETTING –DIFFERENT METHODS

Batch I: Curve setting: different methods
Batch II: Curve setting: different methods

Week-6: SETTING OUT WORKS FOR BUILDINGS AND PIPE LINES

Batch I: Setting out works for buildings and pipe lines
Batch II: Setting out works for buildings and pipe lines

Week-7: DETERMINATION OF AN AREA USING TOTAL STATION

Batch I: Determination of an area using total station
Batch II: Determination of an area using total station

Week-8: TRAVERSING USING TOTAL STATION

Batch I: Determination of an area using total station
Batch II: Determination of an area using total station.

Week 9: HEIGHTS AND DISTANCES USING PRINCIPLES OF TACHEOMETRIC SURVEY

Batch I: Heights and distances using principles of tacheometric survey.
Batch II: Heights and distances using principles of tacheometric survey.

Week-10: CONTOURING USING TOTAL STATION

Batch I: Contouring using total station.
Batch II: Contouring using total station.

Week-11: DETERMINATION OF REMOTE HEIGHT USING TOTAL STATION

Batch I: Determination of remote height using total station.
Batch II: Determination of remote height using total station.

Week-12: STATE-OUT USING TOTAL STATION

Batch I: State-out using total station.
Batch II: State-out using total station.

Week-13: CALCULATION OF DISTANCE, GRADIENT AND DIFFERENT HEIGHTS BETWEEN TWO INACCESSIBLE POINTS USING TOTAL STATION.

Batch I: Calculating distance, gradient and different heights between two inaccessible points using total station.
Batch II: Calculating distance, gradient and different heights between two inaccessible points using total station.

IV. REFERENCE BOOKS:

1. Anderson, James M. Mikhail. "Surveying, Theory and Practice, James M. Anderson, Edward M. Mikhail." (1998).
2. S. S.Bhavikatti, “Surveying Theory and Practical”, IK Books New Delhi, 4th Edition, 2010.
3. 2. H.S. Moondra, Rajiv Gupta , “Laboratory Manual for Civil Engineering”, CBS Publishers Pvt .Ltd New Delhi, 2nd Edition, 2013.
4. P. Venugopala Rao, VijayalakshmiAkella, “Textbook on Surveying”, PHI Learning, New Delhi, 1st Edition, 2015.

V. WEB REFERENCES:

http://www.iare.ac.in

ADVANCED MATERIAL TESTING LABORATORY

<table>
<tr><td colspan="9">V Semester: CE</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">ACEC22</td><td rowspan="2">Core</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>-</td><td>-</td><td>3</td><td>1.5</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: Nil</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: 36</td><td colspan="3">Total Classes: 36</td></tr>
<tr><td colspan="9">Prerequisite: Concrete Technology</td></tr>
</table>

I. COURSE OVERVIEW:

Advanced Material Testing laboratory course emphasizes the practical aspects of the latest developments in the field of concrete construction. It focuses the latest Indian standard specifications and codes, which regulates the concrete construction. The laboratory course covers the properties of concrete and its constituent materials, the role of various admixtures in modifying these properties to suit specific requirements, such as ready mix concrete, reinforcement detailing, disaster-resistant construction, concrete machinery and it also enable the students to acquire knowledge on special and new generation concrete with their applications.

II. COURSE OBJECTIVES:

The Students will try to learn:

I. The factors influencing workability and methods involved in measuring workability of fresh concrete.
II. The importance of water/cement ratio and its influence on compressive strength of hardened concrete.
III. The concept of quality control and design of concrete mix for ensuring quality of concrete

III. COURSE SYLLABUS:

Week 1: TESTS ON CEMENT - CONSISTENCY, SETTING TIMES, SOUNDNESS, COMPRESSIVE STRENGTH

Batch I: Tests on cement - Consistency, Setting times, Soundness, Compressive Strength.
Batch II: Tests on cement - Consistency, Setting times, Soundness, Compressive Strength.

Week 2: GRADATION CHARTS OF AGGREGATES.

Batch I: study of gradation charts of aggregates.
Batch II: study of gradation charts of aggregates.

Week 3: BULKING OF SAND

Batch I: study of bulking of sand
Batch II: study of bulking of sand

Week 4: AGGREGATE CRUSHING AND IMPACT VALUE

Batch I: Measurement of aggregate impact test
Batch II: Measurement of aggregate crushing test

Week 5: WORKABILITY TESTS ON FRESH SELF-COMPACTING CONCRETE

Batch I: Measurement of Workability Tests on Fresh self-compacting concrete
Batch II: Measurement of Workability Tests on Fresh self-compacting concrete

Week 6: AIR ENTRAINMENT TEST ON FRESH CONCRETE.

Batch I: Measurement of Air Entrainment Test on fresh concrete
Batch II: Measurement of Air Entrainment Test on fresh concrete

Week 7: MARSH CONE TEST.
Batch I: Performing Marsh cone Test on fresh concrete
Batch II: Performing Marsh cone Test on fresh concrete

Week 8: PERMEABILITY OF CONCRETE.
Batch I: Performing Permeability of Concrete Test on fresh concrete.
Batch II: Performing Permeability of Concrete Test on fresh concrete.

Week 9: NON DESTRUCTIVE TESTING OF CONCRETE.
Batch I: Performing Non Destructive Testing of Concrete
Batch II: Performing Non Destructive Testing of Concrete.

Week 10: ACCELERATED CURING OF CONCRETE.
Batch I: Performing Accelerated curing test on Concrete
Batch II: Performing Accelerated curing test on Concrete.

Week 11: INFLUENCE OF W/C RATIO ON STRENGTH AND AGGREGATE / CEMENT RATIO ON WORKABILITY AND STRENGTH
Batch I: Influence of W/C ratio on strength of concrete.
Batch II: Influence of Aggregate / Cement ratio on workability and strength.

Week 12: INFLUENCE OF DIFFERENT CHEMICAL ADMIXTURES ON CONCRETE.
Batch I: Finding the Influence of Different Chemical Admixtures on concrete.
Batch II: Finding the Influence of Different Chemical Admixtures on concrete.

IV. REFERENCE BOOKS:

1. HemantSood, "Laboratory Manual on Testing of Engineering Materials", New Age International Publishers, New Delhi, 2nd Edition, 2007.
2. H.S. Moondra, Rajiv Gupta, "Laboratory Manual for Civil Engineering", CBS Publishers, New Delhi, 4th Edition, 2015.

V. WEB REFERENCES:

1. https://www.iare.ac.in
2. https://www.youtube.com/user/MaterialsScience 2000.

OBJECT ORIENTED PROGRAMMING DEVELOPMENT AND LANGUAGES

V Semester: **AE / ECE / EEE / ME / CE**

Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACSC23	Skill	L	T	P	C	CIA	SEE	Total
		-	-	-	-	-	-	-
Contact Classes: Nil	Total Tutorials: Nil	Total Practical Classes: Nil				Total Classes: Nil		

I.COURSE OVERVIEW:

Java's unique architecture enables programmers to develop a single application that can run across multiple platforms seamlessly and reliably. This course, enable the students to gain extensive experience with Java and its object oriented features to create robust console and GUI applications and store and retrieve data from relational databases.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basic object-oriented programming concepts and apply them in problem solving.
II. The inheritance concepts for reusing the program.
III. The programs to implement event handling, user interfaces and graphical interfaces with the help of Java.

III. COURSE SYLLABUS

MODULE-I: FUNDAMENTALS OF OBJECT-ORIENTED PROGRAMMING

Object oriented paradigm: Basic concepts of Object-Oriented Programming, Benefits of OOP, Applications of OOP; Java Evolution: Java Features, How Java differs from C and C++, Java and Internet, Java and World Wide Web, Web Browsers, Hardware and Software Requirements, Java Environment. Overview of Java Language: Simple Java Program, Java Program Structure, Java Tokens, Java Statements, Implementing a Java Program, Java Virtual Machine, Constants, Variables, Data types, Scope of Variables, Symbolic Constants, Type Casting and type promotions, Operators, Operator Precedence and Associativity, Control Statements, break, continue, Arrays-Multi dimensional arrays, Wrapper Classes, Simple examples.

MODULE-II: CLASSES AND OBJECTS

Classes and Objects, constructors, methods, this keyword, garbage collection, finalize, overloading methods and constructors, access control, static members, nested and inner classes, command line arguments, variable length arguments. Inheritance: Forms of inheritance, specialization, specification, construction, extension, limitation, combination, benefits and costs of inheritance. Super uses- final - polymorphism, method overriding - dynamic method dispatch, abstract classes, exploring String class.

MODULE-III: PACKAGES AND INTERFACES

Defining and accessing a package, understanding CLASSPATH, access protection importing packages, Interfaces: Defining and implementing an interface, Applying interfaces, Variables in interfaces and extended interfaces. Exploring java.lang and java.util packages.

Exception Handling: Fundamentals, usage of try, catch, multiple catch clauses, throw, throws and finally. Java Built in Exceptions and creating own exception subclasses.

MODULE- IV: MULTITHREADED PROGRAMMING

Java Thread life cycle model: Thread creation, Thread Exceptions, Thread Priority, Synchronization ,Messaging, Runnable Interface - Interthread Communication - Deadlock - Suspending, Resuming and stopping threads.
I/O Streams: File, Streams, Advantages, The stream classes, Byte streams, Character streams.

MODULE- V APPLET PROGRAMMING

Event handling: basics of event handling, Event classes, Event Listeners, delegation event model, handling mouse and keyboard events, adapter classes, AWT Class hierarchy, AWT Controls, Layout Managers and Menus, limitations of AWT. How Applets differ from Applications: Applet Life Cycle, Creating an Applet, Running the AppletDesigning a Webpage, Applet Tag, Adding Applet to HTML file, More about Applet Tag, Passing parameters to Applets, Aligning the display.

IV. TEXTBOOKS:

1. Herbert Schildt, "The Complete Reference Java J2SE", TMH Publishing Company Ltd, New Delhi, 5th Edition, 2008.
2. Cay Horstmann, "Big Java", John Wiley and Sons, 2nd Edition, 2006.

V. REFERENCES BOOKS:

1. H.M.Dietel and P.J.Dietel, "Java How to Program", Pearson Education/PHI, 6th Edition 2008.
2. Cay.S.Horstmann and Gary Cornell, "Core Java 2" Vol 1, Fundamentals", Pearson Education, 7th Edition, 2007.
3. Cay.S.Horstmann and Gary Cornell, "Core Java 2, Vol 2, Advanced Features", Pearson Education. 7th Edition, 2008.

VI. WEB REFERENCES:

1. http://www.javatpoint.com/java-tutorial
2. http://www.javatutorialpoint.com/introduction-to-java/

VII. E-Text Books:

1. http://bookboon.com/en/java-programming-language-ebooks
2. https://en.wikibooks.org/wiki/Java_Programming

STEEL STRUCTURES DESIGN AND DRAWING

VI Semester: CE									
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**			
ACEC23	Core	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**	
		3	1	0	4	30	70	100	
Contact Classes: 45	**Tutorial Classes: 15**	**Practical Classes: Nil**				**Total Classes: 60**			
Prerequisite: Analysis of Structures									

I. COURSE OVERVIEW:

Steel structures design and drawing deals with the analysis and design of steel structural elements like tension members, compression members, beams and girders etc. This course will focus on mechanical properties of structural steel, concepts of elasticity and plasticity and limit state design. The course will help to enrich the knowledge of design in multi storeyed and industrial structures including bridges. The course will also enhance the knowledge or skill sets of the student for designing efficient, economic and durable steel structures.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The concepts of limit state design and the behavior of structural steel used in design and its properties.
II. The design of structural elements necessary for creating efficient and economic steel structures.
III. The design and drawing of multi storeyed industrial and residential structures including bridges for creating high performance and durable structures.

III.COURSE SYLLABUS:

MODULE –I: INTRODUCTION ON MECHANICAL BEHAVIOUR OF STEEL (9)

Materials, making of iron and steel, types of structural steel, mechanical properties of steel, concepts of plasticity yield strength, loads and combinations, behavior of steel, local buckling. Concept of limit state design – different limit states as per IS 800:2007. Design strengths deflection limits, serviceability, bolted connections, efficiency of joint, prying action, design of tension members, design strength of members.

MODULE -II: COMPRESSION MEMBERS (9)

Design of compression members, buckling class, slenderness ratio, strength design, laced columns, battened columns, slab base.

MODULE -III: BEAMS (9)

Design of beams and bending and shear strength laterally supported beams.

Design of built-up sections, large plates web buckling, crippling and deflection of beams, design of purlin.

MODULE -IV: ECCENTRIC CONNECTIONS (9)

Design of eccentric connections with brackets, beam end connections, web angles, design of truss joints.

MODULE -V: PLATE GIRDERS (9)

Design of plate girders, optimum depth, design of main section, design of end bearing stiffness and intermediate stiffness. Connection between web and flange.

IV. TEXT BOOKS:

1. S. K. Duggal, "Limit state design of steel structures", Tata McGraw-Hill, 3rd Edition, 2019.
2. N. Subramanian, "Design of steel structures", Oxford University Press, 2nd Edition, 2018.

3. S.S. Bhavikatti, “Design of steel structures”, 4th Edition, IK International Publication House, New Delhi, 2014.

V. REFERENCE BOOKS:

1. K. S. Sai Ram, “Design of Steel Structures”, Pearson Education, 2nd Edition, 2015.
2. Dr. Ramachandra and Virendra Gehlot, “Design of Steel Structures Volumes 1 and 2”, Standard Publications, 2nd Edition, 2010.
3. Edwin H. Gaylord, Jr. Charles N. Gaylord and James Stallmeyer, “Design of Steel Structures”, Tata McGraw-Hill Education Private Limited, 3rd Edition, 2010.

VI. WEB REFERENCES:

1. https://nptel.ac.in/courses/105/105/105105162/
2. https://programs.online/swayam/design-of-steel-structures.

VII. E-TEXT BOOKS:

1. https://books.google.co.in/books?id=TFtIpR7XJBAC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false.

GEOTECHNICAL ENGINEERING

VI Semester: CE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC24	Core	L	T	P	C	CIA	SEE	Total
		3	1	0	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		
Prerequisite: Engineering Geology								

I. COURSE OVERVIEW:

Geotechnical engineering is the systematic application of techniques which allows construction with soil and rock. This course features soil basics, including their derivation, identification and classification and emphasizes Principles of water flow in soils, settlement, heave, and shear strength of soils. The course also deals with materials, soil and rock that, by their very nature, exhibit varied and uncertain behavior due to the imprecise physical processes associated with the formation of these materials. Further, The course is useful for designing and development of different forms of foundations in industrial and residential constructions.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental knowledge on soils, importance in the design and construction process of massive structures.
II. The laboratory, field tests conducted on soils to identify the better ground to construction.
III. The methods employed for soil properties prediction, soil layers and its applications
IV. The role of shear strength in load carrying capacity of soils, restored and durable structures.

III.COURSE SYLLABUS:

MODULE –I: INTRODUCTION AND INDEX PROPERTIES OF SOILS (8)

Soil formation, clay mineralogy and soil structure, moisture content, weight-volume relationships, relative density. Grain size analysis, sieve analysis, principle of hydrometer method, consistency limits and indices, I.S. classification of soils.

MODULE -II: PERMEABILITY, EFFECTIVE STRESS AND SEEPAGE THROUGH SOILS (10)

Capillary rise, flow of water through soils, Darcy's Law, Permeability, Factors affecting permeability, Laboratory & field tests for determination of coefficient of permeability, Permeability of layered soils. Total, neutral and effective stress, upward & downward seepage through soils, quick sand condition, flow nets: characteristics and uses.

MODULE -III: STRESS DISTRIBUTION IN SOILS AND COMPACTION (9)

Capillary rise, flow of water through soils, Darcy's Law, Permeability, Factors affecting permeability, Laboratory & field tests for determination of coefficient of permeability.

Permeability of layered soils. Total, neutral and effective stress, upward & downward seepage through soils, quick sand condition, flow nets: characteristics and uses.

MODULE -IV: CONSOLIDATION (10)

Types of compressibility, immediate settlement, primary consolidation and secondary consolidation, stress history of clay, e-p and e-log p curves, normally consolidated soil, over and under consolidated soil, pre-consolidation pressure and its determination, Terzaghi's 1-D consolidation theory, coefficient of consolidation square root time and logarithm of time fitting methods, computation of total settlement and time rate of settlement.

MODULE -V: SHEAR STRENGTH OF SOILS (8)

Importance of shear strength, Mohr's-Coulomb failure theories, types of laboratory tests for strength parameters, strength tests based on drainage conditions, strength envelops, shear strength of sands, dilatancy, critical void ratio, liquefaction, shear strength of clays.

IV. TEXT BOOKS:

1. Braja M. Das, "Principles of geotechnical engineering" Cengage Learning Publishers, 2002.
2. VNS Murthy, "Soil Mechanics and Foundation Engineering", CBS publishers and distributors, 2003.
3. Gopal Ranjan and ASR Rao, "Basic and Applied Soil Mechanics", New age international Pvt. Ltd, New Delhi, 2000.

V. REFERENCE BOOKS:

1. C. Venkataramiah, "Geotechnical engineering", New Age International Pvt. Ltd, 2002.
2. Manojdutta and Gulati, "Geotechnical Engineering", Tata McGraw hill publishers New Delhi, 2005.
3. K.R .Arora, "Soil Mechanics and Foundation Engineering", Standard Publishers and distributors, New Delhi, 2005.
4. B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, "Soil mechanics and foundation", Laxmi publications Pvt. Ltd, New Delhi, 2005.

VI. WEB REFERENCES:

1. http://nptel.ac.in/courses/105107120/1#
2. http://www.nptel.ac.in/courses/105105105/
3. http://www.nptel.ac.in/courses/105105104

VII. E-TEXT BOOKS:

1. https://onlinelibrary.wiley.com/doi/book/10.1002/9781118686195

TRANSPORTATION ENGINEERING

VI Semester: CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC25	Core	L	T	P	C	CIA	SEE	Total
		3	1	0	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		
Prerequisite: Surveying and Geomatics								

I. COURSE OVERVIEW:

The course gives an overview about the Transportation engineering with respect to planning, design, construction and maintenance of highways as per IRC standards, specifications and methods. To impart knowledge of Traffic engineering, traffic regulation, management and traffic safety with integrated approach in traffic planning as well. This course focuses on designing new transportation systems and infrastructures, including highways by analyzing data, identifying problems, and solving them with innovative solutions. Solving these complex problems typically requires the collection and evaluation of systems, traffic flow, accidents, costs, and other statistics.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Understand the highway planning process and carry out surveys involved in planning and highway alignment.
II. Remember various geometric elements involved in design of highways and expressway.
III. Understand the various traffic studies and to implement traffic regulation and control measures.
IV. Understand the engineering properties of pavement materials used in highway construction.
V. Understand the factors affecting design and performance of flexible and rigid pavements as per IRC.

III.COURSE SYLLABUS:

MODULE –I: HIGHWAY DEVELOPMENT AND PLANNING(9)

Classification of roads, road development in India, Current road projects in India, highway alignment, factors affecting alignment, Engineering surveys, drawing and reports, highway project.

MODULE -II: GEOMETRIC DESIGN OF HIGHWAYS(9)

Introduction, highway cross section elements, sight distance elements, stopping sight distance, overtaking sight distance and intermediate sight distance, design of horizontal alignment; design of vertical alignment; design of intersections.

MODULE -III: TRAFFIC ENGINEERING AND CONTROL(9)

Traffic Characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control.

Design of parking facilities; highway lighting and Accident studies: causes and measures.

MODULE -IV: PAVEMENT MATERIALS(9)

Materials used in Highway Construction- Soils, Stone aggregates, bituminous binders, bituminous paving mixes; Portland cement and cement concrete: desirable properties, tests, requirements for different types of pavements.

MODULE -V: DESIGN OF PAVEMENTS(9)

Introduction; flexible pavements, factors affecting design and performance; stresses in flexible pavements; design of flexble pavements as per IRC; rigid pavements- components and functions; factors affecting design
and performance of CC pavements; stresses in rigid pavements; design of concrete pavements as per IRC; problems.

IV. TEXT BOOKS:

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, "Highway Engineering", Revised 10th Edition, Nem Chand & Bros, 2017.
2. Kadiyalai, L.R. "Traffic Engineering and Transport Planning", Khanna Publishers, 2013.
3. ParthaChakraborty, "Principles of Transportation Engineering", PHI Learning, 2017.

V. REFERENCE BOOKS:

1. Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski, "Principles of Highway Engineering and Traffic Analysis", John Wiley, 4th Edition, 2007.
2. Srinivasa Kumar, R, "Textbook of Highway Engineering", Universities Press, 2011.
3. Paul H. Wright and Karen K. Dixon, "Highway Engineering", Wiley Student Edition, 7th Edition, 2009.

VI. WEB REFERENCES:

1. http://www.nptelvideos.in/2012/11/introduction-to-transportation.html
2. http://www.nptelvideos.com/civil_engineering/transportation_engineering_video_lectures.php
3. https://nptel.ac.in/courses/105105107/
4. https://nptel.ac.in/courses/105101087/

VII. E-Text Books:

http://e-booksdirectory.com/details.php?ebook=5616

ESTIMATION, COSTING AND VALUATION

VI Semester: CE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACEC26	Elective	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Building Materials – Planning and Construction								

I. COURSE OVERVIEW:

This course deals with the estimation, costing and valuation of buildings and estimation is the technique of calculating or computing the carious quantities and the expected expenditure to be incurred on a particular work or project. This course focuses on the sanction or approval of any project or work, its estimated cost worked out and necessary funds are sanctioned by the competent authority. The rate of each item should also be reasonable and workable. This course helps in identifying the rates in the estimate for the complete work, which consist of the cost of materials, cost of transport cost of scaffolding, cost of tools and plants , cost of water , taxes, establishment and supervision cost, reasonable cost, reasonable profit of contractor, etc.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The importance and fundamentals of estimation and costing for measuring quantities of construction materials using methods involved in project works.
II. The basic concept of earth work related to roads and canals for estimating earth work quantity using sectional area methods.
III. The concept of bar bending schedule and rate analysis applied for determining quantity of steel and construction costs.
IV. The knowledge of structural valuation, tender documentation and conditions of contract for obtaining required information to file a contract bid in real time

III.COURSESYLLABUS:

MODULE –I: ESTIMATION OF GENEREAL ITEMS IN BUILDINGS (9)

General items of work in building, standard units principles of working out quantities for detailed and abstract estimates, approximate method of estimating. Detailed estimates of buildings.

MODULE -II: EARTHWORKS (9)

Introduction to earth works, earthwork calculations for roads and canals.

MODULE -III: RATE ANALYSIS AND CONTRACTS (9)

Rate analysis - Working out data for various items of work over head. Rate analysis, contingent charges.

Contracts, types of contracts, contract documents, conditions of contract.

MODULE -IV: BAR BENDING SCHEDULE (9)

Reinforcement bar bending and bar requirement schedules.

MODULE -V: VALUATION (9)

Valuation of buildings, standard specifications for different items of building construction. Need for tendering, process of tendering in construction, tendering models and strategies, prequalification of bidders, documents forming a BID, agreements and bonds in tendering process.

IV. TEXT BOOKS:

1. B. N. Dutta, “Estimating and Costing”, UBS publishers, 2000.
2. G. S. Birdie., “Estimating and Costing”, Dhanpat Rai publications, 1988.
3. S. C. Rangwala, Estimating And Costing, Charotar Publishing House, 2002.

V. REFERENCE BOOKS:

1. Standard schedule of rates and standard data book by public works department, 2015.
2. I.S. 1200 (Parts I to XXV – 1974 / method of measurement of building and Civil Engineering works – B.I.S)
3. M. Chakraborthi, “Estimation, Costing and Specifications”, Laxmi publications,1982.
4. National building code, 2015.

VI. WEB REFERENCES:

1. https://onlinecourses.swayam2.ac.in/nou20_cs11/preview
2. https://en.wikipedia.org/wiki/Estimation
3. https://theconstructor.org/practical-guide/quality-control/

VII. E-TEXT BOOKS:

1. https://www.google.com/search?tbm=bks&q=estimation+and+costing&oq=estimation

MANAGEMENT IN CONSTRUCTION

VI Semester: CE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACEC27	Elective	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: No prerequisites required								

I. COURSE OVERVIEW:

Management in construction involves the exercise of formal authority within a structured organizational setting directed towards the efforts of other people using systems and procedures. Management has many applications in construction and the built environment, some of the more common examples of which are set out below. Construction project management is the foundation on which each building project is based. Building projects involve constant changes, and project management is essential to the stability of the entire method. Construction projects have specific limits and objectives, such as the time required to accomplish them.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The latest and the best in the rapidly changing fields of Construction Engineering, Technology and Management.
II. The best management practices and techniques in the construction industry to acquire leadership qualities.
III. The industry programs to enhance the effectiveness and opportunities for innovation in the construction industry.
IV. The advanced research technologies and management approaches to develop projects.

