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
MECHANICAL 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 – UG.20

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; out of which 75 days are for teaching / practical and 15 days for conduct of exams and preparation.

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 8^{th} and 16^{th} 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) starts 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 ≥ 5 ('C' grade or above) in every course in that semester (i.e. when the student gets an SGPA ≥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 ≥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 ≥ 8.0	CGPA ≥ 6.5 and < 8.0	CGPA ≥ 5.5 and < 6.5	CGPA ≥ 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) ≥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 ≥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) ≥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.

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

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.

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

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

(MECHANICAL ENGINEEERING)

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										
AHSC08	Probability and Statistics	BSC	Foundation	3	1	0	4	30	70	100
AMEC05	Solid Mechanics	PCC	Core	3	0	0	3	30	70	100
AMEC06	Thermodynamics	PCC	Core	3	1	0	4	30	70	100
AMEC07	Materials Engineering	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										
AMEC08	Machine Drawing through CAD Laboratory	PCC	Core	0	0	2	1	30	70	100
AMEC09	Materials and Solid Mechanics Laboratory	PCC	Core	0	0	3	1.5	30	70	100
ACSC10	Data Structures Laboratory	PCC	Core	0	0	3	1.5	30	70	100
MANDATORY / VALUE ADDED COURSES										
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										
AMEC10	Kinematics of Machinery	PCC	Core	3	1	0	4	30	70	100
AMEC11	Manufacturing Processes	PCC	Core	3	0	0	3	30	70	100
AMEC12	Fluid Mechanics and Hydraulic Machines	PCC	Core	3	0	0	3	30	70	100
AMEC13	Applied Thermodynamics	PCC	Core	3	0	0	3	30	70	100
AMEC14	Design of Machine Elements	PCC	Core	3	1	0	4	30	70	100
ACSC14	Experiential Engineering Education (ExEEd) – Fabrication / Model Development	ESC	Foundation	2	0	0	1	30	70	100
PRACTICAL										
AMEC15	Manufacturing Processes Laboratory	PCC	Core	0	0	2	1	30	70	100
AMEC16	Fluid Mechanics and Hydraulic Machines Laboratory	PCC	Core	0	0	3	1.5	30	70	100
AMEC17	Applied Thermodynamics Laboratory	PCC	Core	0	0	3	1.5	30	70	100
MANDATORY/VALUE ADDED COURSES										
ACSC18	Fundamentals of Database Systems	VAC-I	Skill	Ref: 8.6, Academic Regulations-UG20						
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										
AMEC18	Dynamics of Machinery	PCC	Core	3	1	0	4	30	70	100
AMEC19	Machine Tools and Metrology	PCC	Core	3	1	0	4	30	70	100
AMEC20	Thermal Engineering	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	Experiential Engineering Education (ExEEd) – Project Based Learning	ESC	Foundation	2	0	0	1	30	70	100
PRACTICAL										
AMEC25	Machine Tools and Metrology Laboratory	PCC	Core	0	0	3	1.5	30	70	100
AMEC26	Theory of Machines Laboratory	PCC	Core	0	0	3	1.5	30	70	100
MANDATORY/VALUE ADDED COURSES										
ACSC23	Object Oriented Programming Development and Languages	VAC-II	Skill	Ref: 8.6, Academic Regulations-UG20						
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										
AMEC27	Finite Element Methods	PCC	Core	3	1	0	4	30	70	100
AMEC28	Machine Design	PCC	Core	3	1	0	4	30	70	100
AMEC29	Heat Transfer	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	Experiential Engineering Education (ExEEd) – Research Based Learning	ESC	Foundation	2	0	0	1	30	70	100
PRACTICAL										
AMEC36	Heat Transfer Laboratory	PCC	Core	0	0	3	1.5	30	70	100
AMEC37	Thermo-Fluid Modeling and Simulation Laboratory	PCC	Core	0	0	3	1.5	30	70	100
MANDATORY/VALUE ADDED COURSES										
ACSC29	Design of Algorithms	VAC-III	Skill	Ref: 8.6, Academic Regulations-UG20						
Total				**17**	**03**	**06**	**22**	**240**	**560**	**800**

VII SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
AMEC38	CAD/CAM	PCC	Core	3	1	0	4	30	70	100
AMEC39	Instrumentation and Control Systems	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	OE	Elective	3	0	0	3	30	70	100
PRACTICAL										
AMEC48	CAD/CAM Laboratory	PCC	Core	0	0	3	1.5	30	70	100
AMEC49	Instrumentation, Control Systems & Production Drawing Practice Laboratory	PCC	Core	0	0	3	1.5	30	70	100
AMEC50	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	OE	Elective	3	0	0	3	30	70	100
PRACTICAL										
AMEC59	Project Work (Phase – II) / Full Semester Internship	PROJ	Project	0	0	16	8	30	70	100
Total				**09**	**00**	**16**	**17**	**120**	**280**	**400**

PROFESSIONAL ELECTIVES COURSES

Course code	PE - I Design	Course code	PE - II Mechatronics	Course code	PE - III Manufacturing
AMEC21	Mechanical Vibrations	AMEC30	Automation in Manufacturing	AMEC40	Unconventional Machining Process
AMEC22	Tool Design	AMEC31	Mechatronics	AMEC41	Additive Manufacturing Processes
AMEC23	Experimental Stress Analysis	AMEC32	Robotics	AMEC42	Design for Manufacturing
AMEC24	Engineering Tribology	AMEC33	Advanced Machine Design	AMEC43	Nano-Materials

Course code	PE - IV Thermal Engineering	Course code	PE - V Computational Engineering	Course code	PE - VI Industrial Management
AMEC44	Automobile Engineering	AMEC51	Computational Fluid Dynamics	AMEC55	Plant Layout and Material Handling
AMEC45	Turbo Machines	AMEC52	Refrigeration and Air-Conditioning	AMEC56	Production Planning and Control
AMEC46	Gas Dynamics	AMEC53	Power Plant Engineering	AMEC57	Operation Research
AMEC47	Gas Turbines and Jet Propulsion Systems	AMEC54	Quality and Precision Engineering	AMEC58	Manufacturing of Composites

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

I Semester: AE / ECE / EEE / ME / CE **II Semester :** CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AHSC01	**Foundation**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		2	-	-	2	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: **Standard applicability of vocabulary and grammer**								

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, 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, 9th 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, 2nd 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

I Semester: AE / ME / CE / EEE / ECE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AHSC03	**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: Basic principles of waves								

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

<table>
<tr><td colspan="10">I 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">ACSC01</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>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">Prerequisites: There are no prerequisites to take this course.</td></tr>
</table>

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.
   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

I SEMESTER: AE / ECE / EEE / ME / CE

II SEMESTER: CSE / CSE (AI & ML) / CSE (DS) / CSE (CS) / CSIT / IT

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AHSC04	Foundation	L	T	P	C	CIA	SEE	Total
		-	-	2	1	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: 45				Total Classes: 45		

Prerequisite: There are no prerequisites to take this course.