III.COURSE SYLLABUS:

MODULE –I: BASICS OF MANAGEMENT (9)

Modern scientific management (Contribution by Fayol, F.W. Taylor, Mayo), management functions, management styles, SWOT analysis in construction.

MODULE -II: PROJECT MANAGEMENT (9)

Basic forms of organization with emphasis on Project and matrix structures; project life cycle, planning for achieving time, cost, quality, project feasibility reports based on socio-techno-economic environmental impact analysis, project clearance procedures and necessary documentation for major works like dams, multistoried structures, ports, tunnels, qualities, role and responsibilities of project manager, Role of Project Management Consultants, Enterprise Resource Planning (ERP).

MODULE -III: CONSTRUCTION SITE MANAGEMENT (9)

Site mobilization – demobilization aspects, various Resources management based on funds availability, 10 coordinating, communicating & reporting Techniques.

Application of MIS to construction, training for construction managers, engineers, supervisors.

MODULE -IV: IMPORTANCE OF MATERIALS MANAGEMENT(9)

Importance of material management and its role in construction industry-scope, objectives and functions, Integrated approach to materials management, Role of materials manager.

MODULE -V: INVENTORY AND STORES MANAGEMENT (9)

Inventory Management – Inventory control techniques. EOQ, advantages and limitation of use of EOQ, periodic ordering, order point control, safety stock, stock outs, application of AC analysis in inventory control, concept of (JIT) Just in time management, Indices used for assessment of effectiveness of inventory management. Stores Management: Receipt and inspection, care and safety in handling, loss on storage, wastage, Bulk purchasing, site layout and site organization, scheduling of men, materials and equipment.

IV. TEXT BOOKS:

1. Montgomery and Runger, “Applied Statistics and Probability for Engineers”, Wiley, India.
2. Miller, Freund-Hall, “Probability and Statistics for Engineers”, Prentice India Ltd. 2009.
3. Pipes and Harvill, “Applied Mathematics for Engineers and Physiscists”, McGraw Hill International Edition, 1970.

V. REFERENCE BOOKS:

1. Calabro, “Reliability Principles and Practices”, McGraw Hill Book Company, 1963.
2. Shrivastava, Shenoy & Sharma, “Quantitative Techniques for Managerial Decisions”, Wiley, 1989.

VI. WEB REFERENCES:

1. https://onlinecourses.swayam2.ac.in/cec22_mg15/preview.

VII. E-TEXT BOOKS:

1. https://engineeringbookspdf.com/download/?file=2201&format=pdf.

CONSTRUCTION SCHEDULING

VI Semester: CE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC28	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisite: No prerequisites required								

I. COURSE OVERVIEW:

Construction Scheduling deals with project scheduling techniques and procedures including; how to create a network diagram, how to define the importance of the critical path in a project network, and defining project activities float. Also covered are the fundamentals of Bar Charts, Precedence Diagrams, Activity on Arrow, PERT, Range Estimating, and linear project operations and the line of balance.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The construction scheduling, management practices and technologies in the construction industry.
II. The construction activity relationships and scheduling tools various types of planning tools like bar chart, CPM networks.
III. The bar charts and critical path method networks for construction activities.
IV. The appropriate mastery of the knowledge, techniques, skills and modern tools of construction scheduling.

III.COURSE SYLLABUS:

MODULE –I: CONSTRUCTION PLANNING (9)

Basic concepts in the development of construction plans. Choice of technology and construction method. Defining Work Tasks: Work breakdown structure, definition, precedence relationships among activities, estimating activity durations, estimating resource requirements for work activities-coding systems.

MODULE -II: SCHEDULING PROCEDURES AND TECHNIQUES (9)

Relevance of construction schedules, bar charts, the critical path method, calculations for critical path scheduling, activity float and schedules, presenting project schedules, critical path scheduling for activity-on-node and with leads, lags and windows, calculations for scheduling with leads, lags and windows, resource oriented scheduling, scheduling with resource constraints and precedences, use of advanced scheduling techniques, scheduling with uncertain durations, crashing and time/cost trade offs, improving the scheduling process.

MODULE -III: COST ANALYSIS (9)

Cost analysis, direct cost, indirect costs, and slope of the project activities, optimization of cost

Schedule through network contraction, applications in construction industry.

MODULE -IV: COST CONTROL(9)

Cost control in construction projects, importance of cost control and its objectives, resource analysis - smoothing and leveling of various construction projects.

MODULE –V: PRECEDENCE NETWORK (9)

Precedence network, advantages of precedence network, logic of precedence network diagram, and computer applications on network problems related to construction industry.

IV. TEXT BOOKS:

1. Chitkara,K K., "Construction Project Management Planning, Scheduling and Control", Tata McGraw Hill Publishing Co, Ltd., New Delhi, 2005.
2. Srinath,L.S., "Pert and CPM Priniples and Applications ", Affiliated East West Press, 2001.

V. REFERENCE BOOKS:

1. Chris Hendrickson and Tung Au, "Project Management for Construction – Fundamentals Concepts for Owners", Engineers, Architects and Builders, Prentice Hall, Pitsburgh, 2000.
2. Moder.J.,C.Phillips and Davis, "Project Management with CPM", PERT and Precedence Diagramming, Van Nostrand Reinhold Co., 3rdEdition, 1983.
3. Willis., E.M., "Scheduling Construction projects", John Wiley and Sons 1986.
4. Halpin,D.W., "Financial and cost concepts for construction Management", John Wiley and Sons, New York, 1985.

VI. WEB REFERENCES:

1. https://nptel.ac.in/courses/105/102/105102199/

VII. E-TEXT BOOKS:

1. https://www.scribd.com/doc/231678531/k-k-Chitkara-Construction-Project-Management
2. http://www.opentextbooks.org.hk/system/files/export/15/15694/pdf/Project_Management.pdf

CONSTRUCTION FINANCE

VI Semester: CE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACEC29	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: No prerequisites required								

I. COURSE OVERVIEW:

This course deals with the construction loans offer progressive drawdown, meaning the lender pays your loan in small chunks – as and when your builder completes a stage rather than in a lump sum. After this time, the loan reverts to principal and interest. Most lenders, such as the big four banks, offer construction loans. Construction financing is a loan provided to build a home from the ground up. One of the great things about construction financing is that it allows clients to custom build a home exactly the way they want it.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The formulation, costing of construction projects, appraisal, finance and private sector participation.
II. The concepts of Construction Economic and Finance such as comparing alternatives proposals, evaluating alternative investments, management of funds, and management of accounting.
III. The construction work basics of quality control and safety work avoid accident.

IV. The principles of estimation of project cost and valuation of structures.

III.COURSE SYLLABUS:

MODULE –I: INTRODUCTION & BASICS OF ECONOMICS & FINANCE (9)

Meaning & necessity of: economics, costing & finance, history & fundamentals of economics, basics of finance & accounting, rates of interest, basics of financial statement, financial analysis, inflation.

MODULE -II: PRINCIPLES OF COSTING, ESTIMATION & VALUATION (9)

Basics of Costing, activity based costing & case studies, basics of estimation & valuation, present & future values of properties, profitability & financial decisions, inventory management.

MODULE -III: ECONOMIC ANALYSIS (9)

Cost implication to different forms of construction and maintenance and maintenance and replacement lives of material, installation and running cost of services, capital investment in project, cost analysis by traders and by functional element, cost planning techniques, cost control during design and construction.

Depreciation, various appraisal criteria methods. Break-even analysis, cash flow analysis, risk analysis and management practice, role of Lender‘s engineer, cost pricing method.

MODULE -IV: FINANCIAL PLANNING (9)

Need and sources of finance, long term finance planning, stock, borrowings, debentures, loan capital, public deposit, dividend policies, bonus shares, market value of shares, reserves; Budget: Budgetary control system, types of budgets, procedure for master budgets. Budget manual, accounting Information System: Project commentary, project running commentary.

MODULE -V: CONSTRUCTION ACCOUNTS (9)

Accounting process, preparation of profit and loss account and balance sheet as per the companies Act 2013, preparation of contract accounts for each project, methods of recording and reporting site accounts between project office and head office, ratio analysis. Escrow account for PPP Project.

IV. TEXT BOOKS:

1. Blank, L.T., and Tarquin,a.J , "Engineering Economy", McGraw Hill Book Co, 4th Edition., 1988.
2. Collier C and GlaGola C, "Engineering Economics & Cost Analysis", Addison Wesley Education Publishers, 3rd Edition, 1998.
3. Patel, B M, "Project Management -Strategic Financial Planning, Evaluation and Control", Vikas Publishing House Pvt. Ltd. New Delhi, 2000.

V. REFERENCE BOOKS:

1. Shrivastava, U.K., "Construction Planning and Management", Galgotia Publications Pvt. Ltd. New Delhi, 2nd Edition, 2000.
2. Teiner, H.M. "Engineering Economic Principles", McGraw Hill Book, 2nd Edition, 1996.

VI. WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc22_ce08/preview.

VII. E-TEXT BOOKS:

https://gacbe.ac.in/images/E%20books/Construction%20Accounting%20and%20Fin.%20Mgmt.%202nd%20ed.%20-%20S.%20Peterson%20(Pearson,%202009)%20BBSbb.pdf

FLIGHT CONTROL THEORY

OE –I: VI Semester: AERO / MECH / CIVIL OE – III: VIII Semester: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT / ECE / EEE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AAEC30	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		

I. COURSE OVERVIEW:

Flight control system of an aircraft is instrumental in establishing stability of the aircraft through control surfaces. This course introduces the concepts of the control system theory such as transfer functions, step response and impulse response. This course covers stability, feedback and different techniques used for control systems analysis. The course emphasizes on the flight control systems, response analysis for control surface inputs and control augmentation systems such as autopilots.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The stability criteria to determine the stability of an aircraft, and specify the aircraft time-domain and frequency-domain response specifications.
II. The classical control theory in the frequency domain and modern control theory in the state- space are effectively mixed to provide the student with a modern view of systems theory.
III. The various control techniques for aircraft control systems, and study some feedback control applications.
IV. The controllability and observability of aerospace systems, and apply the modern control techniques to design enhanced flight control systems.

III. COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO CONTROL SYSTEM (10)

Dynamical systems-principal constituents-input, output-process (plant)-block diagram representation. Inputs- control input, noise. Function of controls regulation (hold), tracking (command)-examples. Measure of effectiveness. Sensitivity of output to control input, noise and system parameters- robustness. Deterministic and stochastic control. Control in everyday life. The pervasiveness of control in nature, engineering and societal systems. The importance of study of control system. Need for stable, effective (responsive), robust control system. Modeling of dynamical systems by differential equations-system parameters. Examples from diverse fields. First and second order systems, higher order systems, single input single output systems, and multiple-input multiple-output.

MODULE –II: MATHEMATICAL MODELING OF DYNAMICAL SYSTEMS (10)

Control system performance- time domain description- output response to control inputs-- impulse and indicial response- characteristic parameters- significance- relation to system parameters- examples- first and second order linear systems, higher order systems. Synthesis of response to arbitrary input functions from impulse and indicial response. Review of Fourier transforms and Laplace transforms- inverse transforms- significance, applications to differential equations. 's' (Laplace) domain description of input- output relations- transfer function representation- system parameters- gain, poles and zeroes. Characteristic equation- significance- examples. Frequency and damping ratio of dominant poles. Relation of transfer functions to impulse response. Partial fraction decomposition of transfer functions- significance.

MODULE –III: STEADY STATE RESPONSE ANALYSIS (10)

System type, steady state error, error constants- overall system stability. Application of feedback in stability augmentation, control augmentation, automatic control-examples. Composition, reduction of block diagrams of complex systems-rules and conventions. Control system components - sensors, transducers, servomotors, actuators, filters-modeling, transfer functions. Single-input single-output systems. Multiple input-multiple output systems, matrix transfer functions-examples. Types of control problems- the problem of analysis, control synthesis, system synthesis- examples- static control of aircraft.

Extension to dynamic control. System identification from input output measurements importance. Flight path stabilization, longitudinal control law design using back stepping algorithm. Experimental determination of system transfer functions by frequency response measurements. Example. Frequency domain description- frequency response- gain and phase shift- significance- representation asymptotic (Bode) plots, polar (Nyquist) plots, frequency transfer functions. Characteristic parameters corner frequencies, resonant frequencies, peak gain, and bandwidth- significance. First and second order systems-extension to higher order systems.

MODULE –IV: AIRCRAFT RESPONSE TO CONTROL (07)

Approximations to aircraft transfer functions, control surface actuators-review. Response of aircraft to elevator input, Response of aircraft to rudder input and Response of aircraft to aileron input to atmosphere. Need for automatic control. Auto pilots Stability augmentation systems-pitch damper and yaw damper.

MODULE –V: FLYING QUALITIES OF AIRCRAFT (08)

Reversible and irreversible flight control systems. Flying qualities of aircraft-relation to airframe transfer function. Pilot's opinion ratings. Flying quality requirements- pole-zero, frequency response and time-response specifications. Displacement and rate feedback determination of gains conflict with pilot input s resolution-control augmentation systems- Full authority fly-by-wire. Auto Pilot-Normal acceleration, Turn rate, Pitch rate Commands-Applications.

. TEXT BOOKS:

1. Kuo, B.C., “Automatic control of Aircraft and Missiles”, John Wiley Sons, New York, 1990.
2. Stevens B.L & Lewis F.L, “Aircraft control & Simulation”, John Wiley Sons, New York, 1992.

REFERENCE BOOKS:

1. Mc Lean, D., “Automatic Flight Control Systems”, Prentice Hall, 1990.
2. Bryson, A.E., “Control of Aircraft and Spacecraft”, Princeton University Press, 1994.
3. E H J Pallett, Shawn Coyle, “Automatic Flight Control”, 4th Edition, 2002.

. WEB REFERENCES:

1. https://www.e-booksdirectory.com/
2. https://www.aerospaceengineering.es/book/

I. E-TEXT BOOKS:

1. https://books.google.co.in/books?isbn=1118870972
2. https://books.google.co.in/books?isbn=0387007261

AIRFRAME STRUCTURAL DESIGN

OE –I: VI Semester: AERO / MECH / CIVIL OE – III: VIII Semester: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT / ECE / EEE							
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AAEC31	Elective	L	T	P	C	CIA	SEE	Total
		3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

This course deals with fundamental aspects of an anatomy of aircraft and the current trends in airframe design. It includes the evolution of the aircraft and space industry, aerodynamics and performance of the aircraft with their applications. It compares and contrasts various thrust vector control mechanisms of different aircraft propulsion systems. It discusses various materials and its properties that are used for manufacturing different parts of an aircraft. This course enriches the knowledge of connection between theoretical and practical methods for performing the airframe design exercises

II. COURSE OBJECTIVES:

The student will try to learn:

I. The fundamental concepts of various airframe designs, aircraft propulsion systems and aerodynamic forces/moments acting on the aircraft and spacecraft under static and dynamic load conditions
II. The characteristics of stability and performance of an aircraft and the role of primary and secondary controls in longitudinal and lateral stability
III. The properties of different materials that are used in industries for manufacturing various components of an aircraft and spacecraft achieving specified stability requirements.
IV. The mathematical modeling of tailless aircraft, flapping wing aircraft and innovative designs in modern aircraft for future requirements.

II. COURSE SYLLABUS:

MODULE-I: HISTORY OF FLIGHT AND SPACE ENVIRONMENT (10)

Balloons and dirigibles, heavier than air aircraft, commercial air transport; Introduction of jet aircraft, helicopters, missiles; Conquest of space, commercial use of space; Different types of flight vehicles, classifications exploring solar system and beyond, a permanent presence of humans in space; Earth‘s atmosphere, the standard atmosphere; The temperature extremes of space, laws of gravitation, low earth orbit, microgravity, benefits of microgravity; Environmental impact on spacecraft, space debris; Planetary environments.

MODULE –II: INTRODUCTION TO AERODYNAMICS (10)

Anatomy of the airplane, helicopter; Understanding engineering models; Aerodynamic forces on a wing, force coefficients; Generating lift, moment coefficients; Aerodynamic forces on aircraft – classification of NACA airfoils, aspect ratio, wing loading, mach number, centre of pressure and aerodynamic centre, aerofoil characteristics-lift, drag curves; Different types of drag.

MODULE –III: FLIGHT VEHICLE PERFORMANCE AND STABILITY (09)

Performance parameters, performance in steady flight, cruise, climb, range, endurance, accelerated flight symmetric maneuvers, turns, sideslips, takeoff and landing.

Flight vehicle Stability, static stability, dynamic stability; Longitudinal and lateral stability; Handling qualities of the airplanes.

MODULE –IV: INTRODUCTION TO AIRPLANE STRUCTURES AND MATERIAL,POWERPLANT (08)

General types of construction, monocoque, semi-monocoque; Typical wing and fuselage structure; Metallic & non-metallic materials, use of aluminum alloy, titanium, stainless steel and composite materials; Basic ideas about engines, use of propellers and jets for thrust production; Principles of operation of rocket, types of rockets.

MODULE –V: SATELLITE SYSTEMS ENGINEERING HUMAN SPACE EXPLORATION (08)

Satellite missions, an operational satellite system, elements of satellite, satellite bus subsystems; Satellite structures, mechanisms and materials; Power systems; Communication and telemetry; Propulsion and station keeping; Space missions, mission objectives. Goals of human space flight missions, historical background, the Soviet and US missions; The mercury, Gemini, Apollo (manned flight to the moon), Skylab, apollo-soyuz, space Shuttle; International space station, extravehicular activity; The space suit; The US and Russian designs; Life support systems, flight safety; Indian effort in aviation, missile and space technology.

IV. TEXT BOOKS:

1. Newman D, “Interactive Aerospace Engineering and Design”, McGraw-Hill, 1st Edition, 2002.
2. Anderson J. D, “Introduction To Flight”, McGraw-Hill Education, 5th Edition, 2002.

V. REFERENCE BOOKS:

1. Kermode. A. C, “Flight without Formulae”, McGraw Hill, 4th Edition, 1997.
2. Barnard R.H and Philpot. D.R, “Aircraft Flight”, Pearson, 3rd Edition, 2004.
3. SwattonP.J, “Flight Planning”, Blackwell Publisher, 6th Edition, 2002.

VI. WEB REFERENCES:

1. http://ase.sbu.ac.ir/FA/Staff/abbasrahi/Lists/Dars/Attachments/11/Vibrations%20of%20Continuous%20Systems.pdf
2. http://arc-test.aiaa.org/doi/book/10.2514/4.862458
3. http://arc-test.aiaa.org/doi/abs/10.2514/5.9781600862373.0719.0728

VII. E-TEXT BOOKS:

1. http://www.gregorypaulblog.com/structural-dynamics-in-aeronautical-engineering-aiaa-education-series.pdf
2. https://aerocastle.files.wordpress.com/2012/10/mechanical_vibrations_5th-edition_s-s-rao.pdf

INDUSTRIAL MANAGEMENT

OE –I: VI Semester: AERO / MECH / CIVIL OE – III: VIII Semester: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT / ECE / EEE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC34	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		

I.COURSE OVERVIEW:

The industrial management prepares engineers to design, improve, install, and operate the integrated systems of people, materials, and facilities needed by industry, commerce, and society. Industrial engineers solve problems that arise in the management of systems, applying the principles of engineering science, product/service and process design, work analysis, human factors principles, and operations research.The focus of this course is how to improve processes or design things that are more efficient and waste less money, time, raw resources, man-power and energy while following safety standards and regulations

II. COURSE OBJECTIVES:

The students will try to learn:

I. The production planning and control procedures to handle industrial disputes.
II. The Work study procedures and quality concepts to enhance more productivity
III. The significant exposure on some maintenance practices in industry for consistent productivity.

III.COURSE SYLLABUS:

MODULE-I: CONCEPTS OF INDUSTRIAL MANAGEMENT (9)

Principles of management- Growth of management thought, Functions of management, Principles of organization, Types of organization and committees.

MODULE –II: WORK STUDY (9)

Concept of productivity, Method Study - Basic steps in method study, Process charts, Diagrams, Principles of motion economy, Micro motionstudy, Therbligs, SIMO chart. Work Measurement - Stop watch procedure of time study, Performance rating, allowances, Work sampling, Simple problems.

MODULE –III: INVENTORY CONTROL (9)

Inventory Control: Inventory, Cost, Deterministic Models and Introduction to Supply Chain Management.

MODULE –IV: QUALITY CONTROL (9)

Quality Control: Process control, SQC, Control charts, Single, Double and Sequential Sampling, Introduction to TQM.

MODULE –V: DEMAND FORECASTING AND COST ESTIMATION (9)

Demand Forecasting and cost Estimation: Characteristics of Forecasts, Forecasting Horizons, Steps to Forecasting, Forecasting Methods, Seasonal Adjustments, Forecasting Performance Measures, Cost Estimation, Elements of cost, Computation of Material Variances Break-Even Analysis.

IV. TEXT BOOKS:

1. O.P. Khanna, “Industrial Engineering and Management”, Khanna Publishers.
2. T.R. Banga and S.C.Sarma, “Industrial Engineering and Management Science”, Khanna Publishers.

V. REFERENCE BOOKS:

1. Ralph M Barnes, "Motion and Time Study", John Willey & Sons Work Study lLO.
2. Ernest J McCormick, "Human factors in Engineering & Design", TMH.
3. Paneer Selvam, "Production & Operation Management", PHI.
4. NVS Raju, "Industrial Engineering Management", Cengage Learning.

VI. REFERENCE BOOKS:

1. https://nptel.ac.in/courses/112/107/112107142/#
2. https://nptel.ac.in/courses/112/107/112107143/#

ELEMENTS OF MECHANICAL ENGINEERING

<table>
<tr><td colspan="11">OE –I: VI Semester: AERO / MECH / CIVIL
OE – III: VIII Semester: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT / ECE / EEE</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">AMEC35</td><td rowspan="2">Elective</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
</table>

I.COURSE OVERVIEW:

The main aim of this course to impart mechanical engineering fundamental basics to allied engineering students so that they have minimum understanding of mechanical system, equipment and process.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamentals of mechanical systems.
II. The significance of mechanical engineering and apply in different fields of engineering.
III. The various applications of engineering materials for designing different engineering components.

III. COURSE SYLLABUS:

MODULE-I: SOURCES OF ENERGY, BASIC CONCEPTS OF THERMODYNAMICS (9)

Sources of Energy : Introduction and application of energy sources like fossil fuels, hydel, solar, wind, nuclear fuels and bio-fuels; environmental issues like global warming and ozone depletion.

Basic concepts of Thermodynamics: Introduction, states, concept of work, heat, temperature; Zeroth, 1st, 2nd and 3rd laws of thermodynamics. Concept of internal energy, enthalpy and entropy (simple numericals).

MODULE –II: BOILER AND TURBINES(9)

Boilers: Introduction to boilers, classification, Lancashire boiler, Babcock and Wilcox boiler. Introduction to boiler mountings and accessories (no sketches).

Turbines: Hydraulic Turbines-Classification and specification, Principles and operation of Pelton wheel turbine, Francis turbine and Kaplan turbine (elementary treatment only).

Hydraulic Pumps: Introduction, classification and specification of pumps, reciprocating pump and centrifugal pump, concept of cavitations and priming.

MODULE –III: PROPERTIES, COMPOSITION AND INDUSTRIAL APPLICATIONS OF ENGINEERING MATERIALS(9)

Metals-Ferrous: cast iron, tool steels and stainless steels and nonferrous: aluminum, brass, bronze. Polymers -Thermoplastics and thermosetting polymers. Ceramics -Glass, optical fiber glass, cermets. Composites -Fiber reinforced composites, Metal Matrix Composites, Smart materials -Piezoelectric materials, shape memory alloys, semiconductors and insulators.

Joining Processes: Soldering, Brazing and Welding Definitions. Classification and methods of soldering, brazing and welding. Brief description of arc welding, oxy-acetylene welding, TIG welding, and MIG welding.

MODULE –IV: MACHINE TOOLS(9)

Lathe -Principle of working of a center lathe. Parts of a lathe. Operations on lathe –Turning, Facing, Knurling, Thread Cutting, Drilling, Taper turning by Tailstock offset method and Compound slide swiveling method, Specification of Lathe.