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

<table>
<tr><td colspan="9">I Semester: CSE / CSE (AI&ML) / CSE (DS) / CSE (CS) / / CSIT / IT
II Semester: AE / ME / CE / ECE / EEE</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">AHSC06</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>2</td><td>-</td><td>-</td><td>2</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 45</td><td>Tutorial Classes: 0</td><td colspan="4">Practical Classes: Nil</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 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, 9thEdition, 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, 2ndEdition, 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

<table>
<tr><td colspan="10">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>
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<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: Knowledge of Linear Algebra and Calculus</td></tr>
</table>

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

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

II Semester : AE / ME / CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AEEC01	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		

Prerequisites: Linear Algebra and Calculus

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		
ACSC06	Foundation	L	T	P	C	CIA	SEE	Total
		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:

1. 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:

I. The basic knowledge about engineering drawing as a communicative language of engineers in ideation.
II. The ability to visualize, create and edit any object with all the physical and dimensional configurations using computer aided drawing tools.
III. 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, 1stEdition, 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

<table>
<tr><td colspan="11">II 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">ACSC03</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>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: Knowledge of Python programming</td></tr>
</table>

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/

PROBABILITY AND STATISTICS

<table>
<tr><td colspan="9">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="9">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 (09)

Random variables: Basic definitions, discrete and continuous random variables; Probability distribution: Probability mass function and probability density functions.

MODULE –II: PROBABILITY DISTRIBUTION (09)

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 (09)

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 (09)

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 (09)

Small sample tests: Student t-distribution, F-distribution and Chi-square distribution.

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 9th Edition, 2014.
2. B. S. Grewal, "Higher Engineering Mathematics", 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 Miller and 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

SOLID MECHANICS

III Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC05	**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: Basic principles of Engineering Mechanics								

I. COURSEOVERVIEW:

Mechanics of Solids is the physical science that deals with the reaction of a body to movement and deformation due to mechanical, thermal, or other loads. The basis of virtually all mechanical design lies in how the material reacts to outside forces. Mechanics is the core of engineering analysis and is one of the oldest of the physical sciences. An in-depth understanding of material properties as well as how certain materials react to outside stimulus is paramount to an engineering education.

II. COURSEOBJECTIVES:

The students will try to learn:

I. The real field problems through evaluating the relationship between stress and strain.
II. The shear force and bending moment diagrams of symmetrical beams.
III. The bending and shear stresses developed in beams of various sections
IV. The various theories of failure, Mohr's circle of stresses, principle stresses and strains.

III. COURSE SYLLABUS:

MODULE-I: SIMPLE STRESSES & STRAINS(12)

Elasticity and plasticity, types of stresses & strains, Hooke's law, stress & strain diagram for mild steel, working stress, factor of safety, lateral strain, Poisson's ratio & volumetric strain, elastic moduli & the relationship between them, bars of varying section, composite bars, temperature stresses.

MODULE –II: SHEAR FORCE AND BENDING MOMENT DIAGRAMS(12)

Definition of beam, types of beams, concept of shear force and bending moment, S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, U.D.L., U.V.L. and combination of these loads – point of contra flexure, relation between S.F., B.M, and rate of loading at a section of a beam.

MODULE –III: PRINCIPAL STRESSES(12)

Principle stresses and strains-computation of principal stresses and strains on inclined planes: Uni-axial problems, Bi axial problems, Mohr's circle: Uni axial problems, Bi axial problems.

THEORY OF FAILURES- Minimum principle stress, strain, shear stress and strain energy theories.

MODULE –IV: FLEXURAL STRESSES, DEFLECTION OF BEAMS(12)

Beams and types transverse loading on beams shear force and bend moment diagrams types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads. moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell‟s reciprocal theorems.

MODULE –V: TORSION, SPRING, STRESSES IN THIN SHELLS AND COLUMNS (12)

Theory of pure torsion, derivation of torsion equations $T/J = q/r = G\theta/L$, assumptions made in the theory of pure torsion, torsional moment of resistance, polar section modulus, introduction to springs: deflection of springs, thin cylinders, thin seamless cylindrical shells, derivation of formula for longitudinal and circumferential stresses, hoop stress, longitudinal and volumetric strains, changes in diameter, and volume of thin cylinders, thin spherical shells, and efficiency of a joint, Euler's column theory.

IV. TEXTBOOKS

1. R.Subramaniam, “The Strength of Materials”, Oxford publishers, 4th Edition, 2018.
2. Dr. Sadhu Singh, “The Strength of Materials”, Khanna Publishers, 12th Edition, 2019.
3. S. Ramamrutam, “Strength of Materials”, Dhanpat Rai Publishing Company, 18th Edition, 2014.

V. REFERENCEBOOKS:

1. Robert J Asaro, Vlado Lubarda, “Mechanics of Solids and Materials”, Cambridge University Press, 4th Edition, 2006.
2. Vazirani, Ratwani, “Analysis of Structures”, Khanna Publishers, 19th Edition, 2014.

VI. WEBREFERENCES:

1. http://www.efunda.com/sm _home/sm.cfm
2. http://www.ocw.mit.edu/resourcs/#sm
3. http://www.som.com

THERMODYNAMICS

III Semester: ME								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC06	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: Linear Algebra and Calculus, Waves and Optics.								

I. COURSE OVERVIEW:

Thermodynamics is the science that deals with the relationship between heat and work and those properties of systems that bear relation to heat and work. General laws of energy transformations concerning all types of systems, mechanical, electrical and chemical may fall within the purview of this science. It is a science based on a number of empirical laws formed by experimentation from which all predictions concerning the physical behavior of the system may be deduced by logical reasoning. Also describes basic power cycles required in the working of automobile engines.

II COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental knowledge on concepts of physics and chemistry for obtaining the axiomatic principles using thermodynamic co-ordinates.
II. The thermodynamic disorderness in the real time physical systems like external/internal heat engines, heat pumps to get the measure of performance characteristics.
III. The performance characteristics of open and closed systems of thermodynamic cycles for effective delineation of real time applications.
IV. The thermodynamic cycles such as power and refrigerant cycles yields to alternative solutions to conserve the environment

III.COURSE SYLLABUS:

MODULE-I: BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS (12)

System, control volume, surrounding, boundaries, universe, types of systems, macroscopic and microscopic viewpoints, concept of continuum, thermodynamic equilibrium, state, property, process, cycle, reversibility, quasi static process, irreversible process, causes of irreversibility, various flow and non-flow processes ,energy in state and in transition, types-work and heat, point and path function, Zeroth law of thermodynamics, concept of quality of temperature, Principles of thermometry, reference points, constant volume gas thermometer, ideal gas scale, Joule‘s experiment, first law of thermodynamics, PMM1, corollaries first law applied to a process, applied to a flow system, steady flow energy equation.

MODULE –II: SECOND LAW OF THERMODYNAMICS (12)

Thermal reservoir, heat engine, heat pump, parameters of performance, second Law of thermodynamics, Kelvin Planck and Claussius statements and their equivalence, Corollaries, PMM of second kind, Carnot’s principle, Carnot cycle and its specialties, thermodynamic scale of temperature, Claussius inequality, Entropy, principle of Entropy increase, availability and irreversibility, thermodynamic potentials, Gibbs and Helmholtz functions, Maxwell relations, elementary treatment of the Third Law of thermodynamics.

MODULE –III: PURE SUBSTANCES &GAS LAWS (09)

Phase transformations, T-S and H-S diagrams, P-V-T surfaces, triple point at critical state properties during change of phase, dryness fraction, Mollier charts, various thermodynamic processes and energy transfer, steam calorimeter.