Milling Machine-Principle of milling, types of milling machines. Working of horizontal and vertical milling machines. Milling processes -plane milling, end milling, slot milling, angular milling, form milling, straddle milling, and gang milling.

MODULE –V: INTRODUCTION TO ADVANCED MANUFACTURING SYSTEMS (9)

Computer Numerical Control (CNC): Introduction. Components of CNC, open loop and closed loop systems, advantages of CNC, CNC Machining centers and Turning centers.

Robots: Robot anatomy, joints and links, common robot configurations. Applications of Robots in material handling, processing and assembly and inspection

IV.TEXT BOOKS

1. V. K. Manglik, “Elements of Mechanical Engineering”, Prentice Hall, 1st Edition, 2013.
2. Mikell P. Groover, “Automation, Production Systems and CIM”, Prentice Hall, 4th Edition, 2013

V.REFERENCE BOOKS:

1. S. Trymbaka Murthy, “A Text Book of Elements of Mechanical Engineering”, University Press, 4th Edition, 2006.
1. K. P. Roy, S. K. Hajra Choudary, Nirjhar Roy, “Element of Mechanical Engineering”, Media Promoters & Publishers, 7th Edition, 2012.
2. Pravin Kumar, “Basic Mechanical Engineering”, Pearson, 1st Edition, 2013

VI.WEB REFERENCES:

1. http://www.nptel.ac.in/courses/112107144/
2. http://www.nptel.ac.in/courses/112101098/download/lecture-37.pdf

MODERN CONSTRUCTION MATERIALS

OE –I: VI Semester: AERO / MECH / CIVIL OE – III: VIII Semester: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT / ECE / EEE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACEC30	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	30	70	100
Contact Classes: 45	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: 45**		

I. COURSE OVERVIEW:

This course provides the scientific basis for the understanding and development of construction materials. It serves as a foundation course for post-graduate students interested in careers involving research, teaching and/or construction engineering, as well as marketing, decision making, innovation and specification related to construction materials.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The concept of modern water proofing and insulating materials in constructions.
II. Importance of composites and chemicals in production of modern concrete.
III. The types of concrete and their constituents and properties.
IV. The impact of building construction on society and demonstrate awareness of contemporary issues.

III.COURSE SYLLABUS:

MODULE-I: STONES – BRICKS – CONCRETE BLOCKS (09)

Stone as building material, Criteria for selection, Tests on stones, Deterioration and Preservation of stone work, Bricks, Classification, Manufacturing of clay bricks, Tests on bricks Compressive Strength, Water Absorption, Efflorescence, Bricks for special use, Refractory bricks, Cement, Concrete blocks, Light-weight concrete blocks.

MODULE-II: LIME – CEMENT – AGGREGATES – MORTAR (09)

Lime, Preparation of lime mortar, Cement, Ingredients, Manufacturing process, Types and Grades, Properties of cement and Cement mortar, Hydration, Compressive strength, Tensile strength, Fineness, Soundness and consistency, Setting time, Industrial byproducts, Fly ash, Aggregates, Natural stone aggregates, Crushing strength, Impact strength, Flakiness Index, Elongation Index, Abrasion Resistance, Grading, Sand Bulking.

MODULE-III: CONCRETE (09)

Concrete, Ingredients, Manufacturing Process, Batching plants, RMC, Properties of fresh concrete, Slump, Flow and compaction Factor, Properties of hardened concrete, Compressive, Tensile and shear strength.

Modulus of rupture, Tests, Mix specification, Mix proportioning, BIS method, High Strength Concrete and HPC, Self compacting Concrete, Other types of Concrete, Durability of Concrete.

MODULE-IV: TIMBER AND OTHER MATERIALS (09)

Timber, Market forms, Industrial timber, Plywood, Veneer, Thermacole, Panels of Laminates, Steel, Aluminum and Other Metallic Materials, Composition, Aluminium composite panel, Uses: Market forms, Mechanical treatment, Paints, Varnishes, Distempers, Bitumens.

MODULE-V: MODERN MATERIALS (09)

Glass, Ceramics, Sealants for joints, Fibre glass reinforced plastic, Clay products, Refractories, Composite materials, Types, Applications of laminar composites, Fibre textiles, Geomembranes and Geotextiles for earth reinforcement.

IV.TEXT BOOKS:

1. W.D. Callister, John Wiley, "Materials Science and Engineering: An Introduction", John Wiley & Sons, Inc. 1994.
2. P.C. Varghese, "Building Materials", Prentice-Hall India, 2005.

V. REFERENCE BOOKS:

1. V. Raghavan, "Materials Science and Engineering", Prentice Hall, 1990.
2. R.A. Higgins, "Properties of Engineering Materials", Industrial Press, 1994.
3. Eds. J.M. Illston and P.L.J. Domone, "Construction Materials: Their nature and behaviour", Spon Press, 3rd Edition, 2002

VI.WEB REFERENCES:

1. https://www.scribd.com/document/394619658/Material-Science-and-Engineering-V-Raghavan-pdf
2. https://files.isec.pt/DOCUMENTOS/SERVICOS/BIBLIO/INFORMA%C3%87%C3%95ES%20ADICIONAIS/Materials-for-engineers-5ed_Higgins.pdf

VII. E-TEXT BOOKS:

1. https://onlinecourses.nptel.ac.in/noc20_ce05/preview
2. http://kaizenha.com/wp-content/uploads/2016/04/Materials-Textbook-8th-Edition.pdf

DISASTER MANAGEMENT

<table>
<tr><td colspan="10">OE –I: VI Semester: AERO / MECH / CIVIL
OE – III: VIII Semester: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT / ECE / EEE</td></tr>
<tr><td rowspan="1">Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">ACEC31</td><td rowspan="2">Elective</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Total Tutorials: Nil</td><td colspan="4">Total Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
</table>

I. COURSE OVERVIEW:

The Disaster management provides a fundamental understanding of different aspects. It deals with the concepts and functions of disaster management to build competencies of professionals and development practitioners. It provides effective supporting environment by the governmental locating substantial resources for effective mitigation of disasters. It helps learners to apply the disaster mitigation strategies, preparedness for reducing damage intensity, loss of life and property.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The concept of environmental hazards, disasters and various approaches dealing with the mitigation of disasters.
II. The knowledge on various types of environmental disasters and their impacts on human beings and nature.
III. The Different types of endogenous and exogenous hazards and their influence on human life and nature.
IV. The immediate response and damage assessment with information reporting and monitoring tools.

III.COURSE SYLLABUS:

MODULE-I: ENVIRONMENTAL HAZARDS AND DISASTERS (09)

Environmental hazards and disasters: meaning of environmental hazards, environmental disasters and environmental stress; concept of environmental hazards, environmental stress and environmental disasters, different approaches and relation with human ecology, landscape approach, ecosystem approach, perception approach, human ecology and its application in geographical researches.

MODULE-II: TYPES OF ENVIRONMENTAL HAZARDS AND DISASTERS (09)

Types of environmental hazards and disasters: Natural hazards and disasters, man induced hazards and disasters, natural hazards, planetary hazards/ disasters, extra planetary hazards/ disasters, planetary hazards, endogenous hazards, exogenous hazards.

MODULE-III: ENDOGENOUS HAZARDS (09)

Endogenous hazards, volcanic eruption, earthquakes, landslides, volcanic hazards/ disasters, causes and distribution of volcanoes, hazardous effects of volcanic eruptions, environmental impacts of volcanic eruptions.

Earthquake hazards/ disasters, causes of earthquakes, distribution of earthquakes, hazardous effects of, earthquakes, earthquake hazards in India, human adjustment, perception and mitigation of earthquake

MODULE-IV: EXOGENOUS HAZARDS (09)

Exogenous hazards/ disasters, infrequent events, cumulative atmospheric hazards/ disasters; Infrequent events: Cyclones , lightning , hailstorms; Cyclones: Tropical cyclones and local storms, destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation); Cumulative atmospheric hazards/ disasters: Floods, droughts, cold waves, heat waves floods; Causes of floods, flood hazards India, flood control measures (human adjustment, perception and mitigation);

Droughts: Impacts of droughts, drought hazards in India, drought control measures, extra planetary hazards/ disasters, man induced hazards /disasters, physical hazards/ disasters, soil erosion, Soil erosion: Mechanics and forms of soil erosion, factors and causes of soil erosion, conservation measures of soil erosion; Chemical hazards/ disasters: Release of toxic chemicals, nuclear explosion, sedimentation processes; Sedimentation processes: Global sedimentation problems regional sedimentation problems, sedimentation and environmental problems, corrective measures of erosion and sedimentation, biological hazards/ disasters, population explosion.

MODULE-V: EMERGING APPROACHES IN DISASTER MANAGEMENT (09)

Emerging approaches in Disaster Management, Three Stages

1. Pre, disaster stage(preparedness)
2. Emergency Stage
3. Post Disaster stage, Rehabilitation.

IV.TEXT BOOKS:

1. Pardeep Sahni, "Disaster Mitigation: Experiences and Reflections", PHI Learning Pvt. Ltd., 1st Edition, 2001.
2. J.Glynn,Gary W.HeinKe, "Environmental Science and Engineering", Prentice Hall Publishers, 2nd Edition, 1996.

V. REFERENCE BOOKS:

1. B. C. Punmia, Ashok K Jain and Arun K Jain, "Mechanics of Materials", Laxmi Publications Pvt. Ltd., New Delhi, 12th Edition, 2007.
2. R. Subramanian, "Strength of Materials", Oxford University Press, 2nd Edition, 2010.
3. D. S. Prakash Rao, "Strength of Materials A Practical Approach Vol.1", Universities Press (India) Pvt. Ltd., India, 3rd Edition, 2007.
4. J. M. Gere, S.P. Timoshenko, "Mechanics of Materials, SI units edition", CL Engineering, USA, 5th Edition, 2000.

VI. Web References:

1. https://www.google.co.in/?gfe_rd=cr&ei=,iAwWLiDIazv8we8_5LADA#q=disater+mangement
2. http://ndma.gov.in/images/policyplan/dmplan/National%20Disaster%20Management%20Plan%20May%202016.pdf
3. http://www.eib.europa.eu/attachments/pipeline/20080021_eia_en.pdf
4. http://www.ndmindia.nic.in/

VII. E-Text Books:

1. http://cbse.nic.in/natural%20hazards%20&%20disaster%20management.pdf\
2. http://www.digitalbookindex.org/_search/search010emergencydisastera.asp
3. http://www.icbse.com/books/cbse,ebooks,download

VI Semester: Common for all branches								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACSC27	Foundation	L	T	P	C	CIA	SEE	Total
		2	-	-	1	30	70	100
Contact Classes: 36	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 36		
Prerequisite: There are no prerequisites to take this course								

I. COURSE OVERVIEW:

Research-based learning (RBL) presents as an alternative learning model that can develop the critical thinking skills. The research-based learning is conducted under constructivism which covers four aspects: learning which constructs student's understanding, learning through developing prior knowledge, learning which involves social interaction process, and meaningful learning which is achieved through real-world experience. The major focus is to engage students in the inquiry process where they formulate questions, conduct investigations, apply information and media to learning, and generate products that illustrate learning. The 5E learning cycle adopted for RBL leads students through five phases: Engage, Explore, Explain, Elaborate, and Evaluate which results in greater benefits concerning student's ability for scientific inquiry.

II. COURSE OBJECTIVES:

The students will try to learn:

I. To provide an opportunity for the students to engage in solving the real-world problems.
II. To introduce the overall process of research from its inception to the report.
III. To create the environment for multi-disciplinary research.
IV. Comprehend the role of ethics in research

III. COURSE SYLLABUS

I. What is Research?
II. Identifying Problem Statement
III. Overview of research-literature
IV. Planning activities, clarifying methods/methodologies
V. Experimentation
VI. Hypothesis testing
VII. Undertaking investigation and analyzing the data
VIII. Interpretation and consideration of results
IX. Presentation of replication studies

GEOTECHNICAL ENGINEERING LABORATORY

<table>
<tr><td colspan="9">VI SEMESTER: CE</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">ACEC32</td><td rowspan="2">Core</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>1.5</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: Nil</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: 36</td><td colspan="3">Total Classes: 36</td></tr>
<tr><td colspan="9">Prerequisite: Geotechnical Engineering</td></tr>
</table>

I. COURSE OVERVIEW:

The geotechnical engineering laboratory intends to train the students on testing of soils to determine physical, index and engineering properties. This course enables the students to perform the most important parameters including: soil classification, compaction, consolidation, permeability, shear parameters such as angle of internal friction etc. Each experiment of soil testing is presented with brief introduction covering all the important aspects related to experiment along with theory and the purpose for which it is to be performed, followed by the detailed explanation of apparatus, procedure and specimen calculations.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The concept behind the soil formation, soil type and the relationships between the soil mass and volume of voids that enables the students to perform moisture content, specific gravity and atterberg limits.
II. The procedure for soil classification through grain size distribution and classification of soil according to IS code.
III. The importance of determining the permeability via (constant head and variable head) tests, so that students can estimate ground water flow, seepage through dams, rate of consolidation and settlement of structures.
IV. The behaviour of soil under different loading conditions that enables the students to derive the bearing capacity, retaining walls design, and evaluate the stability of slopes and embankments, etc.

III.COURSE SYLLABUS:

Week – 1: DETERMINATION OF MOISTURE CONTENT OF SOILS

To determine the natural moisture content of the given soil sample.

Week – 2: DETERMINATION OF SPECIFIC GRAVITY OF SOILS

Determine the specific gravity of soil fraction passing 4.75 mm I.S sieve by density bottle.

Week – 3: DETERMINATION OF ATTERBERG'S LIMITS OF SOILS

To determine liquid limit, plastic limit, shrinkage limit, classify the soil and to find flow index and toughness index.

Week – 4: DETERMINATION OF FIELD DENSITY- CORE CUTTER AND SAND REPLACEMENT METHOD

To determine the mass density of soils by core cutter method and replacement method.

Week – 5: GRAIN SIZE ANALYSIS OF SOILS

To classify the Coarse Grained soils based on sieve analysis.

Week – 6: PERMEABILITY OF SOIL: CONSTANT AND VARIABLE HEAD TEST

To determine coefficient of permeability of given soil sample at desired density by a suitable method.

Week – 7: DETERMINATION OF OMC AND MDD OF SOIL USING COMPACTION TEST
To determine the optimum moisture content and maximum dry density of a soil by proctor test.

Week – 8: DETERMINATION OF CALIFORNIA BEARING RATIO OF SOILS
To determine the California bearing ratio by conducting a load penetration test in the laboratory.

Week – 9: DETERMINATION OF CONSOLIDATION PARAMETERS IN SOILS
To determine the settlements due to primary consolidation of soil by conducting one dimensional test.

Week – 10: DETERMINATION OF UNCONFINED COMPRESSION STRENGTH IN SOILS
To determine the unconfined compressive strength of cohesive soil sample and its sensitivity.

Week–11:DETERMINATION OFSHEAR PARAMETERS USING TRIAXIAL COMPRESSION TEST
To determine shear strength parameter i.e. angle of shearing resistance and cohesion of a given soil sample.

Week – 12: DETERMINATION OFSHEAR PARAMETERS USING DIRECT SHEAR TEST
To determine shear strength parameters of the given soil sample at known density and moisture content by direct shear test.

Week – 13: DETERMINATION OF SHEAR PARAMETERS USING VANE SHEAR TEST
To determine the shear strength of clay specimen.

IV. TEXT BOOKS:

1. Das, B M. “Soil Mechanics Laboratory Manual”, 2021. Engineering Press at OUP, 2001.
2. Kalinski, Michael E. “Soil Mechanics: Lab Manual”, John Wiley & Sons, 2nd Edition, 2011.
3. Ventura Tejeda, Fernando R. "Soil Mechanics Laboratory Manual." (2020).

V. REFERENCE BOOKS:

1. Das, B M., and N Sivakugan. Fundamentals of geotechnical engineering. Cengage Learning, 2016.
2. Murthy, V. N. S. Geotechnical engineering: principles and practices of soil mechanics and foundation engineering. CRC press, 2002.

VI. WEB REFERENCES:

1. http://home.iitk.ac.in/~madhav/geolab.html
2. https://nptel.ac.in/courses/105/101/105101160/

TRANSPORTATION ENGINEERING LABORATORY

VI SEMESTER: CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC33	Core	L	T	P	C	CIA	SEE	Total
		0	0	3	1.5	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 36				Total Classes: 36		
Prerequisite: Concrete Technology Laboratory								

I. COURSE OVERVIEW:

The aim of this course is to conduct experiments on basic principles of Transportation materials laboratory and it is further extended to know the values and strengths of materials like bitumen, cement and aggregates. The experiments on Transportation materials testing is been done under different site conditions and environmental conditions. The course deals with equipment like Abrasion test, Specific gravity, fineness of cement, Impact crushing strength. This course includes experiments and practical studies with Cement, Aggregates, sand and Bitumen.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The properties and behavior of highway material for different loading patterns.
II. The testing procedures of transportation materials like aggregate, bitumen, sand etc. and check their suitability.
III. The properties of cement by conducting setting time, specific gravity and compressive strength tests.
IV. Techniques to characterize various pavement materials through relevant tests.

III.COURSE SYLLABUS:

Week – I:INTRODUCTION TO TRANSPORTATION LABORATORY

Introduction to transportation material laboratory. Do's and Don'ts in materials lab.

Week – 2:AGGREGATE CRUSHING STRENGTH TEST

Measurement of Aggregate crushing test.

Week – 3:AGGREGATE IMPACT TEST

Measurement of Aggregate Impact test

Week – 4:SPECIFIC GRAVITY AND WATER ABSORPTION TEST

Calculation of specific gravity and water absorption test.

Week – 5:ABRASION AND ATTRITION TEST OF COARSE AGGREGATES

To perform Abrasion and Attrition test of coarse aggregates.

Week – 6:SHAPE TESTS OF COARSE AGGREGATES

Measurement of percentage of Flakiness in coarse aggregates. Measurement of percentage of Elongation in coarse aggregates

Week – 7:PENETRATION AND DUCTILITY TEST OF BITUMINOUS MATERIALS

To find the Penetration and ductility value of bitumen sample.

Week – 8:SOFTENING POINT OF BITUMEN MATERIALS

To find the softening point value of bituminous materials.

Week – 9:FLASH AND FIRE POINT TEST OF BITUMEN MATERIALS
To find the flash point value of bitumen sample.

Week – 10:NORMAL CONSISTENCY OF FINENESS OF CEMENT
To perform test and find the normal consistency of fineness of cement.

Week – 11:INITIAL SETTING TIME AND FINAL SETTING TIME OF CEMENT
To find the initial and final setting time of cement.

Week – 12:SPECIFIC GRAVITY AND SOUNDNESS OF CEMENT
To find the specific gravity and soundness of cement.

Week – 13:COMPRESSIVE STRENGTH OF CEMENT
To find the compressive strength of cement.

Week – 14:BULKING OF FINE AGGREGATES
To find the bulking of fine aggregates of sand.

Week – 15:STRUCTURAL EVALUATION OF PAVEMENT USING BENKELMAN BEAM DEFECTION METHOD
Structural evaluation of pavement surface by Benkelman beam deflection method.

IV. TEXT BOOKS:

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, “Highway Engineering”, Nem Chand & Bros, Revised 10th Edition, 2017.
2. Kadiyalai, L.R., “Traffic Engineering and Transport Planning”, Khanna Publishers, 2013.
3. ParthaChakraborty, “Principles Of Transportation Engineering”, PHI Learning, 2017.

V. REFERENCE BOOKS:

1. Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski, “Principles of Highway Engineering and Traffic Analysis”, John Wiley, 4th Edition, 2007.
2. Srinivasa Kumar, R, “Textbook of Highway Engineering”, Universities Press, 2011.
3. Paul H. Wright and Karen K. Dixon, „Highway Engineering‟, Wiley Student Edition, 7th Edition, 2009.

VI.WEB REFERENCES:

1. http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/Transportation_Engineering_Lab/index.html

DESIGN OF ALGORITHMS

VI Semester: AE / ECE / EEE / ME / CE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACSC29	**Skill**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		-	-	-	-	-	-	-
Contact Classes: Nil	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: Nil**		

I. COURSE OVERVIEW:

Design and analysis of algorithms is the process of finding the computational complexity of algorithms. It helps to design and analyze the logic on how the algorithm will work before developing the actual code for a program. It focuses on introduction to algorithm, asymptotic complexity, sorting and searching using divide and conquer, greedy method, dynamic programming, backtracking, branch and bound. NP-hard and NP-complete problems. The applications of algorithm design are used for information storage, retrieval, transportation through networks, and presentation to users.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Assess how the choice of data structures and algorithm design methods impacts the performance of programs.

II. Solve problems using data structures such as binary search trees, and graphs and writing programs for these solutions.

III. Choose the appropriate data structure and algorithm design method for a specified application.

IV. Solve problems using algorithm design methods such as the greedy method, divide and conquer, dynamic programming, backtracking, and branch and bound and writing programs for these solutions.

III. SYLLABUS

MODULE –IINTRODUCTION

Algorithm: Pseudo code for expressing algorithms; Performance analysis: Space complexity, time complexity; Asymptotic notations: Big O notation, omega notation, theta notation and little o notation, amortized complexity; Divide and Conquer: General method, binary search, quick sort, merge sort, Strassen‘s matrix multiplication.

MODULE -IISEARCHING AND TRAVERSAL TECHNIQUES

Disjoint set operations, union and find algorithms; Efficient non recursive binary tree traversal algorithms, spanning trees; Graph traversals: Breadth first search, depth first search, connected components, biconnected components.

MODULE -IIIGREEDY METHOD AND DYNAMIC PROGRAMMING

Greedy method: The general method, job sequencing with deadlines, knapsack problem, minimum cost spanning trees, single source shortest paths.

Dynamic programming: The general method, matrix chain multiplication optimal binary search trees, 0/1 knapsack problem, single source shortest paths, all pairs shortest paths problem, the travelling salesperson problem.

MODULE -IVBACKTRACKING AND BRANCH AND BOUND

Backtracking: The general method, the 8 queens problem, sum of subsets problem, graph coloring, Hamiltonian cycles; Branch and bound: The general method, 0/1 knapsack problem, least cost branch and bound solution, first in first out branch and bound solution, travelling salesperson problem.

MODULE -VNP-HARD AND NP-COMPLETE PROBLEMS

Basic Concepts: Non-deterministic algorithms, the classes NP-Hard and NP-NP Hard problems, clique decision problem, chromatic number decision problem, Cook's theorem.

IV. TEXT BOOKS:

1. Ellis Horowitz, SatrajSahni, SanguthevarRajasekharan, “Fundamentals of Computer Algorithms”, Universities Press, 2nd Edition, 2015.
2. Alfred V. Aho, John E. Hopcroft, Jeffrey D, “The Design And Analysis Of Computer Algorithms”, Pearson

India, 1st Edition, 2013.

V. REFERENCE BOOKS:

1. Levitin A, "Introduction to the Design and Analysis of Algorithms", Pearson Education, 3rd Edition, 2012.
2. Goodrich, M. T. R Tamassia, "Algorithm Design Foundations Analysis and Internet Examples", John Wileyn and Sons, 1st Edition, 2001.
3. Base Sara Allen Vangelder, "Computer Algorithms Introduction to Design and Analysis", Pearson, 3rd Edition, 1999.

VI. WEB REFERENCES:

1. http://www.personal.kent.edu/~rmuhamma/Algorithms/algorithm.html
2. http://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=IntroToAlgorithms
3. http://www.facweb.iitkgp.ernet.in/~sourav/daa.html

VII. E-TEXT BOOKS:

3. https://kailash392.files.wordpress.com/2019/02/fundamentalsof-computer-algorithms-by-ellis-horowitz.pdf.

ENVIRONMENTAL ENGINEERING

VII Semester: CE									
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC34	Core	L	T	P	C	CIA	SEE	Total
		3	1	0	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		
Prerequisite: Hydrology and Water Resources Engineering								

I. COURSE OVERVIEW:

Environmental Engineering is a very popular discipline of engineering that deals with the issues related to the environment. The Environmental Engineers devote themselves finding out renewable sources of energy and solutions to curb pollution and other environmental issues. They work for the sustainable development of the earth and its living organisms. They also make devices for waste and water management in rural and urban areas, improved sanitation system, to stop the water-borne diseases. They study the effects of technological growth on environment such as: the effects of global warming, pollution, reason for shortage of rainfall, acid rain etc. In short, the Environmental Engineers are constantly engaged in maintaining the health of the earth and the living creatures on it; this course also cover the study of construction of oxidation pond, sludge digestion tank, skimming tanks, grit chambers, sedimentation tanks and designing of septic tanks and soak pits.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The quality and quantity of drinking water standards and know the demand of water for a particular community
II. The basic standards of water and study the procedure for determination
III. The conventional process of water and waste water treatment methods, and know the distribution system.