Gas Laws :Equation of state, specific and universal gas constants, throttling and free expansion processes, Vander Waals equation

MODULE –IV: MIXTURES OF PERFECT GASES (12)

Mole fraction, mass friction, gravimetric and volumetric analysis, volume fraction, Dalton‘s law of partial pressure, Avogadro‘s laws of additive volumes, and partial pressure, equivalent gas constant, internal energy, enthalpy, specific heats and entropy of mixture of perfect gases; psychometric properties, dry bulb temperature, wet bulb temperature, dew point temperature, thermodynamic wet bulb temperature, specific humidity, relative humidity, saturated air, vapor pressure, degree of saturation, adiabatic saturation, Carrier's equation, Psychometric chart.

MODULE –V: POWER CYCLES (12)

Otto, Diesel, Dual combustion cycles, description and representation on P-V and T-S diagram, thermal efficiency, mean effective pressures on air standard basis, comparison of cycles.

IV. TEXT BOOKS

1. P. K. Nag, "Engineering Thermodynamics", Tata McGraw Hill, 4th Edition, 2008.
2. Yunus Cengel, Michael A. Boles, "Thermodynamics-An Engineering Approach", Tata McGraw Hill, 7th Edition, 2011.
3. Kalpakjian and Schmid, "Manufacturing Processes for Engineering Materials", Pearson India, 5th Edition, 2014.

V. REFERENCE BOOKS:

1. J. B. Jones, R. E. Dugan, "Engineering Thermodynamics", Prentice Hall of India Learning, 1st Edition, 2009.
2. Y. V. C. Rao, "An Introduction to Thermodynamics", Universities Press, 3rd Edition, 2013.
3. K. Ramakrishna, "Engineering Thermodynamics", Anuradha Publishers, 2nd Edition, 2011.
4. Holman. J.P, "Thermodynamics", Tata McGraw Hill, 4th Edition, 2013.
5. Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", John Wiley & Sons Inc., 4th Edition, 2008.

MATERIALS ENGINEERING

III Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC07	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 Chemistry and Modern Physics

I. COURSE OVERVIEW:

Materials Engineering subject is backbone to mechanical engineering discipline. The students are given inputs on fundamentals of crystallography, microstructures and relation toproperties of materials. Also students acquire knowledge on phase diagrams, heat treatment which will enable them to select materials for industrial applications .Inputs are also planned on ceramics, glasses, polymers and composites as present day designs are based on many advanced materials.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The physical and mechanical, metallurgical engineering concepts for metals and preparation of alloys.
II. The micro structural analysis of metals, alloys and relationship to heat treatment.
III. The properties comparison of ceramics, glasses, composites and polymers for industrial applications.

III. COURSE SYLLABUS:

MODULE –I: STRUCTURE OF CRYSTALLINE SOLIDS (09)

Structure of crystalline solids: Atomic structure & bonding in solids- Unit cell, Space lattice, Crystal structures and its types-calculations of radius, Coordination Number and Atomic Packing Factor for different cubic structures, Indices for planes and directions - Imperfection in solids, point defects, Line defects and Planar defects.

MODULE –II: PHASE DIAGRAMS (09)

Phase diagrams: Basic terms-Solid solutions - Gibbs phase rule- Lever rule – cooling curves Phase diagrams - construction of phase diagrams- binary phase diagrams - Al-Si phase diagram- Invariant reactions, eutectic, peritectic, eutectoid, peritectoid reactions, metatectic& monotectic reactions.

MODULE –III: ENGINEERING MATERIALS-I (09)

Engineering Materials I: Steels and Iron - Carbon phase diagram and heat treatment, study of iron – carbon diagram.

Construction of TTT diagrams, annealing, normalizing, hardening and tempering of steels.

MODULE –IV: ENGINEERING MATERIALS-II, III (09)

Engineering Materials II: Cast Irons, Structure and properties of White cast iron, malleable cast iron, grey cast iron. Engineering Materials III: Non-ferrous metals and alloys, structure and properties of Aluminum Copper and its alloys, titanium and its alloys.

MODULE-V: ENGINEERING MATERIALS-IV (09)

Engineering Materials IV: Ceramics, polymers and composites; crystalline ceramics, glasses, cermets, Structure, properties and applications; Classification, properties and applications of composites,classification, properties and applications of polymers.

IV. TEXT BOOKS:

1. Sidney H Avner, "Introduction to Physical Metallurgy", McGraw-Hill Education, 2nd Edition, 2008
2. Donald R Askeland, Thomson, "Essentials of Material Science and Engineering", Thomson Press, 1st Edition, 2005.

V. REFERENCE BOOKS:

1. Kodgire, "Material Science and Metallurgy", Everst Publishing House, 12th Edition, 2002.
2. William, Callister, "Material science and Engineering", Wiley, 9th Edition, 2014.
3. V Raghavan, "Elements of Material Science", PHI Learning Company Pvt Ltd, 6th Edition, 2015.
4. Er. Amandeep Singh Wadhva, "Engineering Materials and Metallurgy", Laxmi Publications, 1st Edition, 2008.
5. Traugott Fisher, "Material Science", Academic Press Elsevier, 1st Edition, 2013.

VI. WEB REFERENCES:

1. https://www.youtube.com/user/MaterialsScience2000
2. http://www.nptel.ac.in/courses/113105023/

VII. E-TEXT BOOKS:

1. http://engineeringstudymaterial.net/ebook/material-science-and-engineering-an-introduction
2. http://www.scoopworld.in/2015/04/metallurgy-sciencem-text-books-and-notes.html
3. http://engineeringstudymaterial.net/ebook/material-science-and-engineering-an-introduction/
4. https://books.google.co.in/books/about/Material_Science_and_Metallurgy.html?id=au1bG8BA_Z8C

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

MACHINE DRAWING THROUGH CAD LABORATORY

III Semester: ME								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC08	Core	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:

Machine drawing is intended to communicate the necessary technical information required for manufacture and assembly of machine components. Students practice the development of drawings of machine components as per Bureau of Indian Standards (BIS) and assembly using industry leading mechanical design software's. It is used to develop a full range of products, from single parts to assemblies containing thousands of components with accurate fit and therefore involves economic, societal, safety and manufacturing aspects.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The Code of drawing practice as per BIS conventions for mechanical elements using AutoCAD.
II. The 2D drawing of joints, couplings, bearings and keys and their sectional views.
III. The preparation of component drawings, assembly drawings and bill of materials for selected assemblies.
IV. The part drawings of the assembly of various machines and engine components.

III. COURSE OUTCOMES

CO 1	Interpret the various types of materials, machine elements and parts representation for machine drawings.
CO 2	Classify the different types of sectional views to reveal the internal surfaces of machine elements.
CO 3	Make use of the various machine elements to prepare the part drawings for the design process.
CO 4	Dem Draw the bearings, keys and cotter joints drawings for Assembly of machine parts.
CO 5	Categorize the couplings and riveted joints to fasten the components that require frequent assemblies.
CO 6	Develop an assembly drawings of Engine parts, Tailstock, Machine vice and safety valves to facilitate its manufacture

IV. COURSE CONTENT

EXERCISES ON MACHINE DRAWING THROUGH CAD

Note: Students are encouraged to bring their own laptops for laboratory practice sessions.

All dimensions are in mm in experiments.

Safety

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

Safety Rules

1. Always listen carefully to the teacher and follow instructions.
2. When learning how to use a computer / machine, listen very carefully to all the instructions given by the faculty / instructor. Ask questions, especially if you do not fully understand.
3. Bags should not be brought into a lab as people can trip over them.
4. Always be patient, never rush in the lab.
5. Keep your work area clean.

1. Getting Started Exercises

1.1 Introduction to AutoCAD

In the first lab period, the students should become familiar with the location of equipment and components in the lab, the course requirements, and the teaching instructor. Students should also make sure that they have all of the co-requisites and pre-requisites for the course at this time.

i) Familiarization of AutoCAD software and its advantages.

ii) Standard use of Computer Aided Design (CAD) drawings .dwg format

iii) Use of drawing, modifying and edit Commands.

1.2 Conventional Representation

Practice the conventional representation of materials and machine element which are used in assembly drawings.

1. Conventional representation of materials, common machine elements and parts such as screws, nuts, bolts, keys, gears, webs and ribs;
2. Certain draughting conventions are used to represent materials in section and machine elements in engineering drawings.
3. As a variety of materials are used for machine components in engineering applications, it is preferable to have different conventions of section lining to differentiate between various materials.

Hints:

Commands

```
1. Type U (enter) change units in meters.
2. Type L (enter) to give line command and type dimensions as 0.8m. Indicate the
   direction of the line is Ortho is ON.
3. Type O(enter) for offset command and type offset distance as 0.15 (enter) then,
   click inside where parallel line is required
```

4. Type "Tr" (enter) for trim command trim the extra lines.
5. By typing "DT" (enter) text command is given to write the text.
6. The size of dimensions and the size of arrows can be changed by typing (enter) command.
7. By typing "C" (enter) to give circle command
8. By adopting the above command the Representation of various materials is drawn with dimensions.

2. SECTIONAL VIEWS

In order to show such features clearly, one or more views are drawn as if a portion had been cut away to reveal the interior This procedure is called sectioning and the view showing the cut away picture is called section view. A section is an imaginary cut taken through an object to reveal the shape or interior construction.

Types of sections, selection of section planes and drawing of sections and auxiliary sectional views, parts not usually sectioned. Orthographic views when carefully selected may reveal the external features of even the most complicated objects. However, there are objects with complicated interior details and when represented by hidden lines, may not effectively reveal the true interior details. This may be overcome by representing one or more of the views 'in section'.

2.1 Exercises

1. Draw (i) the sectional view from the front, (ii) the view from above and (iii) the view from the right of the given shaft support.
2. Draw (i) the sectional view from the front, (ii) the view from above and (iii) the sectional view from the left of the given Machine block.

Hint:

Use drawing and modifying commands

Try:

Instead of 2D drawings develop the 3D components using AutoCAD software.
Develop the 3D Drawings using catia and solid works software.

3. Dimensioning

BASIC DIMENSIONING
In many applications, a drawing should contain annotations showing lengths or distances or angles between objects to convey the desired information. Dimensioning is the process of adding these annotations to a drawing. AutoCAD provides four basic types of dimensioning; linear, angular, diameter and radius.

DIM and DIMI Commands—DIMI command allows executing one dimensioning command and then returns to the normal command mode. If several dimensioning commands are to be executed, DIM command should be used. In this mode, the normal set of AutoCAD commands is replaced by a special set of dimensioning commands. To end the process of dimensioning, EXIT command has to be used. The elements of dimensioning include the projection line, dimension line, leader line, dimension line termination, the origin indication and the dimension itself.
Methods of dimensioning, general rules for sizes, and placement of dimensions for holes, centers, and curved and tapered features a drawing of a component, in addition to providing complete shape description, must also furnish information regarding the size description. These are provided through the distances between the surfaces, location of holes, nature of surface finish, type of material, etc. The expression of these features on a drawing, using lines, symbols, figures and notes is called dimensioning.

3.1 Exercises

Practice the Principles of Dimensioning and Standard abbreviations using Aligned System

i) Oblique dimensioning
ii) Angular dimensioning
iii) Chain Dimensions
iv) Parallel Dimensions
v) Dimensioning of chords, arcs and angles

Dimensions should be placed parallel to their dimension lines and preferably near the middle, above and clear-off the dimension line Fig. 1Dimensions may be written so that they can be read from the bottom or from the right side of the drawing. Dimensions on oblique dimension lines should be oriented as shown in Fig. 2 Angular dimensions may be oriented as shown in Fig. 3

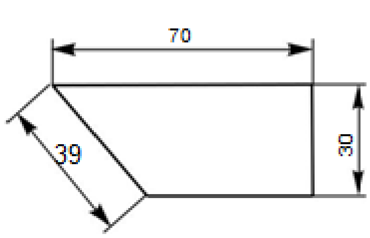


Fig. 1

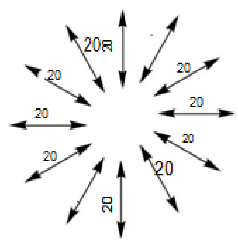


Fig. 2

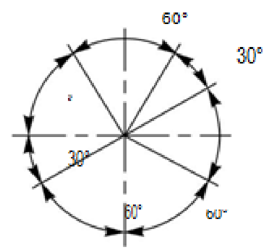


Fig. 3

Hints

1. Type U (enter) change units in meters.
2. Type L (enter) to give line command and type dimensions as 0.8m. Indicate the direction of the line is Ortho is ON.
3. Type O (enter) for offset command and type offset distance as 0.15 (enter) then, click inside where parallel line is required
4. Type Tr (enter) for trim command trim the extra lines.
   By typing „DT“ (enter) text command is given to write the text. By typing „DLI“ (enter) dimensioning is also given.
5. The size of dimensions and the size of arrows can be changed by typing D (enter) command.
6. Use array command for angular dimensioning.
7. By adopting the above command the Representation of various dimensions are to be drawn

Try

Practice the Dimensioning using Uni-directional System method.

4. Machine elements

Drawing and sketching of machine elements in orthographic projections, spacing of views

Thread Profiles

V-Thread (sharp)

This thread profile has a larger contact area, providing more frictional resistance to motion. Hence, it is used where effective positioning is required. It is also used in brass pipe work. British Standard Whitworth (B.S.W) Thread. This thread form is adopted in Britain in inch units. The profile has rounded ends, making it less liable to damage than sharp V-thread.

Buttress Thread

This thread is a combination of V-and square threads. It exhibits the advantages of square thread, like the ability to transmit power and low frictional resistance, with the strength of the V-thread. It is used where power transmission takes place in one direction only such as screw press, quick acting carpenter's vice, etc.

Square Thread

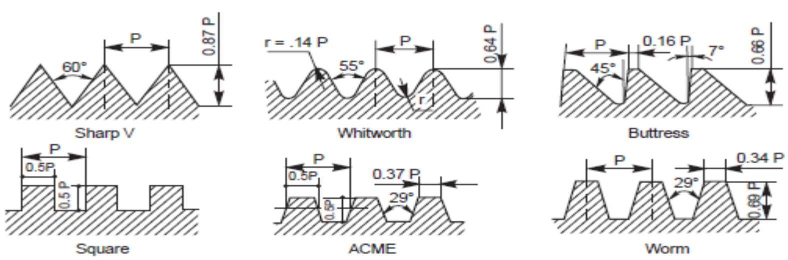
Square thread is an ideal thread form for power transmission. In this, as the thread flank is at right angle to the axis, the normal force between the threads, acts parallel to the axis, with zero radial components. This enables the nut to transmit very high pressures, as in the case of a screw jack and other similar applications.

ACME Thread

It is a modified form of square thread. It is much stronger than square thread because of the wider base and it is easy to cut. The inclined sides of the thread facilitate quick and easy engagement and disengagement as for example, the split nut with the lead screw of a lathe.