III.COURSE SYLLABUS:

MODULE –I: WATER QUALITY, DEMAND AND SUPPLY (9)

Protected water supply, population forecasts, design period, water demand, types of demand, factors affecting fluctuations, fire demand, storage capacity, water quality and testing. Drinking water standards. Comparison from quality and quantity and other considerations, intakes, infiltration galleries, confined and unconfined aquifers, distribution systems, requirements, methods and layouts.

MODULE -II: WATER TREATMENT AND DISTRIBUTION (9)

Layout and general outline of water treatment units, sedimentation, uniform settling velocity, principles, design factors, surface loading, jar test, optimum dosage of coagulant, coagulation, flocculation, clarifier design, coagulants, and feeding arrangements. filtration, theory, working of slow and rapid gravity filters ,multimedia filters, design of filters, troubles in operation comparison of filters, disinfection, types of disinfection, theory of chlorination chlorine demand and other disinfection treatment methods. distribution systems, types of layouts of distribution systems, design of distribution systems, Hardy Cross and equivalent pipe methods, service reservoirs, joints, valves such as sluice valves, air valves, scour valves and check valves water meters, laying and testing of pipe lines, pump house.

MODULE -III SEWAGE TREATMENT AND DISPOSAL (9)

Conservancy and water carriage systems, sewage and storm water estimation, type of concentration, storm water over flows combined flow, characteristics of sewage, cycles of decay, decomposition of sewage, examination of sewage, B.O.D. and C.O.D. equations.

Design of sewers, shapes and materials, sewer appurtenances manhole, inverted siphon, catch basins, flushing tanks, ejectors, pumps and pump houses, house drainage, components requirements, sanitary fittings, traps, one pipe and two pipe systems of plumbing, ultimate disposal of sewage, sewage farming, dilution.

MODULE -IV WASTEWATER TREATMENT (9)

Lay out and general outline of various units in a waste water treatment plant, primary treatment design of screens, grit chambers, skimming tanks-sedimentation tanks-principles and design of biological treatment, trickling filters, standard and high rate.

MODULE -V DESIGN AND WORKING OF TREATMENT UNITS (9)

Construction and design of oxidation ponds, sludge digestion tanks, factors effecting, design of digestion tank, sludge disposal by drying, septic tanks working principles and design-soak pits. Ultimate disposal of waste water, self-purification of rivers, sewage farming.

IV. TEXT BOOKS:

1. Peavy, Howard S., Donald R. Rowe, and George Tchobanoglous. Environmental engineering. Vol. 2985. New York: McGraw-Hill, 1985.
2. Davis, Mackenzie L., and David A. Cornwell. Introduction to environmental engineering. McGraw-Hill, 2008.
3. Duggal, K. N. ”Elements of Environmental Engineering: New Delhi; S.” Chand and Company Ltd (2002).
4. Punmia B.C, Ashok Jain Arun Jain, “Water Supply Engineering”, Laxmi Publications, Pvt. Ltd., New Delhi, 2004.

V. REFERENCE BOOKS:

1. Garg, Santosh Kumar. Water Supply Engineering: Environmental Engineering. Khanna, 1992.
2. Modi, P. N. Sewage Treatment & Disposal and Waste Water Engineering. Standard Book House, 2008.
3. Garg, Santosh Kumar. Sewage disposal and air pollution engineering. Khanna Publsihers, 2012.

VI. WEB REFERENCES:

1. http://site.iugaza.edu.ps/afoul/files/2010/02/Environmental_book.pdf
2. https://www.sanfoundry.com/best-reference-books-btech-environmental-engineering/

VII. E-Text Books:

1. http://site.iugaza.edu.ps/afoul/files/2010/02/Environmental_book.pdf
2. https://libguides.rowan.edu/com.

FOUNDATION ENGINEERING

<table>
<tr><td colspan="9">VII Semester: CE</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">ACEC35</td><td rowspan="2">Core</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
<tr><td colspan="9">Prerequisite: Geotechnical Engineering</td></tr>
</table>

I. COURSE OVERVIEW:

Civil Engineers are required to construct structures on the soil. The loads coming onto these structures, along with the self-weight, have to be safely transmitted to the soil beneath it. A geotechnical engineer must be able to design a footing in such a way that soil below it will not fail there will not be any excessive settlements in the soil. This course enables students to design a shallow and deep foundation, analyze the stability of slopes, and check the stability of retaining walls and embankments against failure. Through this course content engineers can design the foundation for safety and serviceability.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The methods of soil exploration, field tests on soil by planning and soil investigation report documentation.
II. The stability of infinite and finite slopes using different parameters.
III. The various earth pressure theories and stability of retaining walls.
IV. The theoretical, field tests and bearing capacity of shallow, deep and well foundations.

III.COURSE SYLLABUS:

MODULE –I: SOIL EXPLORATION (9)

Need and methods of soil exploration, boring and sampling methods, pits and trenches, drifts and shafts, methods of boring, auger borings, wash borings, rotary drilling, percussion drilling, core drilling, types of soil samples, disturbed samples, undisturbed samples, design features affecting the sample disturbance, split spoon samplers, scraper bucket samplers, shell by tubes and thin walled samplers, piston samplers, preservation and handling of samples. Instrumentation in soil engineering, strain gauges, resistance and inductance type plate load test, pressure meter, geo physical methods, planning and preparation of soil investigation report.

MODULE –II: SLOPE STABILITY (9)

Infinite and finite earth slopes, types of failures, factor of safety of infinites lopes, stability analysis by Swedish arc method, standard method of slices, Bishop's Simplified method, Taylor's Stability number, and stability of slopes of earth dams under different conditions.

MODULE –III: EARTH PRESSURE THEORIES AND RETAINING WALLS (9)

Rankine's theory of earth pressure, earth pressures in layered soils, Coulomb's earth pressure theory, Culmann's graphical method.

Types of retaining walls, stability of retaining walls against overturning, sliding and bearing capacity.

MODULE –IV: SHALLOW AND DEEP FOUNDATIONS (9)

Types, choice of foundation, location of depth, safe bearing capacity, Terzaghi, Meyerhof, Skempton and IS Methods. Safe bearing pressure based on N value, allowable bearing pressure, plate load test, allowable settlements of structures, Analysis of foundation, individual, strip, combined footings and mat foundations conventional. Types of piles, load carrying capacity of piles based on static and dynamic formulae, pile load tests, load carrying capacity of pile groups in sands and clays, settlement of pile groups. Introduction to foundations on expansive soils and marine foundations.

MODULE –V: WELL FOUNDATIONS (9)
Different shapes of wells, components of well, sinking of well, tilts and shifts, principles of analysis and design, IRC guidelines.

IV.TEXT BOOKS:

1. Braja M. Das, "Principles of geotechnical engineering" Cengage learning publishers, 2002.
2. V.N.S Murthy, Geotechnical Engineering: Principles and practices of soils mechanics and foundation engineering", Taylor & Francis Group, 2002.
3. Gopal Ranjan and ASR Rao, "Basic and Applied Soil Mechanics", New age international Pvt. Ltd, New Delhi, 2000.

V.REFERENCE BOOKS:

1. C. Venkataramiah, "Geotechnical engineering", New Age International Pvt. Ltd,2002.
2. Manojdutta and Gulati, "Geotechnical engineering", Tata McGrawhill publishers New Delhi,2005.
3. K.R .Arora, "Soil mechanics and foundation engineering", standard publishers and distributors, New Delhi,2005

VI.WEB REFERENCES:

1. http://nptel.ac.in/courses/105107120/1#
2. https://ocw.mit.edu/courses/civil,and,environmental,engineering/1,364,advanced,geotechnical,engineering, fall,2003/index.html

VII. E-TEXT BOOKS:

https://books.google.co.in/books?hl=en&lr=&id=_MzWBetcVhAC&oi=fnd&pg=PR11&dq=applied+geotechnics&ots=PugqOAphwC&sig=2zr9mAAy9nPcyHaKgmtFpcC1M&redir_esc=y#v=onepage&q=applied%20geotechnics&f=false

CONSTRUCTION ENGINEERING AND MANAGEMENT

VII Semester: CE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC36	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisite: Estimation, Costing and Valuation								

I. COURSE OVERVIEW:

This course deals with the designing, planning, construction, and management of infrastructures such as roads, bridges, airports, railroads, buildings, dams, and other projects. This course helps to know the implementation of safety aspects and to know different legal aspect and its provisions during the execution of civil engineering project. This course addresses the modern construction materials, techniques and effective construction management practices.This course also focuses on the resources management efficiently for successful completion of construction projects.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The construction project schedules, documents for planning and management of construction processes.
II. The various types of planning tools like bar chart, CPM networks and PERT analysis
III. The different methods of project delivery, roles and responsibilities of all constituencies involved in the design and construction process.
IV. The various types of construction contracts, their legal aspects and provisions.

III.COURSE SYLLABUS:

MODULE –I: ORGANISATION AND HUMAN RELATIONS (9)

Management process, Roles, managementtheories, Social responsibilities, planning and strategic management strategy implementation. Decision making: tools and techniques, Organizational structure. Human resource management, motivation performance leadership.

MODULE -II: CONSTRUCTION PROJECT PLANNING (9)

Stages of project planning: pre-tender planning, preconstruction planning, detailed construction planning, roleof client and contractor, Networks: basic terminology, types of precedence relationships, preparation of CPMnetworks: activity on link and activity on node representation, computation of float values, critical and semicritical paths, calendaring networks. PERT- Assumptions underlying PERT analysis.

MODULE -III: PLANNING AND ORGANIZING CONSTRUCTION SITE AND RESOURCES (9)

Site: site layout including enabling structures, developing site organization, Documentation at site; Manpower: planning, organizing, staffing, motivation; Materials: concepts of planning, procurement and inventory control; Equipment: basic concepts of planning and organizing;

Funds: cash flow, sources of funds; Histograms and S-Curves. Earned Value; Resource Scheduling- Bar chart, line of balance technique, resource constraints and conflicts; resource aggregation, allocation, smoothening and leveling.

MODULE -IV: PROJECT MONITORING & CONTROL (9)

Supervision, record keeping, periodic progress reports, periodical progress meetings. Updating of plans: purpose, frequency and methods of updating, Basics of Modern Project management systems such as Lean Construction; Use of Building Information Modelling (BIM) in project management; Quality control: concept of quality, quality of constructed structure, use of manuals and checklists for quality control, role of inspection, basics of statistical quality control. Safety and Health.

MODULE -V: CONSTRUCTION COSTS & CONTRACTS (9)

Make-up of construction costs; Classification of costs, time-cost trade-off in construction projects, time and cost overruns and corrective measures.

Contract, Types of contract, contract document, specification, important conditions of contract, tender and tender document.

IV. TEXT BOOKS:

1. Ghalot, P.S., Dhir,D. M., Construction Planning and Management, Wiley Eastern Limiled,1992.
2. Chitkara,K K., Construction Project Management. Tata McGraw Hill Publishing Co, Ltd., New Delhi, 1998.
3. Punmia,B. C., Project Planning and Control with PERT and CPM, Laxmi Publications, new deIhi,1987.

V. REFERENCE BOOKS:

1. Sengupta, Guha, "Construction Management And Planning". Tata McGraw-Hill Inc, 1994.
2. George J.Ritz , "Total Construction Project Management", McGraw-Hill Inc, 1994.

VI. WEB REFERENCES:

https://nptel.ac.in/courses/105106149/

VII. E-TEXT BOOKS:

1. https://www.scribd.com/doc/231678531/k-k-Chitkara-Construction-Project-ManagemenT.
2. http://civilcafe.weebly.com/uploads/2/8/9/8/28985467/total_construction_project_management_by_george _j._ritz_-_civilenggforall.pdf.
3. http://www.opentextbooks.org.hk/system/files/export/15/15694/pdf/Project_Management.pdf

FOUNDATIONS OF PROJECT MANAGEMENT

<table>
<tr><td colspan="8">VII Semester: CE</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">ACEC37</td><td rowspan="2">Elective</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
<tr><td colspan="9">Prerequisite: No prerequisites required</td></tr>
</table>

I. COURSE OVERVIEW:

This course deals with the designing, planning, construction, and management of infrastructures such as roads, bridges, airports, railroads, buildings, dams, and other projects. This course helps to know the implementation of safety aspects and to know different legal aspect and its provisions during the execution of civil engineering project. This course addresses the modern construction materials, techniques and effective construction management practices. This course also focuses on the resources management efficiently for successful completion of construction projects.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The various management techniques for successful completion of construction projects.
II. The effect of management for project organization, design of construction process, labour, material and equipment utilization, and cost estimation.
III. The tools to initiate a project plan, manage both stakeholders and relationships, organize their team, develop a project charter, and build a business case for a project.
IV. The purpose of Construction management is to control a project's time / delivery, cost and quality

III.COURSESYLLABUS:

MODULE –I: THE OWNERS' PERSPECTIVE (9)

Introduction - Project Life Cycle - Types of Construction - Selection of Professional Services - Construction Contractors - Financing of Constructed Facilities - Legal and Regulatory Requirements - Changing Environment of the Construction Industry - Role of Project Managers.

MODULE -II: ORGANIZING FOR PROJECT MANAGEMENT (9)

Introduction - Project Life Cycle - Types of Construction - Selection of Professional Services - Construction Contractors - Financing of Constructed Facilities - Legal and Regulatory Requirements - Changing Environment of the Construction Industry - Role of Project Managers.

MODULE -III: DESIGN AND CONSTRUCTION PROCESS (9)

Design and Construction as an Integrated System - Innovation and Technological Feasibility.

Innovation and Economic Feasibility - Design Methodology - Functional Design - Construction Site Environment.

MODULE -IV: LABOUR, MATERIAL AND EQUIPMENT UTILIZATION (9)

Historical Perspective - Labour Productivity - Factors Affecting Job-Site Productivity - Labour Relations in Construction - Problems in Collective Bargaining - Materials Management - Material Procurement and Delivery - Inventory Control - Tradeoffs of Costs in Materials Management. - Construction Equipment - Choice of Equipment and Standard Production Rates - Construction Processes Queues and Resource Bottlenecks.

MODULE -V: COST ESTIMATION (9)

Costs Associated with Constructed Facilities - Approaches to Cost Estimation - Type of Construction Cost Estimates - Effects of Scale on Construction Cost - Unit Cost Method of Estimation - Methods for Allocation of Joint Costs - Historical Cost Data - Cost Indices - Applications of Cost Indices to Estimating - Estimate Based on Engineer's List of Quantities - Estimation of Operating Costs.

IV TEXT BOOKS:

1. K.G Krishnamurthy “Construction and Project Management” , CBS Publishers and Distributors, December, 2008.

V REFERENCE BOOKS:

1. Chitkara, K.K. "Construction Project Management: Planning, Scheduling and Control", Tata McGraw Hill Publishing Company, New Delhi, 1998.
2. Choudhury S , "Project Management", McGraw-Hill Publishing Company, New Delhi, 1988.
3. Chris Hendrickson and Tung Au, "Project Management for Construction – Fundamental Concepts for Owners, Engineers, Architects and Builders", Prentice Hall, Pittsburgh, 2000.

VI WEB REFERENCES:

1. https://nptel.ac.in/courses/105/104/105104161/
2. https://www.coursera.org/learn/project-management-foundations

VII E-TEXT BOOKS:

1. https://www.scribd.com/doc/231678531/k-k-Chitkara-Construction-Project-Management
2. http://www.opentextbooks.org.hk/system/files/export/15/15694/pdf/Project_Management.pdf

PROJECT MANAGEMENT: PRINCIPLES, PRACTICES AND SYSTEMS

VII Semester: CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC38	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

Prerequisite: No prerequisites required

I. COURSE OVERVIEW:

The course focuses on the fundamental rules that should be followed for the successful management of projects invested and engaged project sponsor. Project management is the process of leading the work of a team to achieve all project goals within the given constraints. The objective of project management is to produce a complete project which complies with the client's objectives.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The various management techniques for successful completion of construction projects.
II. The effect of management for project organization, design of construction process, labour, material and equipment utilization, and cost estimation.
III. The concept of planning, scheduling, cost and quality control, safety during construction, organization and understand use of project information necessary for construction project.
IV. The formulation, costing of construction projects, appraisal, finance and understand private sector participation.

III.COURSE SYLLABUS:

MODULE –I: INTRODUCTION TO PROJECT MANAGEMENT (9)

Introduction to management, history of construction management, modern management, system approach and emergence of management and purpose of construction management, major problems in construction industry, firm organization, chain of command, division of work, organization charts, functions and responsibilities of construction manager, case studies, future of construction management.

MODULE –II: PRINCIPLES OF CONSTRUCTION MANAGEMENT (9)

Principles of construction management; planning, organizing, staffing, leading, controlling. Decision making in construction industry nature of managerial decision making, the rational model of decision making, challenges to the rational model, improving the effectiveness of decision making tools and techniques, benefit-cost analysis, replacement analysis, break even analysis, risk management in construction industry.

MODULE –III: ORGANIZING FOR PROJECT MANAGEMENT (9)

Project Management – modern trends - Strategic Planning - Effects of Project Risks on Organization - Organization of Project Participants -Traditional Designer-Constructor Sequence –

Professional Construction Management - Owner-Builder Operation - Turnkey Operation - Leadership and Motivation for the Project Team.

MODULE –IV: PLANNING AND ORGANISING (9)

Nature and purpose of planning – planning process – types of planning – objectives – settingobjectives – policies – Planning premises – Strategic Management – Planning Tools andTechniques – Decision making steps and process. Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority –

departmentalization–centralization and decentralization, Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management , Career planning and management.

MODULE –V: LABOUR, MATERIAL AND EQUIPMENT UTILIZATION (9)

Historical Perspective - Labor Productivity - Factors Affecting Job-Site Productivity - Labor Relations in Construction - Problems in Collective Bargaining - Materials Management - Material Procurement and Delivery - Inventory Control - Tradeoffs of Costs in Materials Management. - Construction Equipment - Choice of Equipment and Standard Production Rates - Construction Processes Queues and Resource Bottlenecks.

IV. TEXT BOOKS:

1. Stephen P. Robbins & Mary Coulter, "Management", 10^{th} Edition, Prentice Hall (India) Pvt.Ltd., 2009.
2. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", Pearson Education, 6^{th} Edition 2004.

V. REFERENCE BOOKS:

1. Sahakian, William, S. Ed., "History of Psychology", F.E. Peacock Publishers, Inc. Itasca, U.S.A., 1981.
2. Charles G. Morris, Albert Anthony Maisto, Ann Levine, "Psychology: An Introduction", Prentice Hall 2002.

VI. WEB REFERENCES:

1. https://onlinecourses.swayam2.ac.in/cec22_mg15/preview

VII. E-TEXT BOOKS:

1. https://www.opentextbooks.org.hk/system/files/export/15/15694/pdf/Project_Management_15694.pdf.

PROJECT MANAGEMENT: BEYOND THE BASICS

VII Semester: CE									
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC39	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		
Prerequisite: No prerequisites required								

I. COURSE OVERVIEW:

This Course of project management focuses beyond the fundamentals of project management. It aims to sensitize learners about the concept of planning in general and business planning specifically. The course would also give insights the learners about successfully managing projects.The objective of project management is to produce a complete project which complies with the client's objectives

II. COURSE OBJECTIVES:

The student will try to learn:

I. The concept of Planning and its importance for Businesses.
II. The concept of Project and importance of its management.
III. The critical examination of project which needs to be undertaken using various models.
IV. The importance of human resources for the projects.
V. The concept of project audit, project life cycle and project termination process.

III.COURSE SYLLABUS:

MODULE –I: PROJECT MANAGEMENT AND ETHICS (9)

The skills of project manager needs to master, Demands placed on a project manager, Identifying and evaluating stakeholders, Lines of communication, Ethics in projects.

MODULE –II: TIME MANAGEMENT (9)

Personnel time, Management and planning, managing time on the project, forecasting the future, Critical path measuring the changes and their effects – Cash flow and cost control.

MODULE –III: FUNDAMENTALS OF MANAGEMENT ACCOUNTING (9)

Management accounting, Financial accounting principles- basic concepts.

Financial statements – accounting ratios - funds flow statement – cash flow statement.

MODULE –IV: FUNDS MANAGEMENT (9)

Project Finance – Sources of finance - Long-term and short -term finance, Working Capital Management, Inventory valuation, Mortgage Financing - International financial managementforeign currency management.

MODULE –V: LINEAR ELEMENT (9)

Linear Element: Shape Functions, Solution for Poisson's Equation, General One Dimensional Equilibrium Problem.

IV. TEXT BOOKS:

1. Stephen P. Robbins & Mary Coulter, "Management", 10th Edition, Prentice Hall (India) Pvt. Ltd., 2009.
2. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", 6th Edition, Pearson Education, 2004.

V. REFERENCE BOOKS:

1. Sahakian, William, S. Ed., "History of Psychology", F.E. Peacock Publishers, Inc. Itasca, U.S.A., 1981.
2. James.A., Adrain, "Quantitative Methods in Construction Management", American Elsevier Publishing Co., Inc., 1973.

VI. WEB REFERENCES:

1. https://onlinecourses.swayam2.ac.in/cec22_mg15/preview

VII. E-TEXT BOOKS:

1. https://www.opentextbooks.org.hk/system/files/export/15/15694/pdf/Project_Management_15694.pdf

PRESTRESSD CONCRETE STRUCTURES

VII Semester: CE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACEC40	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Reinforced Concrete Structures Design and Drawing								

I. COURSE OVERVIEW:

A prestressed concrete structure is different from a conventional reinforced concrete structure due to the application of an initial load on the structure prior to its use. In prestressed concrete high strength concrete and high strength steel are combined such that the full section is effective in resisting tension and compression. This is an active combination of the two materials. This subject provides students an understanding and ability to analyse and design prestressed concrete structural elements. The primary topics includes the concept and principles of prestressing, methods of prestressing concrete, stress limits, losses of prestress, selection of section, serviceability and strength requirements. Students will also be able to complete analysis and design procedure of simply supported prestressed concrete non-composite and composite beams.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The concepts of prestressed concrete structures and the behavior of these structures subjected to loads for the design purpose.

II. The design of structural elements necessary for creating efficient and economic prestressed concrete structures.

III. The design and drawing of multi storeyed industrial and residential structures including bridges for creating high performance and durable structures.

III.COURSE SYLLABUS:

MODULE –I: INTRODUCTION (9)

Historic development- General principles of pre-stressing pre-tensioning and post tensioning-Advantages and limitations of Prestressed concrete- General principles of PSC- Classification and types of pre-stressing materials- high strength concrete and high tensile steel their characteristics. Methods and Systems of prestressing: Pre-tensioning and Post-tensioning methods and systems of prestressing like Hoyer system, MagnelBlaton system, Freyssinet system and Gifford- Udall System-Lee McCall system.

MODULE -II: LOSSES OF PRESTRESS (9)

Loss of pre-stress in pre-tensioned and post-tensioned members due to various causes like elastic shortage of concrete, shrinkage of concrete, creep of concrete, relaxation of stress in steel, slip in anchorage, frictional losses.

MODULE -III: FLEXURE (9)

Analysis of sections for flexure, beams pre-stressed with straight, concentric, eccentric, bent and parabolic tendons- stress diagrams, Elastic design of PSC beams of rectangular and I section Kern line, Cable profile and cable layout.

Shear: General Considerations, Principal tension and compression, improving shear resistance of concrete by horizontal and vertical pre-stressing and by using inclined or parabolic cables, Analysis of rectangular and I beam for shear, Design of shear reinforcements- Bureau of Indian Standards (BIS) Code provisions.

MODULE -IV: TRANSFER OF PRE-STRESS IN PRE-TENSIONED MEMBERS (9)

Transmission of pre-stressing force by bond, Transmission length, Flexural bond stresses, IS code provisions, Anchorage zone stresses in post tensioned members, stress distribution in End block, Analysis by Guyon, Magnel, Zielinski and Rowe's methods, Anchorage zone reinforcement, BIS Provisions.

MODULE -V: COMPOSITE BEAMS AND DEFLECTIONS (9)

Different Types: Propped and Unpropped, stress distribution, Differential shrinkage, Analysis of composite beams, General design considerations.