Worm Thread

Worm thread is similar to the ACME thread, but is deeper. It is used on shafts to carry power to worm wheels.



4.1 Exercises

1. Draw Screw thread nomenclature, forms of threads, Thread series, Thread designation, Representation of threads, Bolted joints, locking arrangement for nuts, Foundation bolts
2. Draw Screwed (Threaded) fasteners: Hexagonal (Bolt Head) Nut
3. Draw the three views of a hexagonal headed bolt of nominal diameter 25 mm and length 100 mm; with a hexagonal nut and washer.

Hints

```
Empirical relations:
Major or nominal diameter of
bolt                        = D
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Thickness of nut, T          = D
Width of nut across flat surfaces, W = 1.5D + 3 mm
Radius of chamfer, R    = 1.5D
```
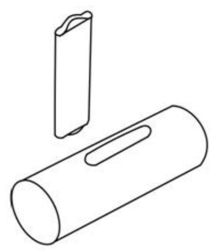

Try;

1. Instead of 2D drawings develop the Hexagonal (Bolt Head) Nut in 3D using Solid works software
2. Instead of 2D drawings develop the 3D components using AutoCAD software.
3. Develop the 3D Drawings using catia and solid works software.

5. Keys and Cotter Joints

A cotter is a flat wedge shaped piece, made of steel. It is uniform in thickness but tapering in width, generally on one side; the usual taper being 1:30. The lateral (bearing) edges of the cotter and the bearing slots are generally made semi-circular instead of straight (Fig. 1.0).

This increases the bearing area and permits drilling while making the slots. The cotter is locked in position by means of a screw as shown in Fig. 1.1. Cotter joints are used to connect two rods, subjected to tensile or compressive forces along their axes. These joints are not suitable where the members are under rotation. The following are some of the commonly used cotter joints:



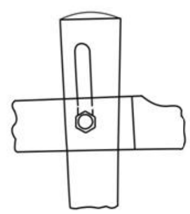


Fig. 1.0 Cotter and the bearing slot   Fig. 1.1 Locking arrangement of cotter

Knuckle Joint

A knuckle joint is a pin joint used to fasten two circular rods. In this joint, one end of the rod is formed into an eye and the other into a fork (double eye). For making the joint, the eye end of the rod is aligned into the fork end of the other and then the pin is inserted through the holes and held in position by means of a collar and a taper pin (Fig. 1.0). Once the joint is made, the rods are free to swivel about the cylindrical pin.
Knuckle joints are used in suspension links, air brake arrangement of locomotives, etc.

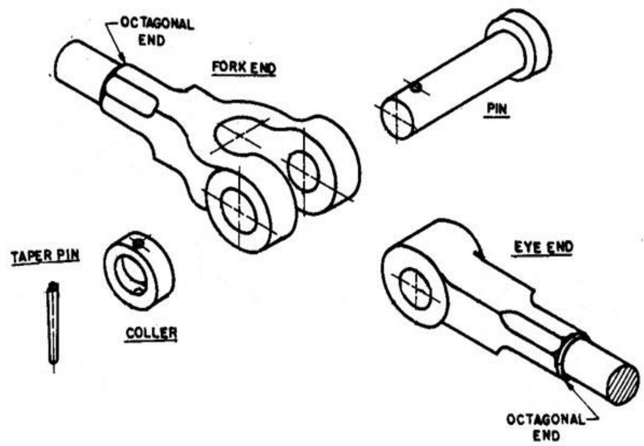


Fig. 1.0

1.1 Exercises

1. Draw the sectional view from the front, and view from the side of a cotter joint with sleeve used to connect two rods of 50 mm diameter each.
2. Draw a Knuckle joint with 50 mm diameter (D)
3. Sketch the following types of keys in two views, as fitted in position between a shaft and the mounting. Choose the shaft diameter as 30 mm and the hub diameter of the mounting as 60 mm:
   a. Hollow saddle key, (b) flat saddle key,
   b. Taper sunk key, (d) single headed feather key,
   c. Splines and (f) woodruff key.

Try

Draw the sectional views of Cotter Joint with Socket and Spigot Ends in 3D using Solid works software.

6. Riveted joints

To study & draw Riveted Joints, Rivets and riveting, Rivet heads, Classification of riveted joints

Riveted joints are permanent fastenings and riveting is one of the commonly used method of producing rigid and permanent joints. Manufacture of boilers, storage tanks, etc., involve joining of steel sheets, by means of riveted joints. These joints are also used to fasten rolled steel sections in structural works, such as bridge and roof trusses.

6.1 Practice the various types of riveted joints.

Draw (a) sectional view from the front and (b) view from above, of the following riveted joints, to join plates of thickness 10 mm:

(i) Single riveted lap joint,
(ii) Double riveted chain lap joint,
(iii) Single riveted, single strap butt joint

Try;

Draw the sectional views of Double riveted, Double strap butt joint

7. COUPLINGS

Couplings are used to join two shafts so that they act as a single unit during rotation and power can be transmitted from one shaft to the other.

7.1 Exercise

Assemble the parts of a protected flanged coupling and draw the following views:

(i) Half sectional view from the front, with top half in section, and
(ii) View from the right.

8. BEARINGS

Bearings are supports for shafts, providing stability, and free and smooth rotation. The importance of bearings may be understood from the supporting requirement of machine tool spindles, engine crankshafts, transmission or line shafts in workshops, etc. Bearings are broadly classified into two categories: sliding contact bearings and rolling contact bearings or anti-friction bearings.

8.1 Exercises

Draw (a) sectional view from the front and (b) view from above, of the following bearings
i) Journal Bearing
ii) Pivot Bearing
iii) Collar bearing.

9. ASSEMBLY DRAWINGS-I

Assembly drawings for the Engine parts–stuffing box, Eccentrics, I.C. engine connecting rod. A machine is an assembly of various links or parts. It is necessary to understand the relation between the various parts of the unit for the purpose of design and production. An assembly drawing is one which represents various parts of a machine in their working position. These drawings are classified as design assembly drawings, working assembly drawings, sub-assembly drawings, installation assembly drawings, etc. The final assembly drawings are prepared from design assembly drawings or from the working drawings (component drawings).

9.1 Exercises

Assemble all parts of the stuffing box for a vertical steam engine, and draw,

(i) Half sectional view from the front, with left half in section, (ii) half sectional view from the right and (iii) view from above.

Try

1. Instead of 2D drawings develop the assembly drawing in 3D using Solid works software
2. Develop the 3D components using AutoCAD software.
3. Develop the 3D Drawings using catia and solid works software.

10. ASSEMBLY DRAWINGS-II

Screw jacks are used for raising heavy loads through very small heights. In this, the screw works in the nut which is press fitted into the main body. The tommy bar is inserted into a hole through the enlarged head of the screw and when this is turned, the screw will move up or down, thereby raising or lowering the load.

10.1 Exercises

Assemble all parts of the screw jack, and draw the following views:
(i) Half sectional view from the front, and
(ii) View from above.

Try

Instead of 2D drawings develop the assembly drawing in 3D using Solid works software

11. ASSEMBLY DRAWINGS-III

Assembly drawings for the Machine vice

It consists of the base which is clamped to the machine table using two T-bolts. The sliding block is fixed in the centre slot of the base by means of the guide screw. The movable jaw is fixed to the sliding block with four screws. One of the serrated plates is fixed to the jaw of the base by means of screws and the other to the movable jaw by the one end of the guide screw is fixed to the base by means of the washer and nut. The movable jaw is operated by means of a handle which fits onto the square end of the guide screw.