Deflections: Importance of control of deflections, Factors influencing deflections, short term deflections of uncracked beams, prediction of longtime deflections, BIS code requirements.

IV.TEXT BOOKS:

1. N. Krishna Raju, "Pre-stressed Concrete", Tata McGraw Hill Book Education Pvt. Ltd, 6th Edition, 2018.
2. N. Rajagopalan, "Prestressed Concrete", Alpha Science International Ltd, 2nd edition, 2005.

V. REFERENCE BOOKS:

1. T.Y. Lin and Burn, "Design of Pre-stress Concrete Structures", John Wiley, New York, 3rd Edition, 2010.
2. S. Ramarnrutham, "Prestressed Concrete", Dhanpat Rai & Sons publishing, Delhi, 1st Edition, 2003.

VI. WEB REFERENCES:

1. https://nptel.ac.in/courses/105/106/105106117/
2. https://odp.inflibnet.ac.in/index.php/module_details?course=pre-stressed%20concrete%20structures&source=swayam&subsource=NPTEL

VII. E-TEXT BOOKS:

1. https://books.google.co.in/books?id=pT88BAAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false.

STRUCTURAL DYNAMICS

VII Semester: CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC41	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

Prerequisite: Analysis of structures

I. COURSE OVERVIEW:

Structural Dynamics is of utmost importance for understanding the analysis and design consideration of structures subjected to dynamic loading. This course introduces the basic concepts of dynamic loading and the response of structures to such loads, and then uses these concepts to illustrate applications in practical structures. It begins with the derivation of the basic equations of motion for an ideal single degree-of-freedom structure using various approaches, and the solution of these equations for different types of loading. Further, the development of equations for multi-degree-of-freedom structures is considered, with multi-storied buildings as the example structures, and free and forced vibration response analysis of these multi-storied buildings shall be discussed.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The dynamics response of single and multi-degree freedom systems using fundamental theory and equations of motion.
II. The numerical solution of structural responses of different loading conditions for the design of structures.
III. The responses of structures subjected to earthquakes and blasts for the efficient and economic design of structures.

III.COURSE SYLLABUS:

MODULE -I:THEORY OF VIBRATIONS (9)

Introduction, basic concepts of vibration, dynamic loading, comparison of static loading and dynamic loading, causes of dynamic effects, basic definitions types of vibration, response of the system, degrees of freedom, SHM, Consequences of vibration

Introduction to undamped vibrations, vibration analysis, free vibration of undamped SDOF system, derivation of equation of motion, solution of the equation of motion, equivalent stiffness of spring combinations, natural frequency, time-period, influence of gravitational force.

MODULE -II: DAMPED VIBRATIONS OF SDOF SYSTEM (9)

Introduction types of damping, measurement of damping, introduction to harmonic excitation, undamped harmonic excitation, damped harmonic excitation, characteristics curves, measurement of damping, vibration measuring instruments, vibration isolation.

MODULE -III: RESPONSE TO PERODIC AND IMPULSIVE LOADING (9)

Introduction to periodic loading, Fourier series and analysis and response, derive an expression for the response of an SDOF system for the given loading function.

Introduction to impulsive loading, differential equation method, Duhamel's integral.

MODULE -IV: TWO DEGREE OF FREEDOM SYSTEM (9)

Introduction, concept of shear building, free vibrations of undamped system, damped free vibration, forced vibrations of undamped system, forced vibrations of damped system.

MODULE -V: MULTIPLE DEGREE OF FREEDOM SYSTEM (9)

Introduction, Free vibration analysis, undamped system, natural frequencies and normal modes, orthogonality and normality principles, damped systems, decoupling of equations, superposition method, forced vibration.

IV. TEXT BOOKS:

1. S. Kavita and S. R. Damodaraswamy, "Basics of structural Dynamics and Aseismic Design", PHI Learning Pvt. Ltd., 1st Edition, 2012.
2. Clough R. W. and Penzien J, "Dynamics of Structures", McGraw Hill ,1st Edition, 1993.
3. Chopra A. K, "Structural Dynamics and Introduction to Earthquake Engineering", illustrated, Prentice Hall, 4th Edition, 2012.
4. Smith J. W, "Vibration of Structures - Application in Civil Engineering Design", Chapman and Hall, 1st Edition, 1988.

V. REFERENCE BOOKS:

1. Humar J. L., "Dynamics of Structures", Prentice Hall, 2nd Edition, 2002.
2. Paz Mario, "Structural Dynamics Theory and Computation", CBS Publication, 5th Edition, 2002.
3. Hart and Wong, "Dynamics of Structures", John Wiley, 1st Edition, 1999.

VI. WEB REFERENCES:

1. http://nptel.ac.in/courses/105101006/

VII. E-TEXT BOOKS:

http://scmero.ulb.ac.be/Teaching/Courses/MECA-H-303/MECA-H-303-Lectures.pdf

DESIGN OF HYDRAULIC STRUCTURES

VII Semester: CE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC42	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisite: No prerequisites required								

I. COURSE OVERVIEW:

This course mainly deals with Hydraulic design involving the application of flow theory to the design of various water containment and control structures. Hydraulic structures can be defined broadly as structures designed to handle water in any way – retention, conveyance, control, regulation, mixing and energy dissipation. Such structures are required in all facets of water engineering; the principal facets being water quantity management (flood control, water supply, hydropower, irrigation and drainage, navigation, environmental and recreation use), water-quality management, thermal-power generation, and aspects of road and rail transportation. To ensure that a hydraulic structure functions as required entails the design application of equations based on continuity, momentum and energy principles coupled with useful notions about the mechanical behavior of construction materials, notably concrete, various metals and soils.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The concept of reservoir planning, methods to perform stability analysis and construction methods of earth dams.
II. The implementation of engineering mechanics on gravity dams and design of gravity dams under various loading conditions.
III. The design principles of various types hydraulic structures e.g., spillways, syphons, etc. and principles of energy dissipation.
IV. The seepage theory for design of weir and Barrages on various types of foundations.
V. The general features of hydro-electric schemes for proper development of hydropower projects.

III. COURSE SYLLABUS:

MODULE –I: RESERVOIR PLANNING AND EARTH DAMS (9)

Reservoir Planning: Investigations, Capacities, Zones of storage, Mass Inflow and Mass Demand curves, Life of Reservoir. Earth Dams: Types, causes of failure and design criteria, soils suitability for earth dam construction, construction methods, foundation requirements, typical earth dam sections, estimation of seepage through and below the dam, seepage control, stability of slopes by slip circle method of analysis, pore pressures, sudden draw down, steady seepage and construction pore pressure condition.

MODULE -II: GRAVITY DAMS (9)

Gravity dams: Design Criteria, forces acting on gravity dams, elementary profile, low and high gravity dams, stability analysis, practical profile, evaluation of profile by method of zoning, foundation treatment, construction joints, galleries in gravity dams.

MODULE -III: SPILLWAYS AND ENERGY DISSIPATERS (9)

Spillways: Ogeespillwayanditsdesign,detailsofsyphon,shaft,chuteandsidechannel spillways, emergency spill ways, design of outlets and rating curves

Energy dissipaters: Principles of energy dissipation Energy dissipaters based on tail water rating curve and jump height curves Spillway crest gates - vertical lift and radial gates, their design principles. Design of canal regulating structures, Design of Channel transitions, Design of Sarda type Falls, Design of cross drainage works i.e.Syphon aqueduct and Canal syphon.

MODULE -IV: STRUCTURES ON PREVIOUS FORMATIONS (9)

Structures on Pervious formations: Bligh's creep theory, limitations, Khoslas's theory of independent variable, Khosla's corrections, Design of Weir and Barrages :design of waterways and crest levels, design of impervious floors and protection works.

MODULE -V: HYDROPOWER PLANTS (9)

Introduction of Hydropower development, general features of hydro-electric schemes, selection of turbines.

IV. TEXT BOOKS:

1. B.C. Punmia , Ashok Kumar Jain, Arun Kumar Jain, Pande Brij Basi Lal, "Irrigation and Water Power Engineering", Laxmi publications Pvt. Ltd., New Delhi, 16th Edition, 2016.
2. Garg, Santosh Kumar. "Irrigation Engineering and Hydraulic Structures: Water Resources Engineering, Earthen dams and rock fill dams. Khanna Publishers Pvt. Ltd. New Delhi, India, 2015.
3. Dandekar, M. M., and Kamal N. Sharma, "Water Power Engineering" Vikas Publishing House, 1979.

V. REFERENCE BOOKS:

1. Creager, William Pitcher, Joel De Witt Justin, and Julian Hinds, "Engineering for Dams: General Design" Vol. 1. John Wiley & Sons, 1950.
2. Murthy, ChallaSatya, "Water Resources Engineering: Principles and Practice" New Age International, 2002.
3. Asawa, G. L, "Elementary Irrigation Engineering", New Age International, 1999.

VI. WEB REFERENCES:

1. https://nptel.ac.in/courses/105105110/
2. https://nptel.ac.in/courses/105103096/

VII. E-TEXT BOOKS:

1. https://www.e-booksdirectory.com/details.php?ebook=2264.

ELEMENTS OF EARTHQUAKE ENGINEERING

VII Semester: CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC43	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisite: No prerequisites required								

I. COURSE OVERVIEW:

This course provides the fundamental concepts, principles and application of earthquake engineering in seismic analysis and design of structures. This course begins with the Engineering Seismology explaining the causes of occurrence of earthquake and its characterization. This course covers harmonic and periodic motion including both damped and un-damped free and forced vibration, single- and multi-degree-of freedom systems. Earthquakes and how they influence building design will be the subject of this course. Students will learn about the earth science behind earthquakes and the fundamentals of the physics and behavior of structural systems designed to resist earthquake motions. System and material selection for seismic design considering the structure.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The concepts of prestressed concrete structures and the behaviour of these structures subjected to loadsfor the design purpose.
II. The design of structural elements necessary for creating efficient and economic prestressed concrete structures.
III. The design and drawing of multi storeyed industrial and residential structures including bridges for creating high performance and durable structures.

III.COURSE SYLLABUS:

MODULE –I: ENGINEERING SEISMOLOGY (9)

Causes of earthquakes, seismic waves, magnitudes, intensity and energy release characteristics of strong earthquakes, ground motions, soils effects and liquefaction.

MODULE -II: THEORY OF VIBRATIONS (9)

Introduction to long and short period structure, single, two and multi-degree of freedom systems, concepts of damped and undamped vibrations, response spectrum, response spectrum analysis.

MODULE -III: SEISMIC DESIGN PHILOSOPHY (9)

Concept of seismic resistant design, reduction factors, over strength, ductility and redundancy, determination of earthquake forces on structures.

Seismic design and detailing of reinforced concrete and steel buildings.

MODULE -IV: SEISMIC PERFORMANCE OF BUILDINGS (9)

Case Studies of few serious earthquakes in the country in the past, damages to buildings, damage patterns, performance of non engineered buildings, rural houses during the earthquakes.

MODULE -V: SEISMIC RESISTANT DESIGN (9)

Basic principles of earthquake resistance. Concepts of earthquake resistant construction in rural areas. Base isolation and energy and dissipation devices. Seismic retrofitting, repair, rehabilitation and retrofitting strategies, Importance of reanalysis. Case Studies.

IV. TEXT BOOKS:

1. Pankaj Agarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall of India, 2006.
2. S.L. Kramer, "Geotechnical Earthquake Engineering", Pearson Education, 2004.
3. Mario Paz, "International Handbook of Earthquake Engineering: Codes, Programs, and Examples", Springer Verlag, 1995.

V. REFERENCE BOOKS:

1. **A.**K. Chopra, "Dynamics of Structures, Theory and Applications to Earthquake Engineering", Pearson Education, 2004.
2. D.S. Prakashrao, "Design Principles and Detailing of Concrete Structures", Tata McGraw-Hill Publishing Company, 1995.

VI. WEB REFERENCES:

1. http://nptel.ac.in/downloads/105101004/
2. http://www.ndmindia.nic.in/oneweektrainingarchitects.pdf

VII. E-TEXT BOOKS:

1. https://drive.google.com/file/d/0B5oarfYUwEDrSlRxZVdDeGdETnc/view
2. http://civilhouse.ir/newsletter/NO2/Earthquake.pdf

COMPUTER ARCHITECTURE

OE – I: VI Semester: ECE / EEE OE –II: VII Semester: AERO / MECH / CIVIL								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACSC24	Elective	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		

I. COURSE OVERVIEW:

This course introduces the principles of computer organization and the basic architecture concepts. The main objective of this course is to give students to a clear understanding of the modern computer architecture. It also helps the students to know about hardware and software implementation of (ALU) arithmetic and logic unit to solve addition, subtraction, multiplication and division. It also defines the constituent parts of the system, how they are interconnected, and how they interoperate in order to implement the architectural specification. In this course, students will learn the basics of hardware components from basic gates to memory and I/O devices, instruction set architectures and designs to improve the performance.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The organization and architecture of computer systems and electronic computers.
II. The assembly language program execution, instruction format and instruction cycle.
III. How to design a simple computer using hardwired and micro programmed control methods.
IV. The basic components of computer systems besides the computer arithmetic.
V. The input-output organization, memory organization and management, and pipelining.

III. SYLLABUS

MODULE – I: INTRODUCTION TO COMPUTER ORGANIZATION (09)

Basic computer organization, CPU organization, memory subsystem organization and interfacing, input or output subsystem organization and interfacing, simple computer levels of programming languages, assembly language instructions, a simple instruction set architecture.

MODULE –II: ORGANIZATION OF A COMPUTER (09)

Register transfer: Register transfer language, register transfer, bus and memory transfers, arithmetic micro operations, logic micro operations, shift micro operations; Control memory.

MODULE –III: CPU AND COMPUTER ARITHMETIC (09)

CPU design: Instruction cycle, data representation, memory reference instructions, input-output, and interrupt, addressing modes, data transfer and manipulation, program control.

Computer arithmetic: Addition and subtraction, floating point arithmetic operations, decimal arithmetic unit.

MODULE –IV: INPUT-OUTPUT ORGANIZATION (09)

Input or output organization: Input or output Interface, asynchronous data transfer, modes of transfer, priority interrupt, direct memory access.

MODULE –V: MEMORY ORGANIZATION (09)

Memory organization: Memory hierarchy, main memory, auxiliary memory, associative memory, cache memory, virtual memory; Pipeline: Parallel processing, Instruction pipeline.

IV. TEXT BOOKS:

1. M. Morris Mano, “Computer Systems Architecture”, Pearson, 3rd Edition, 2015.
2. Patterson, Hennessy, “Computer Organization and Design: The Hardware/Software Interface”, Morgan Kaufmann, 5th Edition, 2013.

V. REFERENCE BOOKS:

1. John. P. Hayes, “Computer System Architecture”, McGraw-Hill, 3rd Edition, 1998.
2. Carl Hamacher, Zvonko G Vranesic, Safwat G Zaky, “Computer Organization”, McGraw-Hill, 5th Edition, 2002.
3. William Stallings, “Computer Organization and Architecture”, Pearson Edition, 8th Edition, 2010.

VI. WEB REFERENCES:

1. https://www.tutorialspoint.com/computer_logical_organization/
2. https://www.courseera.org/learn/comparch
3. https://www.cssimplified.com/.../computer-organization-and-assembly-language-programming

VI. E-TEXT BOOKS:

1. https://www.groupes.polymtl.ca/inf2610/.../ComputerSystemBook.pdf
2. https://www.cse.hcmut.edu.vn/~vtphuong/KTMT/Slides/TextBookFull.pdf

ADVANCED DATA STRUCTURES

<table>
<tr><td colspan="9">OE – I: VI Semester: ECE / EEE
OE –II: VII Semester: AERO / MECH / CIVIL</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">ACSC25</td><td rowspan="2">Elective</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
</table>

I. COURSE OVERVIEW:

The course is intended to provide the foundations of the practical implementation and usage of Advanced Data Structures. It also covers some classical results and recent advancements on data structures, and the algorithms acting upon them. Typical topics include in sorting and searching, reorganizing lists and search trees based on the online sequence of queries to speed up searches, improving efficiency based on the distribution of queries, performing fast text retrieval by constructing indexes, and improving space efficiency of data structures for large data sets. The main objective of this course is to ensure that the student evolves into a competent programmer capable of designing and analyzing the implementations of different data structures for different kinds of problems.

II.COURSE OBJECTIVES:

The students will try to learn:

I. The basic data structures and techniques of algorithm analysis.
II. The dictionaries, hashing mechanisms and skip lists for faster data retrieval.
III. The comprehension of heaps, priority queues and its operations.
IV. Briefly about balanced trees and their operations.
V. The tries and pattern matching algorithms.

III. SYLLABUS:

MODULE – I: OVERVIEW OF DATA STRUCTURES (09)

Algorithms; Performance analysis: Time complexity and Space complexity, Asymptotic notation. Review of basic data structures - The list ADT, Stack ADT, Queue ADT, Linked list – Single linked list, Double linked list, Circular linked list.

MODULE – II: DICTIONARIES, HASH TABLES (09)

Dictionaries: Linear list representation, Skip list representation, operations - insertion, deletion and searching, Hash table representation, hash functions, collision resolution - separate chaining, open addressing - linear probing, quadratic probing, double hashing, rehashing, extendible hashing, comparison of hashing and skip lists.

MODULE – III: PRIORITY QUEUES (09)

Priority Queues – Definition, ADT, Realizing a Priority Queue using Heaps, Insertion, Deletion,.

Application-Heap Sort, External Sorting- Model for external sorting, Multiway merge, Polyphase merge.

MODULE – IV: SEARCH TREES (09)

Binary Search Trees - Definition, ADT, Operations - Searching, Insertion, Deletion, AVL Trees - Definition, ADT, Balance factor, Operations – Insertion, Deletion, Searching, Introduction to Red – Black and Splay Trees, B-Trees, B-Tree operations - insertion, deletion, searching, Comparison of Search Trees.

MODULE – V: PATTERN MATCHING AND TRIES (09)

Pattern matching algorithms - the Boyer - Moore algorithm, the Knuth – Morris - Pratt algorithm. Tries – Definition, concepts of digital search tree, Binary trie, Patricia, Multi-way trie.

IV. TEXT BOOKS:

1. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, “Fundamentals of Computer Algorithms”, Universities Press Private Limited, India, 2nd Edition, 2008.
2. G.A. V.Pai, “Data Structures and Algorithms”, Tata McGraw Hill, New Delhi, 1st Edition, 2008.
3. Richard F Gilberg, Behrouz A Forouzan, “Data Structures - A Pseudocode Approach with C”, Cengage Learning, Thomson Press (India) Ltd, 2nd Edition, 2006.

V. REFERENCE BOOKS:

1. D. Samanta, “Classic Data Structures”, Prentice Hall of India Private Limited, 2nd Edition, 2003.
2. Aho, Hop craft, Ullman, “Design and Analysis of Computer Algorithms”, Pearson Education India, 1st Edition, 1998.
3. Goodman, Hedetniemi, “Introduction to Design and Analysis of Algorithms”, Tata McGraw Hill, New Delhi, India, 1st Edition, 2002.
4. Adam Drozdek, “Data Structures and Algorithms in C++”, Thomson Course Technology, 3rd Edition, 2005.
5. M. T. Goodrich, R. Tomassia, “Data structures and Algorithms in Java”, Wiley India, 3rd Edition, 2011.

VI. WEB REFERENCE:

1. https://www.tutorialspoint.com/data_structures_algorithms/data_structures_basics.htm
2. https://www.geeksforgeeks.org/data-structures/
3. http://www.nptelvideos.in/2012/11/data-structures-and-algorithms.html

VII. E-TEXT BOOKS:

1. https://pdfs.semanticscholar.org/19ec/55ed703eb24e1d98a4abd1a15387281cc0f8.pdf
2. https://www.academia.edu/35961658/Data.Structures.A.Pseudocode.Approach.with.C.2nd.edition_1_.pdf
3. https://sonucgn.files.wordpress.com/2018/01/data-structures-by-d-samantha.pdf

ARTIFICIAL INTELLIGENCE

OE – I: VI Semester: ECE / EEE OE –II: VII Semester: AERO / MECH / CIVIL								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACSC26	Elective	L	T	P	C	CIA	SEE	Total
		3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

Artificial Intelligence has emerged as an increasingly impactful discipline in science and technology. Al applications are embedded in the infrastructure of many products and industries search engines, medical diagnoses, speech recognition, robot control, web search advertising and even toys. This course provides a broad overview of modern artificial Intelligence, learn how machines can engage in problem solving, reasoning, learning, and interaction design, test and implement algorithms.

II.COURSE OBJECTIVES:

The students will try to learn:

I. Gain a historical perspective of AI and its foundations.
II. Become familiar with basic principles of AI toward problem solving, inference, knowledge representation, and learning.
III. Explore the current scope, potential, limitations, and implications of intelligent systems.

III. SYLLABUS:

MODULE – I: INTRODUCTION (09)

Introduction: AI problems, Intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, Structure of agents, Problem solving agents, Problem formulation.

MODULE – II: KNOWLEDGE REPRESENTATION & REASONS (09)

Knowledge – Based Agents, the Wumpus world.
Propositional Logic: Reasoning patterns in propositional logic - Resolution, Forward & Backward Chaining. Inference in First order logic: Propositional vs. first order inference.

MODULE – III: SEARCHING: (09)

Searching for solutions, uniformed search strategies – Depth limited search, bi-direction search, Comparing uninformed search strategies.

Search with partial information (Heuristic search), TSP problem, best first search, A* search, Hill climbing, Simulated annealing search.

MODULE – IV: CONSTRAIN SATISFACTION PROBLEMS (09)

Backtracking search for CSPs local search for constraint satisfaction problems. Game Playing: Games, Min - Max algorithm, Optimal decisions in multiplayer games, Alpha-Beta pruning.

MODULE – V: PLANNING: (09)

Classical planning problem, Language of planning problem, planning with state – space search, forward state spare search, backward state space search, Heuristics for state space search, Partial order planning Graphs, Planning graphs.

IV. TEXT BOOKS:

1. Stuart Russel, Peter Norvig, “Artificial Intelligence – A Modern Approach”, Pearson Education. 3rd Edition, 2009.

V. REFERENCE BOOKS:

1. E.Rich and K.Knight, “Artificial Intelligence”, Tata McGraw Hill, 3rd Edition, 2008.
2. Patterson, “Artificial Intelligence and Expert Systems”, PHI, 2nd Edition, 2009.
3. Giarrantana/ Riley, “Expert Systems: Principles and Programming”, Thomson, 4th Edition, 2004.
4. Ivan Bratka, “PROLOG Programming for Artificial Intelligence, Pearson Education, 3rd Edition, 2000.

CYBER CRIME AND COMPUTER FORENSICS

<table>
<tr><td colspan="9">OE – I: VI Semester: ECE / EEE
OE –II: VII Semester: AERO / MECH / CIVIL</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>AITC19</td><td>Elective</td><td>3</td><td>-</td><td>-</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
</table>

I. COURSE OVERVIEW:

This course is designed to introduce the participant to the cybercrime prevention, detection and incident management processes, policies, procedures and cybercrime governance activities. The course is focus on cybercrime management standards, guidelines and procedures as well as the implementation and governance of these activities. In addition, it also provides the students an understanding of the new and advanced digital investigation techniques for machines, systems and networks since new technologies are opening today the door to new criminal approaches.

II.COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental concepts of computer forensics and different types of forensics systems.
II. The methodologies to analyze and validate the forensics data.
III. The different tools and tactics that is associated with cyber forensics.

III. SYLLABUS:

MODULE – I: INTRODUCTION (09)

Introduction: Computer forensics fundamentals, types of computer forensics technology, types of computer forensics systems, vendor and computer forensics services.

MODULE – II: COMPUTER FORENSICS EVIDENCE AND CAPTURE (09)

Data recovery, evidence collection and data seizure, duplication and preservation of digital evidence, computer image verification and authentication.

MODULE – III: COMPUTER FORENSIC ANALYSIS (09)

Discover of electronic evidence, identification of data, reconstructing past events, fighting against macro threats.

Information warfare arsenal, tactics of the military, tactics of terrorist and rogues, tactics of private companies.

MODULE – IV: INFORMATION WARFARE (09)

Arsenal, surveillance tools, hackers and theft of components, contemporary computer crime, identity theft and identity fraud, organized crime &terrorism, avenues prosecution and government efforts, applying the first amendment to computer related crime, the fourth amendment and other legal issues.

MODULE – V: COMPUTER FORENSIC CASES (09)

Developing forensic capabilities, searching and seizing computer related evidence, processing evidence and report preparation, future issues.