11.1 Exercises

Assemble all parts of the Machine vice, and draw the following views:
(i) Half sectional view from the front, and
(ii) View from above.

12. ASSEMBLY DRAWINGS-IV

Certain jobs requiring milling operations, in relation to their axes of rotation, are usually supported between centers. The job is held between the centre in the dividing head and adjustable center provided in the tail-stock. This is similar to the lathe tail-stock.

12.1 Exercises

Assemble all parts of the tailstock, and draw the following views:
(i) Half sectional view from the front, and
(ii) View from above.

Try

Instead of 2D drawings develop the assembly drawing in 3D using Solid works software

13. ASSEMBLY DRAWINGS-V

Assembly drawings for the Rams-bottom Safety Valve

In Rams-bottom safety valve, spring load is used to lift the valves, when excess pressure of steam is built-up. It is mostly used in a locomotive boiler. Whenever steam pressure exceeds the designed value of the spring force, the excess pressure lifts the valves, allowing steam to escape till the pressure decreases to the permissible value.

13.1 Exercises

Assemble all parts of the Rams-bottom Safety Valve, and draw the following views:
(i) Half sectional view from the front, and
(ii) View from above.

Try

Instead of 2D drawings develop the assembly drawing in 3D using Solid works software

14. ASSEMBLY DRAWINGS-VI

Assembly drawings for the connecting rod

Assemble all parts of connecting rod, and draw the following views:

(i) Half sectional view from the front, and

(ii) View from above.

Try

Instead of 2D drawings develop the assembly drawing in 3D using Solid works software

V. REFERENCE BOOKS

1. K.L. Narayana, P. Kannaiah, K. Venkata Reddy, “Machine Drawing”, New Age Publishers, 3rd edition, 2012.
2. K.C. John, “Text book of Machine Drawing”, PHI Eastern Economy, 1st edition, 2010.
3. P.S Gill, “Machine Drawing”, S.K Kataria & Sons, 1st edition, 2013
4. N. D. Bhatt, V. M Pancahal, “Machine Drawing”, Charotar, 1st edition, 2014.

VI. REFERENCE BOOKS

1. http://www.iare.ac.in

MATERIALS AND SOLID MECHANICS LABORATORY

III Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC09	**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: Fundamentals of solid mechanics								

I. COURSE OVERVIEW:
This laboratory course concerned with the micro structures of both ferrous and nonferrous materials, mechanical properties of materials such as percentage elongation, modulus of elasticity, hardness of materials, modulus of rigidity etc. Investigating the mechanical properties of materials are highly important before going to fabrication of products for yielding the higher performance.

II. COURSE OBJECTIVES:
The students will try to learn:
1. The processes of cold/hot working, re-crystallization, grain growth and microstructural properties of materials.
2. The parameters such as factor of safety, Poisson's ratio, three elastic moduli and their relationships in the selection and characterization of a material.
3. The theory of pure torsion, bending, stiffness, slope and deflection of beams.

III. COURSE OUTCOMES
CO 1	Utilize the concepts crystallography, crystal structures, crystallographic planes, and miller indices to analyse the microstructural properties of materials.
CO 2	Make use of the Jominy end quench test apparatus to measure the capacity of steel hardenability in depth under a given set of conditions.
CO 3	Distinguish the regions of elasticity and plasticity, stress-strain relationships under various types of loads by conducting a tensile test on universal testing machine.
CO 4	Analyze the mechanical properties of a material by conducting compression and torsion tests on different materials.
CO 5	Compare the hardness values of ferrous and nonferrous materials by conducting experiments on Rockwell and Brinell's hardness testing machines.
CO 6	Determine the impact strength of a material by adopting Charpy and Izod test procedures.

Dos

1) For safety purpose the students should compulsorily wear shoes.
2) Students should come in uniform prescribed.
   i. For boys, half sleeve shirts, tucked in trousers
   ii. For ladies, half sleeve overcoat, hair put inside the overcoat
3) Be punctual to the classes.
4) To come prepared with procedure relevant to the experiment.

Don’t

1) Don’t operate any machine without knowledge and permission of the lab personnel
2) Don’t unplug any machine from power supply.
3) Don’t remove any parts of the machine

EXERCISES ON MATERIALS AND SOLID MECHANICS LABORATORY

1. Getting Started Exercises

1.1 Introduction to Laboratory

The solid Mechanics Laboratory is well equipped with destructive testing machineries. Students will be able to understand the basic concepts of Solid Mechanics and enable to apply them to practical problems in this laboratory. Different types of tests are conducted in this laboratory as per standards (ASTM and IS) for mechanical properties of various materials such as Young's Modulus, Shear Modulus, Hardness, Toughness, Stiffness, etc. Many students of Final year are utilizing this laboratory for their project works for testing of various materials like composite materials, ferrous and nonferrous alloys.

- To familiarize students with lab equipments
- Inform the students on lab evaluation process
- Inform the students about laboratory precautions
- To familiarize students sample preparations
- Learning outcomes of the lab

2. Microstructure of Steels

Metallic materials, when considered in a broad sense, may be divided into two large groups, ferrous and nonferrous. The ferrous materials are iron-based, and the nonferrous materials have some element other than iron as the principal constituent. The bulk of the nonferrous materials is made up of the alloys of copper, aluminium, magnesium, nickel, tin, lead, and zinc. The temperature at which the allotropic changes take place in iron is influenced by alloying elements, the most important of which is carbon. This is the part between pure iron and an interstitial compound, iron carbide, Fe,C, containing 6.67 percent carbon by weight.

2.1. Study of microstructure of steels

- Introduction
- Procedure
- Observations
- Further probing experiments

2.2. Observations

The microstructure of low carbon steels as shown in fig. 2.1

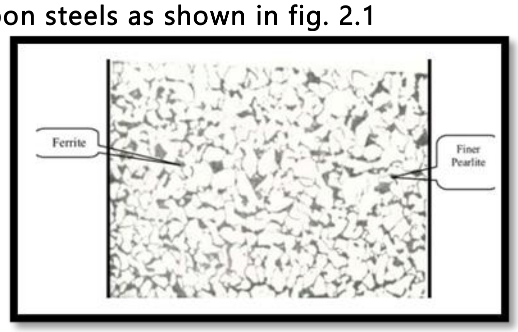


fig. 2.1: Microstructure of low carbon steels

The microstructure of medium carbon steels as shown in fig. 2.2

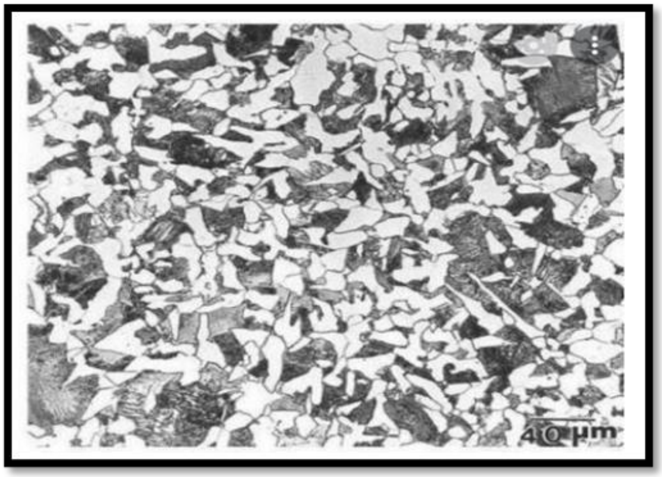


fig. 2.2: Microstructure of medium carbon steels

2.3. Precautions

- Wear tight overalls and shoe for safety.
- Be aware about mounting press and the time of etching process.
- Don't touch the specimen when it is so hot and use tongs for hold it.
- Be away at the time of belt polishing and disc polishing.

2.4. Further Probing Experiments

1. Change the values of magnification lens and obtain the microstructures.
2. Obtain the microstructures of LCS, MCS and HCS using trinocular.

3. Microstructure of Cast Iron

3.1. Introduction

Cast irons are a class of ferrous alloys with carbon contents above 2.14 % by weightage; in practice, however, most cast irons contain between 3.0 and 4.5 % of Carbon and, in addition, other alloying elements. A re-examination of the iron–iron carbide phase diagram reveals that alloys within this composition range become completely liquid at temperatures between approximately 1150 and 13000C (2100 and 2350F), which is considerably lower than for steels. Thus, they are easily melted and amenable to casting. Furthermore, some cast irons are very brittle, and casting is the most convenient fabrication technique.

3.2. Procedure

1. Cut the specimen into required shape by using cutoff machine.
2. Mount the specimen in mounting press by adding 2 spoons of Bakelite powder.
3. Polish the specimen on belt polisher to make the surface even.
4. Then polish the specimen again by using sand and emery papers.
5. After polishing the specimen is again polish on the belt polisher by adding 2-3 drops of water.
6. Observe the micro-structure of specimen under microscope and note it down.
7. Apply approximate etchant to the specimen.
8. Observe the micro scope structure and note it down.

3.3. Observation

The microstructure of medium Grey Cast Iron as shown in fig.3.1

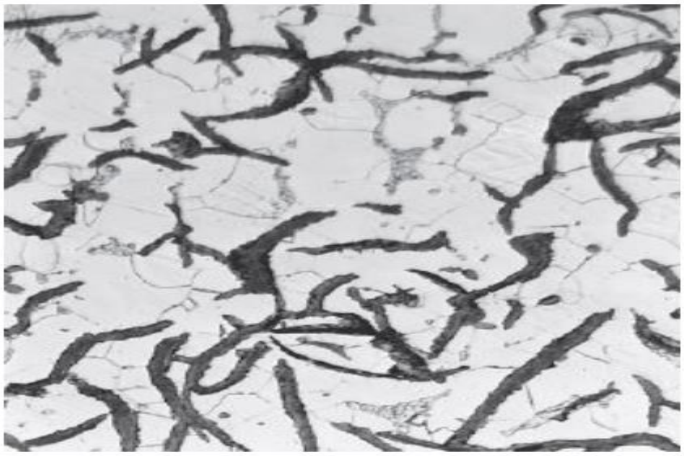


fig. 3.1: Microstructure of Grey Cast Iron

3.4. Further Probing Experiments

1. Change the values of magnification lens and obtain the microstructures.
2. Obtain the microstructures of different cast irons using trinocular.

4. Microstructure of Copper

4.1. Introduction

Steel and other ferrous alloys are consumed in exceedingly large quantities because they have such a wide range of mechanical properties, may be fabricated with relative ease, and are economical to produce. However, they have some distinct limitations chiefly (1) a relatively high density, (2) a comparatively low electrical conductivity, and (3) an inherent susceptibility to corrosion in some common environments. Thus, for many applications it is advantageous or even necessary to use other alloys that have more suitable property combinations. Alloy systems are classified either according to the base metal or according to some specific characteristic that a group of alloys share.

4.2. Procedure

1. Cut the specimen into required shape by using cutoff machine.
2. Mount the specimen in mounting press by adding 2 spoons of Bakelite powder.
3. Polish the specimen on belt polisher to make the surface even.
4. Then polish the specimen again by using sand and emery papers.
5. After polishing the specimen is again polish on the belt polisher by adding 2-3 drops of water.
6. Observe the micro-structure of specimen under microscope and note it down.
7. Apply approximate etchant to the specimen.
8. Observe the micro scope structure and note it down.

4.3. Observation

The microstructure of Copper as shown in fig.4.1

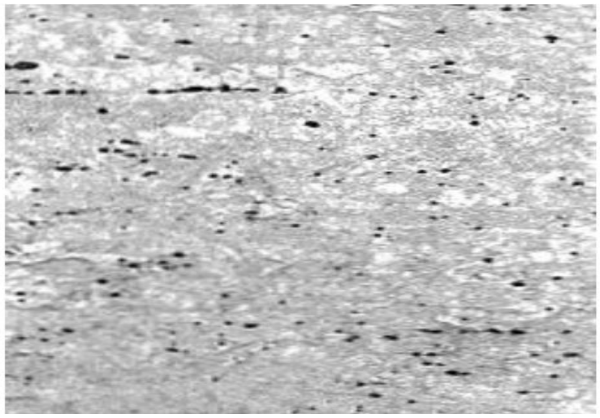


fig.4.1: Microstructure of Copper

4.4. Further Probing Experiments

1. Change the values of magnification lens and obtain the microstructures.
2. Obtain the microstructures of different copper alloys using trinocular.

5. Microstructure of High Carbon Steels

5.1. Introduction

Steels are iron–carbon alloys that may contain appreciable concentrations of other alloying elements; there are thousands of alloys that have different compositions and/or heat treatments. The mechanical properties are sensitive to the content of carbon, which is normally less than 1.0 percentage by weight. Some of the more common steels are classified according to carbon concentration—namely, into low, medium and high carbon types. Subclasses also exist within each group according to the concentration of other alloying elements. Plain carbon steels contain only residual concentrations of impurities other than carbon and a little manganese. For alloy steels, more alloying elements are intentionally added in specific concentrations. High-Carbon Steels are normally having carbon contents between 0.60 and 1.4 percentage by weight, are the hardest, strongest, and yet least ductile of the carbon steels.

5.2. Procedure

1. Cut the specimen into required shape by using cutoff machine.
2. Mount the specimen in mounting press by adding 2 spoons of Bakelite powder.
3. Polish the specimen on belt polisher to make the surface even.
4. Then polish the specimen again by using sand and emery papers.
5. After polishing the specimen is again polish on the belt polisher by adding 2-3 drops of water.
6. Observe the micro-structure of specimen under microscope and note it down.
7. Apply approximate etchant to the specimen.
8. Observe the micro scope structure and note it down.

5.3. Observation

The microstructure of High Carbon Steel as shown in fig.5.1

fig.5.1: Microstructure of High Carbon Steels

5.4. Further Probing Experiments

1. Change the values of magnification lens and obtain the microstructures.
2. Obtain the microstructures of different high carbon steels using trinocular.

6. Tension test of Mild Steel

6.1. Introduction

The objective of this experiment is to evaluate the mechanical (tensile) properties of selected metallic materials using the tensile test method. These mechanical properties include modulus of elasticity, yield strength, ultimate tensile strength, failure strength, ductility, and strain to failure.

6.2. Procedure

1. Measure the original length and diameter of the specimen. The length may either be length of gauge section which is marked on the specimen with a preset punch or the total length of the specimen.
2. Insert the specimen into grips of the test machine and attach strain-measuring device to it.
3. Begin the load application and record load versus elongation data.
4. Take readings more frequently as yield point is approached.
5. Measure elongation values with the help of dividers and a ruler.
6. Continue the test till Fracture occurs.
7. By joining the two broken halves of the specimen together, measure the final length and diameter of specimen as shown in fig.6.1.