IV. TEXT BOOKS:

1. John R. Vacca, “Computer Forensics: Computer Crime Scene Investigation”, Cengage Learning, 2nd Edition, 2005. (UNIT I – IV)
2. Marjie T Britz, “Computer Forensics and Cyber Crime: An Introduction”, Pearson Education, 2nd Edition, 2008. (UNIT IV – V)

V. REFERENCE BOOKS:

1. MariE-Helen Maras, “Computer Forensics: Cybercriminals, Laws, and Evidence”, Jones & Bartlett Learning; 2nd Edition, 2014.
2. Chad Steel, “Windows Forensics”, Wiley, 1st Edition, 2006.
3. Majid Yar, “Cybercrime and Society”, SAGE Publications Ltd, Hardcover, 2nd Edition, 2013.
4. Robert M Slade, “Software Forensics: Collecting Evidence from the Scene of a Digital Crime”, Tata McGraw Hill, Paperback, 1st Edition, 2004.

ETHICAL HACKING

<table>
<tr><td colspan="9">OE – I: VI Semester: ECE / EEE
OE –II: VII Semester: AERO / MECH / CIVIL</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">AITC20</td><td rowspan="2">Elective</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
</table>

I. COURSE OVERVIEW:

This course will provide fundamentals of the tools and techniques used by hackers and information security professionals alike to break into an organization. This course will immerse you into the Hacker Mindset so that you will be able to defend against future attacks. It puts you in the driver's seat of a hands-on environment with a systematic ethical hacking process. It will give an overview of how to scan, test, hack and secure own systems thought the different phases of ethical hacking include reconnaissance, gaining access, enumeration, maintaining access, and covering various tracks.

II.COURSE OBJECTIVES:

The students will try to learn:

I. The concepts of security testing and the knowledge required to protect against the hacker and attackers.
II. The reconnaissance and the publicly available tools used to gather information on potential targets.
III. The scanning techniques used to identify network systems open ports.
IV. The network system vulnerabilities and confirm their exploitability.
V. The techniques for identifying web application vulnerabilities and attacks.

III. SYLLABUS:

MODULE – I: INTRODUCTION TO HACKING (09)

Introduction to hacking, important terminologies, penetration test, vulnerability assessments versus penetration test, pre-engagement, rules of engagement, penetration testing methodologies, osstmm, nist, owasp, categories of penetration test, types of penetration tests, vulnerability assessment summary, reports.

MODULE – II: INFORMATION GATHERING AND SCANNING (09)

information gathering techniques, active information gathering, passive information gathering, sources of information gathering, tracing the location, traceroute, icmp traceroute, tcp traceroute, usage, udp traceroute, enumerating and fingerprinting the webservers, google hacking, dns enumeration, enumerating snmp, smtp enumeration, target enumeration and port scanning techniques, advanced firewall/ids evading techniques.

MODULE – III: NETWORK ATTACKS (09)

Vulnerability data resources, exploit databases, network sniffing, types of sniffing, promiscuous versus nonpromiscuous mode, mitm attacks, arp attacks, denial of service attacks.

Stripping https, traffic dns spoofing, arp spoofing attack manipulating the dns records, dhcp spoofing,
remote exploitation, attacking network remote services, overview of brute force attacks, traditional brute force.

MODULE – IV: EXPLOITATION (09)

Introduction to metasploit, reconnaissance with metasploit, port scanning with metasploit, compromising a windows host with metasploit, client side exploitation methods, e–mails with malicious attachments, creating a custom executable, creating a backdoor with set, pdf hacking, social engineering toolkit, browser exploitation, post, exploitation, acquiring situation awareness, hashing algorithms, windows hashing methods.

MODULE – V: WIRELESS AND WEB HACKING (09)

Wireless hacking, introducing aircrack, cracking the wep, cracking a wpa/wpa2 wireless network using aircrack, ng – evil twin attack, causing denial of service on the original ap, web hacking, attacking the authentication, brute force and dictionary attacks, types of authentication.

IV. TEXT BOOKS:

1. Rafay Baloch, "Ethical Hacking and Penetration Testing Guide", CRC Press, 2014.

V. REFERENCE BOOKS:

1. Kevin Beaver, "Ethical Hacking for Dummies", Wiley, 6th Edition, 2018.
2. Jon Erickson , "Hacking: The Art of Exploitation", Rogunix, 2nd Edition, 2007.

MOBILE COMPUTING

OE – I: VI Semester: ECE / EEE OE –II: VII Semester: AERO / MECH / CIVIL								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AITC21	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		

I. COURE OVERVIEW:

With the increasing popularity of mobile devices, mobile computing has become part of our daily life. This course will cover the nomenclature and implementation of mobile computing and mobile communication. It also provide a systematic explanation of mobile computing as a discrete discipline and will provide an in-depth coverage of mobile systems and devices used for application development, mobile databases, client-server computing agents, application servers, security protocols, mobile Internet, and ad-hoc and sensor networks.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The concept of wireless transmission protocols.
II. The typical mobile networking infrastructure through a popular GSM protocol architecture.
III. The various layers of mobile networks for location management.
IV. The database issues in mobile environments and data delivery models.
V. The platforms and protocols used in mobile environment.

III. SYLLABUS:

MODULE-I: INTRODUCTION (08)

Mobile computing – Paradigm, promises/Novel applications and impediments and architecture; Mobile and handheld devices, limitations of mobile and handheld devices. GSM – Services, system architecture, radio interfaces, protocols, localization, calling, handover, security, new data services, GPRS.

MODULE-II: MEDIA ACCESS LAYER AND MOBILE NETWORK LAYER (08)

Motivation for a specialized MAC (Hidden and exposed terminals. Near and far terminals), SDMA, FDMA, TDMA, CDMA, wireless LAN (IEEE802.11) system and protocol architecture; Mobile network layer: Packet delivery and handover management, location management, registration, tunneling and encapsulation, route optimization, DHCP.

MODULE-III: MOBILE TRANSPORT LAYER (08)

Conventional TCP/IP protocols, indirect TCP, snooping TCP, mobile TCP, other transport layers protocols for mobile networks;

Database issues: Database hoarding & caching techniques, C-S computing and adaptation, transactional models, query processing, data recovery process and QoS issues.

MODULE-IV: DATA DISSEMINATION AND SYNCHRONIZATION (10)

Communications asymmetry, classification of data delivery mechanisms, data dissemination, broadcast models, selective tuning and indexing methods.

MODULE-V: MOBILE ADHOC NETWORKS(MANET'S) (09)

Introduction, applications and challenges of a MANET, routing, classification of routing algorithms, algorithms such as DSR, AODV, DSDV; Mobile Agents, Service Discovery.

IV. TEXT BOOKS:

1. Jochen Schiller, “Mobile Communications”, Pearson Education, 2nd Edition, 2009.
2. Raj Kamal, “Mobile Computing”, Oxford University Press, Illustrated, 2nd Edition, 2012.

V. REFERENCE BOOKS:

1. Adelstein, Frank, Gupta, Sandeep KS, Richard III, Golden, Schwiebert, Loren, “Fundamentals of Mobile and Pervasive Computing”, McGraw-Hill Professional, 2005.
2. Hansmann, Merk, Nicklous, Stober, “Principles of Mobile Computing”, Springer, 2nd Edition, 2003.
3. Martyn Mallick, “Mobile and Wireless Design Essentials”, Wiley Dream Tech, 1st Edition, 2003.

VI. WEB REFERENCE:

1. https://en.wikipedia.org/wiki/Mobile_computing
2. https://www.tutorialspoint.com/mobile_computing/mobile_computing_quick_guide.h
3. https://media.techtarget.com/searchMobileComputing/downloads/Mobile_and_pervasive_computing_Ch06 pdf

VII. E-TEXT BOOKS:

1. https://books.google.co.in/books?id=HoFdSmH77wsC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&false
2. https://books.google.co.in/books?id=LSqPLwEACAAJ&source=gbs_book_other_versions

ADVANCED STRUCTURAL DESIGN LABORATORY

<table>
<tr><td colspan="10">VII Semester: CE</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours/Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">ACEC44</td><td rowspan="2">Core</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>-</td><td>-</td><td>3</td><td>1.5</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: Nil</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: 36</td><td colspan="3">Total Classes: 36</td></tr>
<tr><td colspan="9">Prerequisite: No prerequisites required</td></tr>
</table>

I. COURSE OVERVIEW:

STAAD. Pro software is one of the most widely used structural analysis and design software products worldwide. It supports over 90 international steel, concrete, timber aluminum design codes. Students can make use of various forms of analysis from the traditional static analysis to more recent analysis methods like p-delta analysis, geometric non-linear analysis, Pushover analysis (Static-Non Linear Analysis) or a buckling analysis. It can also make use of various forms of dynamic analysis methods from time history analysis to response spectrum analysis. The response spectrum analysis feature is supported for both user defined spectra as well as a number of international code specified spectra.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basic elements with different loading type and supports with the aid of STAAD Pro software.
II. The Analysis and design of 2D frame and multi-storey buildings with different load set.
III. Design of steel structures with truss elements subjected to lateral load.
IV. The Modeling and analyze of bridge truss and deck slab for moving loads.

III.COURSE SYLLABUS:

Week- l: INTRODUCTION TO STAAD PRO

Basic commands used in STAAD Pro.

Week- 2: ANALYSIS OF CONTINUOUS BEAM

Analysis of continuous beam using STAAD Pro.

Week- 3: ANALYSIS OF SINGLE STOREY FRAME

Analysis of single storey frame.

Week- 4: ANALYSIS OF MULTI-STOREY FRAME

Analysis of multi-storey frame.

Week- 5: DESIGN OF MULTI-STOREY FRAME

Design of multi-storey frame design.

Week- 6: ANALYSIS OF MULTI-STOREYED BUILDING

Analysis of multi-storeyed building.

Week- 7: DESIGN OF MULTI-STOREYED BUILDING

Design of multi-storeyed building.

Week- 8:WIND LOAD ANALYSIS ON RCC BUILDING

Wind load analysis on RCC building.

Week- 9: ANALYSIS AND DESIGN OF STEEL TRUSS
Analysis and design of steel truss.
Week- 10: ANALYSIS AND DESIGN OF ISOLATED FOOTING
Analysis and design of isolated footing

Week- 11: ANALYSIS AND DESIGN OF COMBINED FOOTING
Analysis and design of combined footing.

Week- 12: ANALYSIS AND DESIGN OF TRAPEZODIAL FOOTING
Analysis and design of trapezoidal footing.

IV. TEXT BOOKS:

1. T.S.Sarma, “STAAD Pro V8ifor Beginners”, Notion Press, 1st Edition, 2014.
2. Sagale, Akshay, and Sandip Dongre. "Analysis and Design of Cable Stayed Bridge using STAAD-PRO”, 1st Edition, 2014.

V. WEB REFERENCES:

1. http://www.iu.hio.no/~pererikt/Konstr/Konstr-design-II/staadpro/manual-staadpro2005.pdf
2. http://www.iare.ac.in.

PROJECT PLANNING LABORATORY

<table>
<tr><td colspan="9">VII SEMESTER: CE</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">ACEC45</td><td rowspan="2">Core</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>1.5</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: Nil</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: 36</td><td colspan="3">Total Classes: 36</td></tr>
<tr><td colspan="9">Prerequisite: No prerequisites required</td></tr>
</table>

I. COURSE OVERVIEW:

This course deals with the application of scientific and technical knowledge to the processes used to construct infrastructure projects. This instructional program is highly interdisciplinary and aims at developing strong abilities to conduct construction engineering and management work involving basic concepts and principles, technical analysis, planning, design, and management, and the development of knowledge that positively impacts the construction industry. The program provides the student with skills in planning, designing, and implementing construction processes and systems. The course provides both a broad awareness of construction concepts and an understanding of scientific and technical knowledge to address construction problems.

II. COURSE OBJECTIVES:

The Students will try to learn:

I. The concepts of the construction techniques, equipment, project feasibility and project planning through site visits.
II. The Basic tools knowledge software in MS project and advances in construction.
III. The work flow of construction activities and cash flow analysis.
IV. The allocation of resources, planning, scheduling of the construction and tendering process.

III.COURSE SYLLABUS:

Week- l: SITE VISIT-I

Site visit to study the construction techniques and use of major construction equipment associated with the ongoing work. Report on the site visit to be submitted.

Week- 2: MS PROJECT BASICS

To learn Basics knowledge on MS Project Software.

Week- 3: NEW ADVANCES IN CONSTRUCTION

Collection of techno- commercial information on the new construction materials, methods and construction equipment available in the market.

Week- 4: WORK FLOW OF CONSTRUCTION ACTIVITIES

Performing and reporting of time and motion study work measurement of any one construction activity

Week- 5: QUANTITY ESTIMATION AND PURCHASE

Field exercise on estimation of quantities and bulk purchases

Week- 6: PRECEDENCE NETWORK

Preparation, crashing and updating of precedence network for a major construction work.

Week- 7: CASH FLOW ANALYSIS

Exercise on cash flow analysis

Week- 8: MODEL PREPARATION

Preparation of models and charts related to various construction techniques, equipment, organizational structures of existing companies. This is a group activity to generate interest and explore creativity.

Week- 9: RESOURCES ALLOCATION USING MS PROJECT

Exercise on Industrial Building Project resources allocation in MS Project

Week- 10: PROJECTPLANNING AND SCHEDULLING

Exercise on Hospital Building Project planning and scheduling in MS Project

Week- 11: TENDERING

Collection and study of tender notices, tender documents of contract document associated with civil engineering works.

Week- 12: VALUATION

Valuation of land and building using various methods. A report to be submitted on the same.

IV. TEXT BOOKS:

1. K.S.Menon, "Purchasing and Inventory Control", Wheeler Publication, 1996.
2. Peurifoy, "Construction Planning, Equipment and Method", Tata McGraw-Hill, 2010.

V.REFERENCE BOOKS

1. Dr. MaheshVarma, "Construction Equipment Planning and Applications", Metropolitan Book Co., 1975.
2. Bohlander and Shnell, "Managing Human Resources", Paperback, 2012.
3. BiswajeetPattanayak, "Human Resource Management", PHI Learning, 3rd Edition, 2010.

V. WEB REFERENCES:

http://www.iare.ac.in

PROJECT WORK - I

VII Semester: Common for all branches								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACEC46	**Project**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		0	0	4	2	30	70	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 36**				**Total Classes: 36**		

The object of Project Work I is to enable the student to take up investigative study in the broad field of Civil Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic;
2. Working out a preliminary Approach to the Problem relating to the assigned topic;
3. Conducting preliminary Analysis / Modeling / Simulation/Experiment/Design/Feasibility;
4. Preparing a Written Report on the Study conducted for presentation to the Department;
5. Final Seminar, as oral Presentation before a departmental committee.

GROUND IMPROVEMENT TECHNIQUES

VIII Semester: CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC47	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

Prerequisite: Geotechnical Engineering

I. COURSE OVERVIEW:

The soils at construction sites are not always totally suitable for supporting physical infrastructure such as buildings, bridges, highways, tunnels and dams. Under these conditions, soil needs to be treated using ground improvement techniques. Similarly specific types of soil improvement techniques are required in the case of expansive soils and collapsible soil and in the case of earthquake prone areas. The course addresses various ground improvement techniques along with principles, design issues and construction procedures.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The importance and fundamentals of ground improvement techniques for measuring field parameters by using traditional and modern methods involved in civil construction.
II. The mechanical methods and suitable equipment to proliferate the ground for making the soil to withstand all the loads acting on it.
III. The physical, chemical and hydraulic modification methods and its applications for strengthen the soil.
IV. The applications of modern methods in civil construction alteration works, short creating, soil reinforcement, soil nailing, bolting involved in inclusion and confinement process.

III.COURSE SYLLABUS:

MODULE – I: INTRODUCTION TO GROUND MODIFICATION (9)

Need and objectives, identification of soil types, in situ and laboratory tests to characterize problematic soils; mechanical, hydraulic, physical, chemical, electrical, thermal methods and their applications.

MODULE – II: MECHANICAL MODIFICATION (9)

Deep compaction techniques- blasting, vibro compaction, dynamic tamping and compaction piles.

MODULE – III: HYDRAULIC MODIFICATION (9)

Objective and techniques, traditional dewatering methods and their choice, design of dewatering system, electro-osmosis, electro kinetic dewatering.

Filtration, drainage and seepage control with geosynthetics, preloading the vertical drains.

MODULE – IV: PHYSICAL AND CHEMICAL MODIFICATION (9)

Modification by admixtures, shotcreting and guniting technology, modification at depth by grouting, crack grouting and compaction grouting. Jet grouting, thermal modification, ground freezing.

MODULE – V: MODIFICATION BY INCLUSIONS AND CONFINEMENT (9)

Soil reinforcement, reinforcement with strip, and grid reinforced soil. In-situ ground reinforcement, and ground anchors, rock bolting and soil nailing.

IV. TEXT BOOKS:

1. Hausmann, Raj, P, Manfred R, “Engineering Principles of Ground Modification”, 1990.
2. Purushothama, “Ground Improvement Techniques”, (HB). Firewall Media, 1999.
3. Moseley, Michael P., and Klaus Kirsch, eds, “Ground improvement” CRC Press, 2004.

V. REFERENCE BOOKS:

1. Koerner, Robert M, “Designing with Geosynthetics-Vol. 1”, Vol. 1. Xlibris Corporation, 2012.
2. Shukla, Sanjay Kumar, and Sanjay Kumar Shukla, eds, “Geosynthetics and their Applications,” London: Thomas Telford, 2002.
3. Jones, Colin JFP, “Earth Reinforcement and Soil Structures”, Elsevier, 2013.

VI. WEB REFERENCES:

1. http://nptel.ac.in/courses/105104034/
2. http://www.myopencourses.com/subject/ground-improvement-techniques-1
3. https://www.youtube.com/watch?v=4PZcTeA6R18

VII. E-TEXT BOOKS:

1. http://www.sciencedirect.com/science/book/9780124080768

GEOTECHNICAL ENGINEERING AND MANAGEMENT

VIII Semester: CE									
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC48	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisite: Geotechnical Engineering								

I. COURSE OVERVIEW:

Modern structures, such as buildings, embankments and dams, must satisfy exacting stability and deformation criteria, and they may have to be sited on weak or compressible ground. It is the responsibility of the geotechnical engineer to plan and direct the necessary ground investigations and laboratory testing, interpret the results, and propose methods of design and construction to overcome difficulties caused by inadequate ground. This course addresses the modern construction methods, techniques and effective construction management practices. This course also focuses on the resources management efficiently for successful completion of foundations in the infrastructure projects.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The effect of management for project organization, design of construction process, labour, material and equipment utilization, and cost estimation.
II. The various earth pressure theories and stability of retaining walls.
III. The tools to initiate a project plan, manage both stakeholders and relationships, organize their team, develop a project charter, and build a business case for a project.
IV. The purpose of Construction management is to control a project's time / delivery, cost and quality on soils, importance in the design and construction process of massive structures.

III.COURSESYLLABUS:

MODULE –I: GEOTECHNICAL ASSET MANAGEMENT (9)

Introduction - Project Life Cycle - Types of Construction - Introduction to asset management and risk management- Limit states for geotechnical assets - Geotechnical asset and consideration of asset management procedures used to manage these assets - Instruments and gauges, measurements - load, pressure, groundwater and pore water pressures, and deformations.

MODULE -II: GROUND INVESTIGATIONS (9)

Introduction - Trial pits, boreholes; geophysical methods, soil sampling, sampling disturbance, soil classification - conduct and interpretation of field tests including static cone and Standard Penetration Testing, - Vane test, pressure meter and plate loading tests; - Analysis, correlation and presentation of results, swelling clay soils, - Location of mine voids and shafts.

MODULE -III: SLOPES AND RETAINING STRUCTURES (9)

Causes of slope failure - Stability analysis of infinite slopes - Circular and non-circular slip surfaces - Method of slices -Stability charts -Investigation of unstable areas- Rock slope stability -Remedial measures

Earth pressure theories - Rankine and Coulomb - Effect of water - Surcharge and inclined soil surfaces - compaction pressures for cohesive and granular soils - Basic design principles - Geotechnical aspects of the design of gravity walls and sheet pile walls.

MODULE -IV: LABOUR, MATERIAL AND EQUIPMENT UTILIZATION (9)

Historical Perspective - Labour Productivity - Factors Affecting Job-Site Productivity - Labour Relations in Construction - Problems in Collective Bargaining - Materials Management - Material Procurement and Delivery - Inventory Control - Tradeoffs of Costs in Materials Management. - Construction Equipment - Choice of Equipment and Standard Production Rates - Construction Processes Queues and Resource Bottlenecks.

MODULE -V: COST ESTIMATION (9)

Costs Associated with Constructed Facilities - Approaches to Cost Estimation - Type of Construction Cost Estimates - Effects of Scale on Construction Cost - Unit Cost Method of Estimation - Methods for Allocation of Joint Costs - Historical Cost Data - Cost Indices - Applications of Cost Indices to Estimating - Estimate Based on Engineer's List of Quantities - Estimation of Operating Costs.

IV.TEXT BOOKS:

1. Knappett J.A. and Craig R.F., Craig's, "Soil Mechanics", Spon Press, 8th Edition, 2012.
2. Barnes, G.E., Soil Mechanics, "Principle and Practice", Macmillian Press Ltd, 3rd Edition, 2009.
3. K.G Krishnamurthy, "Construction and Project Management", CBS Publishers and Distributors, December, 2008.

V.REFERENCE BOOKS:

1. Terzaghi, K., Peck, R.B. and Mesri, G, "Soil Mechanics in Engineering Practice", 1996.
2. Powrie, W., "Soil Mechanics Concepts and Applications" Spon Press, Taylor and Fracis Group, London, 2nd Edition, 2002.
3. Chitkara, K.K. "Construction Project Management: Planning, Scheduling and Control", Tata McGraw Hill Publishing Company, New Delhi, 1998.

VI.WEB REFERENCES:

1. https://www.birmingham.ac.uk/postgraduate/courses/taught/civilengineering/geotechnical-engineering-management.aspxhttps://nptel.ac.in/courses/105/104/105104161/
2. https://nptel.ac.in/content/syllabus_pdf/105101001.pdf

VII.E-TEXT BOOKS:

1. https://easyengineering.net/advanced-soil-mechanics-book-pdf-by/
2. http://www.opentextbooks.org.hk/system/files/export/15/15694/pdf/Project_Management.pdf

APPLIED GEOTECHNICS

VIII Semester: CE									
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACEC49	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Geotechnical Engineering								

I. COURSE OVERVIEW:

Civil Engineers are required to construct structures on the soil. The loads coming onto these structures, along with the self-weight, have to be safely transmitted to the soil beneath it. A geotechnical engineer must be able to design a footing in such a way that soil below it will not fail there will not be any excessive settlements in the soil. This course enables students to design a shallow and deep foundation, analyze the stability of slopes, and check the stability of retaining walls and embankments against failure. Through this course content engineers can design the foundation for safety and serviceability.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The methods of soil exploration, field tests on soil by planning and soil investigation report documentation.
II. The stability of infinite and finite slopes using different parameters.
III. The various earth pressure theories and stability of retaining walls.
IV. The theoretical, field tests and bearing capacity of shallow, deep and well foundations

III.COURSE SYLLABUS:

MODULE –I: SOIL EXPLORATION (9)

Introduction, objectives and importance, stages and methods of exploration- test pits, borings, geophysical methods, stabilization of boreholes, sampling techniques, undisturbed, disturbed and representative samples, geophysical exploration and bore hole log. Drainage and dewatering methods, estimation of depth of ground water table (hvorslev's method).

MODULE -II STRESS DISTRIBUTION IN SOILS (9)

Introduction, Boussinesq's and Westergaard's theory for concentrated load, circular and rectangular load, equivalent point load method, pressure distribution diagrams and contact pressure. Newmark's chart Foundation Settlement - Approximate method for stress distribution on a horizontal plane, Types of settlements and importance, Computation of immediate and consolidation settlement.

MODULE -III: EARTH PRESSURE AND SLOPE STABILITY (9)

Active, Passiveand at rest earth pressure, Rankine's theory for cohesionless and cohesive soils, Coulomb's theory, Rebhann's and Culmann's graphical construction.

Assumptions, infinite and finite slopes, factor of safety, use of Taylor's stability charts, Swedish slip circle method for C and C-ø (Method of slices) soils, Fellineous method for critical slip circle.

MODULE -IV: BEARING CAPACITY OF SHALLOW FOUNDATION (9)

Types of foundations, determination of bearing capacity by Terzaghi's and BIS method (IS: 6403), Effect of water table and eccentricity, field methods - plate load test and SPT Proportioning of shallow foundations- isolated and combined footings (only two columns).

MODULE -V: DEEP FOUNDATIONS (9)

Types and classification of piles, single loaded pile capacity in cohesionless and cohesive soils by static formula, efficiency of file group, group capacity of piles in cohesionless and cohesive soils, negative skin friction, pile load tests, settlement of piles, under reamed piles (only introductory concepts – no derivation).

IV. TEXT BOOKS:

1. Ranjan, Gopal, and A. S. R. Rao, "Basic and Applied Soil Mechanics", New Age International, 2007.
2. Murthy, V. N. S. "Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering", CRC Press, 2002.
3. Das, Braja M., and Nagaratnam Sivakugan, "Fundamentals of Geotechnical Engineering", Cengage Learning, 2016.

V. REFERENCE BOOKS:

1. Lambe, T. William, and Robert V. Whitman, "Soil Mechanics" Vol. 10. John Wiley & Sons, 1991.
2. Bolton, Malcolm D, "A Guide to Soil Mechanics" Universities Press, 2013.
3. Bowles, Joseph E, "Foundation Analysis and Design" 1988.

VI. WEB REFERENCES:

1. https://nptel.ac.in/courses/105/101/105101201/
2. https://nptel.ac.in/courses/105/105/105105185/
3. https://civiconcepts.com/blog/pile-load-test

VII. E-TEXT BOOKS:

https://books.google.co.in/books?hl=en&lr=&id=_MzWBetcVhAC&oi=fnd&pg=PR11&dq=applied+geotechnics&ots=PugqOAphwC&sig=2zr9mAAy9nPcyHaKgmtFpcC1M&redir_esc=y#v=onepage&q=applied%20geotechnics&f=false

ADVANCED GEOTECHNICAL ENGINEERING

VIII Semester: CE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACEC50	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Geotechnical Engineering								

I. COURSE OVERVIEW:

This course Advanced Geotechnical Engineering includes additional discussions on clay minerals, nature of water in clay, repulsive potential and pressure in clay, and weight– volume relationships. Stresses and displacements in a soil mass is used to valuate displacements in a semi-infinite elastic medium due to various types of loading in addition to those to estimate stress. Pore water pressure due to undrained loading" has additional discussions on the directional variation of pore water pressure parameter A due to anisotropy in cohesive soils. Settlement of shallow foundations." More recent theories available in literature on the elastic settlement have been summarized. The advanced course material on advanced geotechnical engineering will be very useful to undergraduate students, post-graduate students, researchers, teachers and practitioners. A number of chosen problems will be solved to illustrate the concepts clearly.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The concept of soil formation and soil types including their characteristics and this can be used for finding the Index properties and engineering properties of soil.
II. The importance of shear strength and effect of pore water on different types of soil.
III. Behavior of soil mass under two and three dimensional loads.
IV. The knowledge of soil compressibility and consolidation theory in practice to estimate settlement of soil medium.

III.COURSE SYLLABUS:

MODULE –I: SOIL AGGREGATE, PLASTICITY, AND CLASSIFICATION (9)

Introduction , Soil—separate size limits, Clay minerals, Nature of water in clay, Repulsive potential, Repulsive pressure, Flocculation and dispersion of clay particles, Consistency of cohesive soils, Liquidity index , Activity, Grain-size distribution of soil, Weight–volume relationships, Relative density and relative compaction, Effect of roundness and non-plastic fines on e_{max} and e_{min} for granular soils and Unified soil classification system.

MODULE -II: STRESSES AND STRAINS—ELASTIC EQUILIBRIUM (9)

Introduction, Basic definition and sign conventions for stresses, Equations of static equilibrium, Concept of strain, Hooke's law, Plane strain problems, Equations of compatibility for three-dimensional problems, Stresses on an inclined plane and principal stresses for plane strain problems, Strains on an inclined plane and principal strain for plane strain problems, Stress components on an inclined plane, principal stress, and octahedral stresses—three-dimensional case, Strain components on an inclined plane, principal strain, and octahedral strain—three-dimensional case.

MODULE -III: STRESSES AND DISPLACEMENTS IN A SOIL MASS (9)

Introduction, two-dimensional problems: Vertical line load on the surface, Vertical line load on the surface of a finite layer, Vertical line load inside a semi-infinite mass, Horizontal line load on the surface, Horizontal line load inside a semi-infinite mass, Uniform vertical loading on an infinite strip on the surface, Uniform strip load inside a semi-infinite mass, Uniform horizontal loading on an infinite strip on the surface.

Three-dimensional problems: Stresses due to a vertical point load on the surface, Deflection due to a concentrated point load at the surface, Horizontal point load on the surface, Stresses below a circularly loaded flexible area (uniform vertical load), Vertical displacement due to uniformly loaded circular area at the surface, Vertical stress below a rectangular loaded area on the surface, Deflection due to a uniformly loaded flexible rectangular area, Stresses in a layered medium, Vertical stress at the interface of a three-layer flexible system and Distribution of contact stress over footings.

MODULE -IV: PORE WATER PRESSURE DUE TO UNDRAINED LOADING (9)

Introduction, Pore water pressure developed due to isotropic stress application, Pore water pressure parameter B, Pore water pressure due to uniaxial loading, Directional variation of A_f, Pore water pressure under triaxial test conditions, Henkel's modification of pore water pressure equation and Pore water pressure due to one-dimensional strain loading (Oedometer test).

MODULE -V: SETTLEMENT OF SHALLOW FOUNDATIONS (9)

Introduction, Elastic settlement: Modulus of elasticity and Poisson's ratio, Settlement based on theory of elasticity, Generalized average elastic settlement equation, Improved equation for elastic settlement, Calculation of elastic settlement in granular soil using simplified strain influence factor. Consolidation settlement: One-dimensional primary consolidation settlement calculation, Skempton–Bjerrum modification for calculation of consolidation settlement, Settlement of over consolidated clays, Settlement calculation using stress path, Comparison of primary consolidation settlement calculation procedures, Secondary consolidation settlement and Pre-compression for improving foundation soils.

IV. TEXT BOOKS:

1. Das, Braja M., and B. M. Das, "Advanced Soil Mechanics", Vol. 270. New York: Taylor & Francis, 2008.
2. Van Baars, Stefan, "Advanced Soil Mechanics" Neopubli, 2016.
3. Das, Braja M, "Principles of Geotechnical Engineering", Cengage learning, 2021.

V. REFERENCE BOOKS:

1. Terzaghi, Karl, Ralph B. Peck, and GholamrezaMesri, "Soil Mechanics in Engineering Practice", John Wiley & Sons, 1996.
2. Holtz, Robert D., William D. Kovacs, and Thomas C. Sheahan, "An Introduction to Geotechnical Engineering" Vol. 733. Englewood Cliffs: Prentice-Hall, 1981.

VI. WEB REFERENCES:

1. https://nptel.ac.in/courses/105/101/105101001/
2. https://nptel.ac.in/courses/nptel_download.php?subjectid=105101001

VII. E-TEXT BOOKS:

1. Mitchell, James Kenneth, and Kenichi Soga, "Fundamentals of Soil Behavior", Vol. 3. New York: John Wiley & Sons, 2005.
2. Das, Braja M., and Nagaratnam Sivakugan, "Principles of Foundation Engineering", Cengage learning, 2018.

REPAIR, REHABILITATION AND RETROFITTING OF STRUCTURES

VIII Semester: CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
ACEC51	Elective	3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

Prerequisite: Building Materials – Planning and Construction

I. COURSE OVERVIEW:

The primary objective of this course is to introduce the concept of Rehabilitation, retrofitting and study how to overcome the defects in regular construction practices, establish their effectiveness in overcoming the problems faced, study their efficiency. The course consists of Retrofitting components in addition to adapting new techniques in construction practices. Retrofitting aims to strengthen a structure to satisfy the requirements of the current codes for seismic design. In this respect, seismic retrofit is beyond conventional repair or even rehabilitation. The applications include different types of buildings, industrial structures, bridges, urban transport structures, marine structures and earth retaining structures. The benefits of retrofitting include the reduction in the loss of lives and damage of the essential facilities, and functional continuity of the life line structures. For an existing structure of good condition, the cost of retrofitting tends to be smaller than the replacement cost. Thus, the retrofitting of structures is an essential component of long term disaster mitigation.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The basic concepts of degradation, damage grades in civil structures for evaluating Structural performance by using rehabilitation and retrofitting methods.
II. The knowledge on structural maintenance, repairs and rehabilitation for obtaining assessment of damage in construction failure.
III. The mechanism of corrosion and surface deterioration in structures for preventing structural damage.
IV. The application of special materials for improving the performance of the traditional structures.
V. The application of modern techniques in existing structures for strengthening and demolition in real time situations

III.COURSE SYLLABUS:

MODULE –I: INTRODUCTION (9)

Deterioration of structures; distress in structures; causes and prevention, mechanism of damage; types of damage; damage under accidental and cyclic loads, cracking in structures, evaluation of damage.

MODULE -II: MAINTENANCE AND DIAGNOSIS OF FAILURE (9)

Maintenance, repair and rehabilitation, facets of maintenance, importance of maintenance, various aspects of inspection; Assessment procedure for evaluating a damaged structure; Diagnosis of construction failures.

MODULE -III: DAMAGES AND THEIR REMEDIES (9)

Corrosion damage of reinforced concrete, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, cathodic protection, rust eliminators.

Causes of deterioration of concrete, steel, masonry and timber structures, surface deterioration, efflorescence, causes and preventive measures; coatings for embedded steel and set concrete.

MODULE -IV: MATERIALS AND TECHNIQUES OF REPAIR (9)
Special concrete and mortar, concrete chemicals, expansive cement, polymer concrete sulphurinfiltrated concrete, ferro cement, fiber reinforced concrete, methods of repair in concrete, steel, masonry and timber structures. Gunite and shotcrete, epoxy injection.

MODULE -V: STRENGTHENING AND DEMOLITION ASPECT (9)
Strengthening of existing structures; repairs to overcome low member strength, deflection, cracking, chemical disruption, weathering, wear, fire, leakage, marine exposure, use of non-destructive testing techniques for evaluation, load testing of structure; demolition of structures using engineered and non-engineered techniques; case studies.

IV. TEXT BOOKS:

1. Shetty .M.S., "Concrete, Technology, Theory and Practice", S.Chand and Company, New Delhi 2010
2. Allen .R.T. and Edwards .S.C., "Repair of Concrete Structures", Blakie and Sons, UK 1987.

V. REFERENCE BOOKS:

1. Raiker .R.N. "Learning from Failures, Deficiencies in Design, Construction and Service", R&D Centre (SDCPL), RaikarBhavan, Bombay 1987.
2. Compbell, Allen and Itarold Roper, "Concrete Structures Materials Maintenance and Repair" Longman Scientific and Technical UK 1991.

VI. WEB REFERENCES:

1. cpwd.gov.in/Units/handbook.pdf
2. http://www.alljntuworld.in/wpcontent/uploads/2016/01/RehabilitationandRetrofittingofStructuresNotes.pdf
3. http://www.tn.gov.in/tsunami/digitallibrary/ebooksweb/04%20REPAIR_RESTORATION_AND_RETROFITTIN.pdf

VII. E-TEXT BOOKS:

1. https://books.google.co.in/books/about/Case_Studies_of_Rehabilitation_Repair_Re.html?id=zraEpIyEpCYC
2. https://books.google.co.in/books/about/Retrofitting_Design_of_Building_Structur.html?id=5XhbZW6JS4YC&redir_esc=y
3. https://books.google.es/books/about/Concrete_Repair_Rehabilitation_and_Retro.html?hl=es&id=nwbNBQAAQBAJ

GREEN BUILDING TECHNOLOGIES

VIII Semester: CE									
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC52	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisite: No prerequisites required								

I. COURSE OVERVIEW:

The course is structured to accommodate the interests and skills of those who are related to building design and technology and building energy and environmental performance. The strong emphasis is targeted to successful integration of renewable and sustainable energy technologies into buildings, which requires an understanding of both design and technology and hence the close co-operation of architecture and engineering.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The use of natural resources to the minimal at the time of construction as well as operation.
II. The importance of Green buildings which emphasize on the resource usage efficiency and also press upon the three R's - Reduce, Reuse and Recycle.
III. The minimization of negative impact on the environment by the construction and operation of a building.
IV. The Hygiene and proper conditions inside the building also help in boosting human productivity.

III.COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO GREEN BUILDINGS (09)

Definition of green buildings and sustainable development, typical Features of green buildings, benefits of green buildings towards sustainable development. Green building rating systems – GRIHA, IGBC and LEED, overview of the criteria as per these rating systems.

MODULE-II: SITE SELECTION AND PLANNING(09)

Criteria for site selection, preservation of landscape, soil erosion control, minimizing urban heat island effect, maximize comfort by proper orientation of building facades, day lighting, ventilation, etc. Water conservation and efficiency: Rainwater harvesting methods for roof & non-roof, reducing landscape water demand by proper irrigation systems, water efficient plumbing systems, water metering, waste water treatment, recycle and reuse systems.

MODULE-III: ENERGY EFFICIENCY (09)

Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy.

Methods to reduce operational energy: Energy efficient building envelopes, efficient lighting technologies, energy efficient appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings.

MODULE-IV: BUILDING MATERIALS (09)

Methods to reduce embodied energy in building materials: Use of local building materials, Use of natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks, use of materials with recycled content such as blended cements, pozzolana cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. Reuse of waste and salvaged materials. Waste

Management: Handling of construction waste materials, separation of household waste, on-site and off-site organic waste management

MODULE-V: INDOOR ENVIRONMENTAL QUALITY (09)

Indoor Environmental Quality for Occupant Comfort and Wellbeing: Day lighting, air ventilation, Exhaust systems, low VOC paints, materials & adhesives, building acoustics. Codes related to green Buildings: NBC, ECBC, ASHRAE, UPC etc.

IV.TEXT BOOKS:

1. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, Indian GreenBuildingCouncil Publishers, 2013.
2. K.S. Jagadish, B.V. Venkatarama Reddy andK.S. Nanjunda Rao, Alternative building materials and technologies, 2008.

V. REFERENCE BOOKS:

1. Green Rating for Integrated Habitat Assessment, GRIHA version, GRIHA rating system, 2015.
2. Sustainable Building Design Manual, Vol.1 and 2, TERI, New Delhi 2004.

VI. Web References:

1. https://juniperpublishers.com/cerj/pdf/CERJ.MS.ID.555638.pdf
2. http://granthaalayah.com/Articles/Vol3Iss9SE/14_IJRG15_S09_32.pdf
3. https://www.worldgbc.org/sites/default/files/World%20Green%20Building%20Trends%202018%20SMR%20FINAL%2010-11.pdf

VII. E-Text Books:

1. https://igbc.in/igbc/html_pdfs/abridged/IGBC%20Green%20Homes%20%20Abridged%20Reference%20Guide%20(Version%202.0).pdf
2. https://www.grihaindia.org/griha-rating

STRUCTURAL ANALYSIS BY MATRIX METHODS

<table>
<tr><td colspan="9">VIII Semester: CE</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">ACEC53</td><td rowspan="2">Elective</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
<tr><td colspan="9">Prerequisite: Analysis of Structures</td></tr>
</table>

I. COURSE OVERVIEW:

This is a second level course on structural analysis. Herein the concept of matrix methods (flexibility and stiffness methods) of structural analysis with application in various structural components will be discussed. Matrix methods of structural analysis are used for the analysis of the framed structures, i.e., structures composed of one-dimensional elements. The solution procedures used in this method are systematic and general. Hence, it is easier to write computer programs using this method. This course will serve as a bridge between structural analysis 1 (the first course on structural analysis) and more advance topic such as finite element method.

II. COURSE OBJECTIVES:

The Students will try to learn:

I. The concept of flexibility and stiffness matrices, force and displacement for use in the analysis of continuous beams and frames.
II. The concepts of flexibility or force method for analyzing the components of various structural elements.
III. The concepts of stiffness or displacement method for analyzing the components of various structural elements.
IV. The analysis of multi-storey rigid jointed frames by approximate methods such as prtal, cantilever and substitute frame methods.

III.COURSE SYLLABUS:

MODULE - I INTRODUCTION TO FORCE AND DISPLACEMENT (9)

Introduction to system approach: Force and Displacement methods.

MODULE – II: FLEXIBILITY METHOD (9)

Matrix Force Method: Introduction to flexibility approach, Choice of redundant, static equilibrium matrix, deformation compatibility matrix, member flexibility matrix, static equilibrium and deformation compatibility checks. Application continuous beams.

MODULE –III: STIFFNESS METHOD (9)

Matrix Displacement or Stiffness Method: Introduction to displacement approach, calculation of kinematic indeterminacy, development of stiffness matrices for continuous beams.

Development of matrix displacement approach and application to continuous beams.

MODULE –IV: ANALYSIS OF RIGID FRAMES BY FLEXIBILITY AND STIFFNESS METHODS (9)

Analysis of single storey, single bay portal frames by flexibility and stiffness matrix methods.

MODULE – V: APPROXIMATE METHODS OF ANALYSIS (9)

Analysis of multi-storey frames for lateral loads: Portal method and Cantilever method; Analysis of multi-storey frames for gravity loads : Substitute frame method.

IV. TEXT BOOKS:

1. A.K.Jain , “Advanced Structural Analysis”, Nem Chand and Brosi Publications, 3rd Edition, 2015.
2. DevdasMenon, “Advanced Structural Analysis”, Narosa Publishers, 1st Edition, 2009.
3. S. S. Bhavikatti, “Structural Analysis Vol.2”, Vikas Publishing House, New Delhi, 3rd Edition 2011.
4. R. C. Hibbler, “Structural Analysis”, Pearson Education, India, 9th Edition, 2012

V. REFERENCE BOOKS:

1. T. S. Thandavamoorthy, “Structural Analysis”, Oxford Higher Education, India, 2nd edition 2011.
2. C. S. Reddy , “Basic Structural Analysis”, McGraw Hill Education (India), Delhi, 3rd Edition, 2011
3. C. K. Wang, “Intermediate Structural Analysis”, McGraw Hill Education (India), Delhi, 2nd Edition, 1983

VI. WEB REFERENCES:

1. https://lecturenotes.in/subject/154/structural-analysis-1-sa-1
2. https://nptel.ac.in/downloads/105101085/
3. http://www.ce.memphis.edu/3121

VIII. E-TEXT BOOKS:

1. https://www.kopykitab.com/Structural-Analysis-I-by-S-S-Bhavikatti
2. https://www.pdfdrive.com/fundamental-structural-analysis-e25550099.html

DESIGN OF BRIDGE STRUCTURES

VIII Semester: CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACEC54	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisite: Reinforced Concrete Structures Design and Drawing								

I. COURSE OVERVIEW:

The course of Bridge Engineering comprises the study of different types of bridges and their components. It involves the thorough understanding of various classes of loading as mentioned in IRC codes. This course mainly discusses the design of box culvert, deck slab bridge subjected to Class AA tracked vehicle, design of T-beam bridge using Pigeaud's method. It also discusses the design of design of a deck type welded plate girder bridge of single line B.G, **d**esign of composite bridges consisting of RCC slabs over steel girders including shear connectors. It includes the discussion on various types of bridge bearings and stability analysis of piers and abutments.

II. COURSE OBJECTIVES:

The Students will try to learn:

I. The importance of site investigation and various loads, as per IRC, to be considered in bridge design.
II. Various design aspects of box-culvert, deck slab and T-beam bridges.
III. The design of plate girder bridges and composite bridges with shear connectors.
IV. Functions of bridge bearings and stability analysis of piers, abutments and wing- wall.

III. COURSE SYLLABUS:

MODULE – I: INTRODUCTION (9)

Introduction: Importance of site investigation in Bridge design, Highway Bridge loading standards, Railway Bridge loading standards (BG, MG), various loads in bridges, Impact factor. Box culvert: General aspects: Design loads, Design of Box culvert subjected to IRC classAA tracked vehicle only.

MODULE – II: DECK SLAB BRIDGE (9)

Deck slab bridge: Introduction, Effective width method of Analysis, Design of deck Slab Bridge (Simply supported) subjected to class AA Tracked Vehicle only.

MODULE –III: BEAM & SLAB BRIDGE (T-BEAM BRIDGE) (9)

Beam & slab bridge (T-beam bridge): General features, Design of interior panel of slab, (Pigeauds method).

Design of a T-beam bridge subjected to IRC class AA tracked vehicle only.

MODULE –IV: PLATE GIRDER BRIDGE AND COMPOSITE BRIDGES(9)

Plate girder bridge: Introduction, Elements of a plate girder and their design, Design of a Deck type welded plate girder bridge of single line B.G. Composite bridges: Introduction, Advantages, Design of Composite Bridges consisting of RCC slabs over steel girders including shear connectors.

MODULE – V: BRIDGE BEARINGS, PIERS AND ABUTMENTS(9)

Bridge bearings: General features, Types of Bearings, Design principles of steel Rocker & Roller Bearings, Design of a steel Rocker Bearing, Design of Elastomeric pad Bearing. Piers &abutments: General features, Bed Block, Types of piers, Forces acting on piers, Stability analysis of piers, forces acting on abutments, Stability analysis of abutments, Types of wing walls, Approaches, Types of Bridge foundations (excluding Design).

IV. TEXT BOOKS:

1. D. Johnson Victor, "Essentials of Bridge Engineering", Oxford Publishers, 6th Edition, 2017.
2. T.R.Jagadeesh& M.A Jairam, "Design of Bridge Structures", Prentice Hall India Learning Private Limited, 2nd Edition, 2009.
3. N.KrishnaRaju, "Design of Bridges", Oxford &IBH Publishing Co Pvt.Ltd, 5th Edition, 2017.
4. S. Ponnuswamy, "Bridge Engineering", McGraw Hill Education, 3rd Edition, 2017.

V. REFERENCE BOOKS:

1. Rangwala, "Bridge Engineering", Charotar Publishing House Pvt. Ltd, 16th Edition, 2015.
2. S.P.Bindra, "Principles and Practice of Bridge Engineering", DhanpatRai Publications, 1stEdition,2012.
3. N.KrishnaRaju, "Prestressed Concrete Bridges", CBS publishers, 1st Edition, 2010.
4. M.K. Pant, "Elements of Bridge Engineering", S.K. Kataria & Sons, 1st Edition, 2014.

VI. WEB REFERENCES:

1. https://nptel.ac.in/courses/105105165/

VII. E-TEXT BOOKS:

1. https://books.google.co.in/books?id=FNl04EyZ7iEC&printsec=frontcover&source=gbs_ge_summary_r&cad=

SOFT SKILLS AND INTERPERSONAL COMMUNICATION

<table>
<tr><td colspan="10">OE – I: VI Semester: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT
OE –II: VII Semester: ECE / EEE
OE – III: VIII Semester: AERO / MECH / CIVIL</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">AHSC15</td><td rowspan="2">Elective</td><th>L</th><th>T</th><th>P</th><th>C</th><th>CIA</th><th>SEE</th><th>Total</th></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
</table>

I. COURSE OVERVIEW:

The objectives of the Soft Skills and Interpersonal Communication are to give each student a realistic perspective of work and work expectations, to help formulate problem solving skills, to guide students in making appropriate and responsible decisions, to create a desire to fulfill individual goals, and to educate students about unproductive thinking, self-defeating emotional impulses, and self- defeating behaviors.

II. COURSE OBJECTIVES:

The students will try to learn:

I. How to communicate in a comprehensible English accent and pronunciation.
II. The four language skills i.e., Listening, Speaking, Reading and Writing effectively.
III. The art of interpersonal communication skills to avail the global opportunities.
IV. The understanding of soft skills resulting in an overall grooming of the skills.

III. SYLLABUS

MODULE-I: SOFT SKILLS (09)

Soft Skills: An Introduction – Definition and Significance of Soft Skills; Process, Importance and Application of Soft Skills, Discovering the Self; Setting Goals; Positivity and Motivation: Developing Positive Thinking and Attitude.

MODULE –II: EFFECTIVENESS OF SOFT SKILLS (09)

Developing interpersonal relationships through effective soft skills; Define Listening, Speaking, Reading and Writng skills; Barriers to Listening, Speaking, Reading and Writing; Essential formal writing skills; Public Speaking: Skills, Methods, Strategies and Essential tips for effective public speaking.

MODULE-III: ORAL AND AURAL SKILLS (09)

Vocabulary:
Sounds of English vowels sounds and constant sounds, Word Accent and connected speech- contractions, questions tags, Listening for information, Taking notes while listening to lectures (use of Dictionary).

Group Discussion: Importance, Planning, Elements, Skills, Effectively disagreeing, Initiating.

MODULE-IV: VERBAL AND NON-VERBAL COMMUNICATION (09)

Interpersonal communication-verbal and nonverbal etiquette; Body language, grapevine, Postures, Gestures, Facial expressions, Proximity; Conversation skills, Critical thinking, Teamwork, Group Discussion, Impact of Stress; Measurement and Management of Stress.

MODULE-V: INTERPERSONAL COMMUNICATION (09)

Significance; Effectiveness of writing; Organizing principles of Paragraphs in documents; Writing introduction and conclusion; Techniques for writing precisely; Letter writing; Formal and Informal letter writing; E-mail writing, Report Writing.

IV. TEXT BOOKS:

Handbook of English for Communication (Prepared by Faculty of English, IARE)

V. REFERENCE BOOKS:

1. Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2. Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3. Klaus, Peggy, Jane Rohman & Molly Hamaker. "The Hard Truth about Soft Skills", London: HarperCollins E-books, 2007.
4. Stein, Steven J. & Howard E. Book. "The EQ Edge: Emotional Intelligence and Your Success" Canada: Wiley & Sons, 2006
5. Suresh Kumar. English for Success. Cambridge University Press IndiaPvt.Ltd.2010.
6. Dorling Kindersley. Communication Skills & Soft Skills - An Integrated Approach. India Pvt. Ltd. 2013.

VI. WEB REFERENCES:

1. www.edufind.com
2. www.myenglishpages.com
3. http://grammar.ccc.comment.edu
4. http://owl.english.prudue.edu

VII. E-Text Books:

1. http://bookboon.com/en/communication-ebooks-zip
2. http://www.bloomsbury-international.com/images/ezone/ebook/writing-skills-pdf.pdf
3. https://americanenglish.state.gov/files/ae/resource_files/developing_writing.pdf
4. http://learningenglishvocabularygrammar.com/files/idiomsandphraseswithmeaningsandexamplespdf.pdf
5. http://www.robinwood.com/Democracy/General Essays/CriticalThinking.pdf

CYBER LAW AND ETHICS

<table>
<tr><td colspan="9">OE – I: VI Semester: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT
OE –II: VII Semester: ECE / EEE
OE –III: VIII Semester: AERO / MECH / CIVIL</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">AHSC16</td><td rowspan="2">Elective</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
</table>

I. COUSRE OVERVIEW

This course consists of a sustained study of ethical and legal issues that arise in relation to employment in the public and private sectors, including allocation of resources, corporate and social responsibility, relationships, and discrimination. The main focus of this course will be on the ethical and legal standards governing information technology. New technology creates ethical challenges for individuals around the globe, and applies to most persons regardless of whether they are employed in the information technology field or a more traditional occupation. The study of this course provides a framework for making ethical decisions that professionals are likely to encounter in the workplace. This course will not only focus on ethics but on the legal, economic, social, cultural and global impacts of decisions that are made in the context of professional occupations.

II. COUSRE OBJECTIVES:

The students will try to learn:

I. The key terms and concepts in cyber society, cyber ethics.
II. The fundamentals of Cyber Law
III. The importance of nine P's in ethics.
IV. The artificial intelligence and Blockchain ethics.

III. SYLLABUS

MODULE-I: CYBER SOCIETY (09)

Definitions, Specificities of the Cyberspace, Dimensions of Cyber Ethics in Cyber Society, Fourth Industrial Revolution, Users' Motivations in Cyber-Space, Core Values and Virtues, Old Values or Eschatological Vision?, Cyber Ethics by Norms, Laws and Relations Artificial Intelligence Ethics: "AI for Good", Cyber-Capitalism: Cyber-Ethics as Business Ethics.

MODULE-II: CYBER LAW AND CYBER ETHICS (09)

Cyber Law and Cyber Ethics

The importance of cyber law, the significance of cyber ethics, cyber crime is unethical and illegal, ethics education has positive impact, the need for cyber regulation based on cyber ethics, very dangerous times.

MODULE-III: ETHICS IN THE INFORMATION SOCIETY, THE NINE P'S (09)

Principles: ethical values, participation: access to knowledge for all, people: community, identity, gender, generation, education, profession: ethics of information professions, privacy: dignity, data mining, security.

Piracy: intellectual property, cybercrime, protection: children and young people, power: Economic power of technology, media and consumers, policy: ethics of regulation and freedom.

MODULE-IV: DISRUPTIVE CYBER TECHNOLOGIES AND AI ETHICS (09)

Disruptive Cyber Technologies and Ethics -I

Artificial: negative moral judgment?, artificial: ethically positive innovation?, intelligence: action-oriented ability, creation story: human beings responsibility, the commandment to love and artificial intelligence;

Artificial Intelligence Ethics: Top nine ethical issues in artificial intelligence, five core principles to keep AI ethical, ethics should inform AI, but which ethics?

MODULE-V: DISRUPTIVE CYBER TECHNOLOGIES AND ETHICS –II (09)
Disruptive Cyber Technologies and Ethics -II
BLOCKCHAIN ETHICS:
Blockchain definition and description, Blockchain anonymity and privacy: ethical, no possibility to be forgotten, Blockchain for voting, Blockchain for transparent trade tracing, Blockchain energy: environmental impact, decentralized or majority-owned, ethically more benefits or dangers, future jobs in cyber society.

IV. TEXT BOOKS:

1. Christoph Stuckelberger, Pavan Duggal, "Cyber Ethics 4.0 Serving Humanity with Values", Globethics.net Global Series, 2018.

V. REFERENCE BOOKS:

1. Dr. Farooq Ahmad, Cyber Law in India, Allahbad Law Agency- Faridabad.
2. J.P. Sharma, SunainaKanojia, Cyber Laws
3. Harish Chander , Cyber Laws and IT Protection.

VI. E-REFERENCE:

https://www.globethics.net/documents/4289936/13403236/Ge_Global_17_web_isbn9782889312641.pdf/

ECONOMIC POLICIES IN INDIA

OE – I: VI Semester: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT **OE –II:** VII Semester: ECE / EEE **OE –III:** VIII Semester: AERO / MECH / CIVIL								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AHSC17	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		

I. COURSE OVERVIEW

The objective of this course is to provide a broad sweep of the concept, structure and trends in the Indian economy in a roughly chronological manner. It begins with a review of the evolution of the Indian economy during colonial rule and introduces the roots of Indian underdevelopment. This course is designed to acquaint the students in a comprehensive manner with different aspects of Indian economy. The policy issues and measure to understand economic initiatives for improving economic development and growth, agriculture and industry, planning of the different sectors of the economy and the place of Indian economy in the international level particularly after economic reforms and covered.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The economic development elements and its measures
II. The inside knowledge on monetary policy and its importance in economic development
III. The importance of fiscal policies in promoting the economy
IV. The policies and practices in resource base infrastructure
V. The industrial and exit policies related to the industries

III. SYLLABUS

MODULE-I: INTRODUCTION ECONOMIC DEVELOPMENT AND ITS DETERMINANTS (09)

Approaches to economic development and its measurement – sustainable development; Role of State, market and other institutions; Indicators of development – PQLI, Human Development Index (HDI), gender development indices.

MODULE-II: MONEY, BANKING AND PRICES (09)

Analysis of price behavior in India; Financial sector reforms; Interest rate policy; Review of monetary policy of RBI; Money and capital markets; Working of SEBI in India.

MODULE-III: FISCAL POLICY AND PUBLIC FINANCES (09)

Fiscal federalism – Centre-State financial relations; Finances of central government; Finances of state governments; Parallel economy; Problems relating to fiscal policy; Fiscal sector reforms in India.

MODULE-IV: RESOURCE BASE AND INFRASTRUCTURE (09)

Energy; social infrastructure – education and health; Environment; Regional imbalance; Issues and policies in financing infrastructure development. Policies and Performance in Industry Growth; productivity; diversification; small scale industries; public sector; competition policy; foreign investment.

MODULE-V: THE INDUSTRIAL AND EXIT POLICIES (09)

Industrial policy; Public Sector enterprises and their performance; Problem of sick units in India; Privatization and disinvestment debate; Growth and pattern of industrialization; Small-scale sector; Productivity in industrial sector; Exit policy – issues in labour market reforms; approaches for employment generation.

IV. TEXT BOOKS:

1. The Wealth of Nations-Adam Smith, introduction by Alan B Krueger.
2. The Strength of Economic Development by Albert Hirschman.
3. Money, Banking and Public Finance by Dr. V.C.Sinha
4. Government of India, Economic Survey (Annual), Ministry of Finance, New Delhi.
5. Jain, a. K. (1986), Economic Planning in India, Ashish Publishing House, New Delhi.

V. REFERENCE BOOKS:

1. Ahluwalia, I. J. and I. M. D Little (Eds.) (1999), India's Economic Reforms and Development (Essays in honour of Manmohan Singh), Oxford University Press, New Delhi.
2. Bardhan, P. K. (9th Edition) (1999), The Political Economy of Development in India, Oxford University Press, New Delhi.
3. Bawa, R. s. and P. S. Raikhy (Ed.) (1997), Structural Changes in Indian Economy, Guru Nanak Dev University Press, Amritsar.
4. Brahmananda, P. R. and V. R. Panchmukhi (Eds.) (2001), Development Experience in the Indian Economy: Inter-State Perspectives, Book well, Delhi.
5. Chakravarty, S. (1987), Development Planning: The Indian Experience, Oxford University Press, New Delhi.
6. Dantwala, M. L. (1996), Dilemmas of Growth: The Indian Experience, Sage Publications, New Delhi.
7. Datt, R. (Ed.) (2001), Second Generation Economic Reforms in India, Deep & Deep Publications, New Delhi.

VI. WEB REFERENCE:

1. Parikh, K. S. (1999), India Development Report – 1999-2000, Oxford University Press, New Delhi8.
2. Reserve Bank of India, Report on Currency and Finance, (Annual).
3. Sandesara, J. c. (1992), Industrial Policy and Planning, 1947-19919 : Tendencies, Interpretations and Issues, Sage Publications, New Delhi.

GLOBAL WARMING AND CLIMATE CHANGE

<table>
<tr><td colspan="10">OE – I: VI Semester: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT
OE –II: VII Semester: ECE / EEE
OE –III: VIII Semester: AERO / MECH / CIVIL</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">AHSC18</td><td rowspan="2">Elective</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
</table>

I. COURSE OVERVIEW

This course aims to address the whole complexity of climate change as an issue, by bringing together the science, impacts, economics, abatement technologies, and policy solutions. The course will address several important questions like what is the scientific basis for our understanding of climate change, and in what ways is that scientific basis uncertain. What changes in climate might we expect over the coming centuries? What would be the impacts of these changes in climate for human well-being and the natural world? What are the sources of emissions of greenhouse gases? What technologies exist or might be developed to allow us to slow climate change, and what international policy solutions might be necessary or preferred?

II. COURSE OBJECTIVES:

The students will try to learn:

I. The importance of Ozone layer in the atmosphere.
II. The comprehend composition of atmosphere.
III. The impacts of climate change on ecosystem.
IV. The initiatives taken by different countries to reduce emission of greenhouse gases.

III. SYLLABUS:

MODULE – I: EARTH’S CLIMATE SYSTEM (09)

Role of ozone in environment, Ozone layer – Ozone depleting gases, Green House Effect – Radioactive effects of Greenhouse gases, The Hydrological cycle, Green House Gases and Global Warming, Carbon Cycle.

MODULE –II: ATMOSPHERE AND ITS COMPONENTS (09)

Importance of Atmosphere – Physical and chemical characteristics of Atmosphere, Vertical structure of the atmosphere, Composition of the atmosphere, Atmospheric stability, Temperature profile of the atmosphere, Lapse rates, Temperature inversion, Effects of inversion on pollution dispersion.

MODULE – III: IMPACTS OF CLIMATE CHANGE (09)

Causes of Climate change: Changes of Temperature in the environment, Melting of ice pole, sea level rise, Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem, Water Resources, Human Health, Industry, Settlement and Society.

Methods and Scenarios, Projected Impacts for different regions, Uncertainties in the projected impacts of Climate Change, Risk of Irreversible Changes.

MODULE – IV: OBSERVED CHANGES AND ITS CAUSES (09)

Climate change and Carbon credits, CDM – Initiatives in India-Kyoto Protocol, Paris Convention - Intergovernmental Panel on Climate change, Climate Sensitivity and Feedbacks. The Montreal Protocol – UNFCCC – IPCC – Global Climate Models (GCM) - Evidences of Changes in Climate and Environment- on a Global scale and in India.

MODULE – V: CLIMATE CHANGE AND MITIGATION MEASURES (09)

Clean Development Mechanism, Carbon Trading – Examples of future clean technology, Biodiesel – Natural Compost, Eco-friendly plastic, Alternate Energy –Hydrogen, Bio-fules, Solar Energy, Wind and Hydroelectric Power. Mitigation Efforts in India and Adaptation funding. Key Mitigation Technologies and Practices –

Energy Supply, Transport, Buildings, Industry, Agriculture, Forestry – Carbon sequestration, Carbon capture and storage (CCS), Waste (MSW & Bio-waste, Biomedical, Industrial waste) – International and Regional cooperation.

IV. TEXT BOOKS:

1. Dr. Sushil Kumar Dash, "Climate Change: An Indian Perspective (Environment and Development)", Cambridge University Press India Pvt Ltd, 2007.
2. Adaptation and mitigation of climate change – Scientific Technical Analysis, Cambridge University Press, Cambridge, 2006.

V. REFERENCE BOOKS:

1. Atmospheric Science, J.M. Wallace and P.V Hobbs, Elsevier/ Academic Press, 2006.
2. "Climate Change and Climate Variability on Hydrological Regimes", Jan C. Van Dam, Cambridge University Press, 2003.

VI. E-TEXT BOOKS

1. https://www.worldcat.org/title/encyclopedia-of-global-warming-climate-change/oclc/805580328
2. https://libguides.nus.edu.sg/c.php?g=433566&p=2955835

INTELLECTUAL PROPERTY RIGHTS

OE – I: VI Semester: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT OE –II: VII Semester: ECE / EEE OE –III: VIII Semester: AERO / MECH / CIVIL								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AHSC19	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		

I. COUSRE OVERVIEW:

The course will cover the philosophy of intellectual property rights, various technical and legal dimensions of IPR, and implications of IPR for growth and development of science, along with the various socio-economic and ethico-legal consequences of IPR on economic development. Students can also get disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects and also aware about current trends in IPR and Govt. steps in fostering IPR.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The knowledge in world trade organization and agreements between nations.
II. The intellectual property with international trade agreements.
III. The different types of intellectual property rights.
IV. The different laws in protection of intellectual property rights and its implementation.

III. SYLLABUS:

MODULE- I: INTRODUCTION (10)

General agreement on tariffs and trade (GATT) eight rounds: Uruguay round, world trade organization: structure, technology transfer, dispute resolution mechanism, Doha declaration world trade organization agreements including trade related intellectual properties rights and trade related investment measures.

MODULE- II: WORLD INTELLECTUAL PROPERTY ORGANIZATION (08)

Paris convention, Bern convention, Budapest treaty, Madrid agreement, huge agreement.

MODULE- III: PATENTS (09)

Historical background of intellectual property rights, introduction, definition and classification of intellectual property, patents, patentable and non-patentable inventions. Legal requirements for patents, types of patent applications.

Patent document: specification and claims, important procedural aspects, management of intellectual property rights assets and intellectual property portfolio, commercial exploitation of intellectual property.

MODULE- IV: DESIGNS AND GEOGRAPHICAL INDICATIONS (10)

Designs: basic requirements, procedure, convention application term, date, geographical indication: definition, what can be registered, who can apply, rights, term, restrictions.

MODULE- V: TRADEMARK AND COPYRIGHTS (08)

Definition, classification of trademarks, classifications of goods and services, Vienna classification, trademarks procedure, trademarks enforcement: infringement and passing off, remedies, copyrights, term of copyrights, and procedure of copyright assignment of copyright, copyright infringement remedies.

IV. TEXT BOOKS:

1. P. K. Vasudeva,World Trade Organization: Implications on Indian Economy, Pearson Education,2015.
2. P.KrishnaRao, WTO, Text and cases, Excel Books, 2015.
3. Carlos M.Correa- Intellectual property rights, The WTO and Developing countries-Zed books.

V. REFERENCE BOOKS:

1. Caves, Frankel, Jones, World Trade and Payments-An Introduction, Pearson4. Education, 2015.
2. Carlos M.Correa- Intellectual property rights, The WTO and Developing countries-Zed books.
3. Peter-Tobias stoll, Jan busche, Katrianarend- WTO- Trade –related aspects of IPR- Library of Congress.

VI. WEB REFERENCES:

1. http://www.ebooks directory.com
2. http://Campus guides.lib.utah.edu

VII. E-Text Books:

1. http://www.bookboon.com
2. http://www.freemagagement.com
3. http://www.emeraldinsight.com

ENTREPRENEURSHIP

<table>
<tr><td colspan="10">OE – I: VI Semester: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT
OE –II: VII Semester: ECE / EEE
OE –III: VIII Semester: AERO / MECH / CIVIL</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">AHSC20</td><td rowspan="2">Elective</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
</table>

I. COURSE OVERVIEW:

This course aims to provide students with an understanding of the nature of enterprise and entrepreneurship and introduces the role of the entrepreneur, will inculcate the knowledge of government supporting programs. Apart from this, students learn about the women entrepreneurs and success stories of women entrepreneurs, gain the knowledge of project management and profitability appraisal, focus on importance of training the new entrepreneurs as well as existing entrepreneurs. The students can also acquire necessary knowledge and skills required for organizing and carrying out entrepreneurial activities, for analysing and understanding business situations in entrepreneurs act and to master the knowledge necessary to plan entrepreneurial activities. The objective of the course is, to develop the ability of analysing various aspects of entrepreneurship – especially of taking over the risk, and the specificities as well as the pattern of entrepreneurship development and, finally, to contribute to their entrepreneurial and managerial potentials.

II. COUSRE OBJECTIVES:

The students will try to learn:

I. The Entrepreneurial process and also inspire them to be Entrepreneurs.
II. The key steps in the elaboration of business idea.
III. The stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.

III. SYLLABUS:

MODULE-I: UNDERSTANDING ENTREPRENEURIAL MINDSET (09)

The revolution impact of entrepreneurship- The evolution of entrepreneurship - Functions of Entrepreneurs – types of entrepreneurs -Approaches to entrepreneurship- Process approach- Role of entrepreneurship in economic development- Twenty first century trends in entrepreneurship.

MODULE-II: INDIVIDUAL ENTREPRENEURIAL MIND-SET AND PERSONALITY (09)

The entrepreneurial journey Stress and the entrepreneur - the entrepreneurial ego - Entrepreneurial motivations- Motivational cycle – Entrepreneurial motivational behavior – Entrepreneurial competencies. Corporate Entrepreneurial Mindset, the nature of corporate entrepreneur- conceptualization of corporate entrepreneurship Strategy-sustaining corporate entrepreneurship.

MODULE-III: LAUNCHING ENTREPRENEURIAL VENTURES (09)

Opportunities identification- Finding gaps in the market place – techniques for generating ideas- entrepreneurial Imagination and Creativity- the nature of the creativity process - Innovation and entrepreneurship.

Methods to initiate Ventures- Creating new ventures-Acquiring an Established entrepreneurial venture- Franchising- advantage and disadvantages of Franchising.

MODULE-IV: LEGAL CHALLENGES OF ENTREPRENEURSHIP (09)
Intellectual property protection - Patents, Copyrights - Trademarks and Trade secrets - Avoiding trademark pitfalls. Feasibility Analysis - Industry and competitor analysis - Formulation of the entrepreneurial Plan- The challenges of new venture start-ups, developing an effective business model – Sources of finance - Critical factors for new venture development - The Evaluation process.

MODULE-V: STRATEGIC PERSPECTIVES IN ENTREPRENEURSHIP (09)
Strategic planning - Strategic actions strategic positioning- Business stabilization - Building the adaptive firms - Understanding the growth stage – Internal growth strategies and external growth strategies, Unique managerial concern of growing ventures. Initiatives by the Government of India to promote entrepreneurship, Social and women entrepreneurship.

IV. TEXT BOOKS:

1. D F Kuratko and T V Rao, "Entrepreneurship- A South-Asian Perspective", Cengage Learning, 2012.
2. Bruce R. Barringer/ R.Duane Ireland, "Entrepreneurship Successfully Launching New Ventures", Pearson, 4th Edition, 2015.
3. S.S.Khanka, Entrepreneurship Development, S. Chand Publications, 2015.

V. REFERENCE BOOKS:

1. Stuart Read, Effectual Entrepreneurship, Routledge, 2013.
2. Rajeev Roy, Entrepreneurship, Oxford publications, 2nd Edition, 2012.
3. Nandan .H, Fundamentals of Entrepreneurship, PHI, 2013.

PROJECT WORK - II

<table>
<tr><td colspan="9">VIII Semester: Common for all branches</td></tr>
<tr><th>Course Code</th><th>Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><td rowspan="2">ACEC55</td><td rowspan="2">Project</td><td>L</td><td>T</td><td>P</td><td>C</td><td>CIA</td><td>SEE</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>16</td><td>8</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: Nil</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: 180</td><td colspan="3">Total Classes: 180</td></tr>
</table>

The object of Project Work II & Dissertation is to enable the student to extend further the investigative study taken up under CE P1, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under CE P1;
2. Review and finalization of the Approach to the Problem relating to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including team work;
4. Detailed Analysis / Modeling / Simulation / Design / Problem Solving / Experiment as needed;
5. Final development of product/process, testing, results, conclusions and future directions;
6. Preparing a paper for Conference presentation/Publication in Journals, if possible;
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar Presentation before a Departmental Committee.

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

UNDERTAKING BY STUDENT / PARENT

"To make the students attend the classes regularly from the first day of starting of classes and be aware of the College regulations, the following Undertaking Form is introduced which should be signed by both student and parent. The same should be submitted to the Dean of Academic".

I, Mr. / Ms. --- joining I Semester / III Semester for the academic year 20 - 20 / 20 - 20 in Institute of Aeronautical Engineering, Hyderabad, do hereby undertake and abide by the following terms, and I will bring the ACKNOWLEDGEMENT duly signed by me and my parent and submit it to the Dean of Academic.

1. I will attend all the classes as per the timetable from the starting day of the semester specified in the institute Academic Calendar. In case, I do not turn up even after two weeks of starting of classes, I shall be ineligible to continue for the current academic year.
2. I will be regular and punctual to all the classes (theory/laboratory/project) and secure attendance of not less than 75% in every course as stipulated by Institute. I am fully aware that an attendance of less than 65% in more than 60% of theory courses in a semester will make me lose one year.
3. I will compulsorily follow the dress code prescribed by the college.
4. I will conduct myself in a highly disciplined and decent manner both inside the classroom and on campus, failing which suitable action may be taken against me as per the rules and regulations of the institute.
5. I will concentrate on my studies without wasting time in the Campus/Hostel/Residence and attend all the tests to secure more than the minimum prescribed Class/Sessional Marks in each course. I will submit the assignments given in time to improve my performance.
6. I will not use Mobile Phone in the institute premises and also, I will not involve in any form of ragging inside or outside the campus. I am fully aware that using mobile phone to the institute premises is not permissible and involving in Ragging is an offence and punishable as per JNTUH/UGC rules and the law.
7. I declare that I shall not indulge in ragging, eve-teasing, smoking, consuming alcohol drug abuse or any other anti-social activity in the college premises, hostel, on educational tours, industrial visits or elsewhere.
8. I will pay tuition fees, examination fees and any other dues within the stipulated time as required by the Institution / authorities, failing which I will not be permitted to attend the classes.
9. I will not cause or involve in any sort of violence or disturbance both within and outside the college campus.
10. If I absent myself continuously for 3 days, my parents will have to meet the HOD concerned/ Principal.
11. I hereby acknowledge that I have received a copy of IARE – UG20 Academic Rules and Regulations, Syllabus copy and hence, I shall abide by all the rules specified in it.

ACKNOWLEDGEMENT

I have carefully gone through the terms of the undertaking mentioned above and I understand that following these are for my/his/her own benefit and improvement. I also understand that if I/he/she fail to comply with these terms, shall be liable for suitable action as per Institute/JNTUH/AICTE/UGC rules and the law. I undertake that I/he/she will strictly follow the above terms.

Signature of Student with Date

Signature of Parent with Date
Name & Address with Phone Number