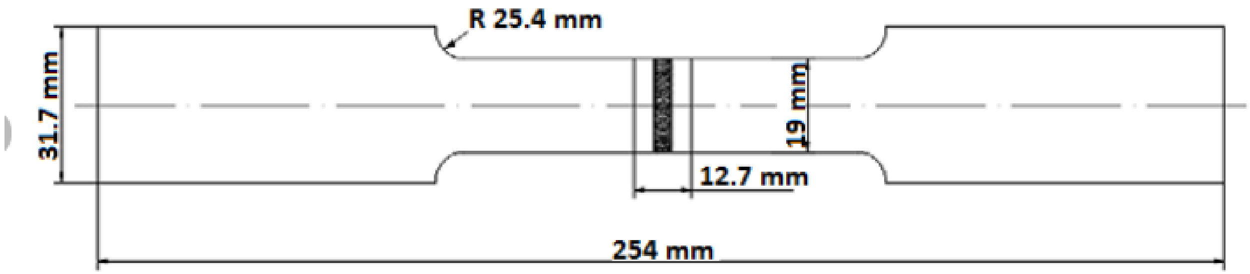


fig.6.1: Tension test specimen preparation

6.3.Further Probing Experiments

1. Calculate the Young's Modulus for ductile materials.
2. Generate stress Vs strain diagram for different materials using servo driven Universal Testing Machine.

7. Torsion test of Mild Steel

7.1.Introduction

The stress resulting from torsion load can be determined by means of the torsion test. This test resembles the tension test in that a load deflection curve is also development (which is transformed to a shear-strain curve). In a torsion test, a solid or hollow cylindrical specimen is twisted and the resultant deformation, measured as the angle through which the bar is twisted. The test then consists of measuring the angle of twist, Φ (rad) at selected increments of torque, T (N.m). Expressing Φ as the angular deflection curve per unit gage length.

7.2.Procedure

1. Measure the original length and diameter of the specimen. The length may either be length of gauge section which is marked on the specimen with a preset punch or the total length of the specimen.
2. Insert the specimen into grips of the test machine and attach strain-measuring device to it.
3. Begin the load application and record load versus elongation data.
4. Take readings more frequently as yield point is approached.
5. Measure elongation values with the help of dividers and a ruler.
6. Continue the test till Fracture occurs.
7. By joining the two broken halves of the specimen together, measure the final length and diameter of specimen as shown in fig.7.1. (All dimensions are in mm).

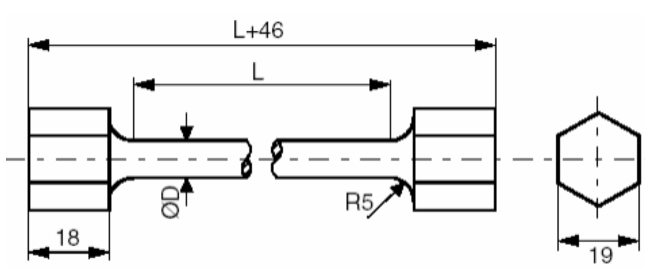


fig.7.1: Torsion test specimen dimensions

7.3. Precautions

1. Wear tight overalls and shoe for safety.
2. If the strain measuring device is an extensometer it should be removed before necking begins.
3. Measure deflection on scale accurately and carefully.

7.4. Further Probing Experiments

1. Calculate the Young's Modulus for various ductile materials.
2. Generate stress Vs strain diagram for different materials using servo driven Universal Testing Machine.

8. Brinell Hardness test

8.1. Introduction

Hardness is defined as a material's ability to resist permanent indentation (that is plastic deformation). Typically, the harder the material, the better it resists wear or deformation. The term hardness, thus, also refers to local surface stiffness of a material or its resistance to scratching, abrasion, or cutting.

8.2. Objectives

1. To determine the hardness number from Brinell hardness test.
2. To measure the ultimate tensile strength of the specimen from the Brinell hardness test.
3. The specimen prepared as per the given dimensions in fig.8.1

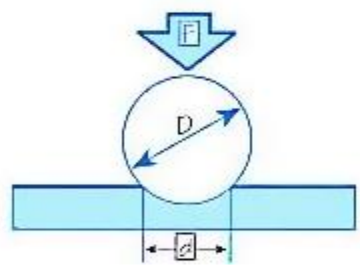


fig.8.1: Brinell hardness test

D = Ball diameter
d = impression diameter
F = load
HB = Brinell result

8.3 Further Probing Experiments

1. Measure the hardness values for different conventional materials.
2. Compare the hardness values same material with different loads and comment on the results.

9. Rockwell Hardness test

9.1. Introduction

Hardness is defined as a material's ability to resist permanent indentation (that is plastic deformation). Typically, the harder the material, the better it resists wear or deformation. The term hardness, thus, also refers to local surface stiffness of a material or its resistance to scratching, abrasion, or cutting.

9.2. Procedure

1. To determine the Brinell hardness number from the Rockwell hardness test
2. To find the ultimate tensile strength of the metal specimens from the Brinell hardness number by using empirical relationships as shown in fig.9.1

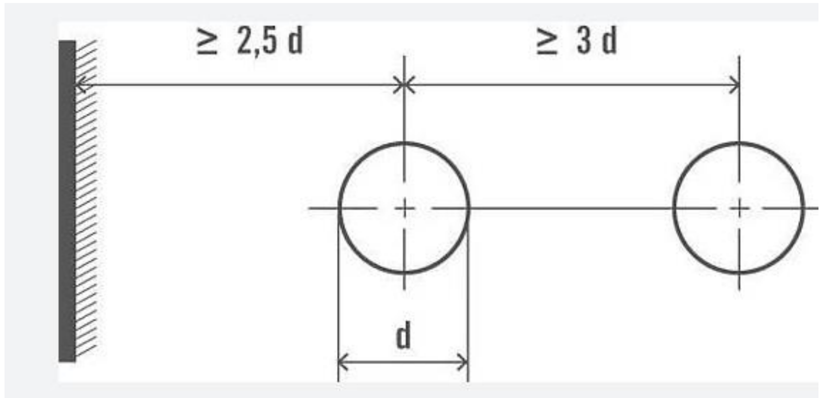


fig.9.1: Rockwell Hardness test specimen as per ISO 6508

9.3 Further Probing Experiments

1. Measure the hardness values for different materials which needs unusual scales.
2. Compare the hardness values same material with different loads and comment on the results.

10. Spring test

10.1. Introduction

Spring test is used to determine the stiffness of helical spring. Stiffness is the ability of a material withstand load per unit deflection. The modulus of rigidity of a spring material varies as a function of chemical composition, cold working, and degree of aging,

10.2. Procedure

1. Measure the diameter of the wire of the spring by using the micrometre.
2. Measure the diameter of spring coils by using the Vernier calliper
3. Count the number of turns.
4. Insert the spring in the spring testing machine and load the spring by a suitable weight and note the corresponding axial deflection in tension or compression.
5. Increase the load and take the corresponding axial deflection readings.
6. Plot a curve between load and deflection. The shape of the curve gives the stiffness of the spring.

10.3 Further Probing Experiments

1. Measure the hardness values for different materials which needs unusual scales.
2. Compare the hardness values same material with different loads and comment on the results.

11. Compression test

11.1. Introduction

In modern design offices, a special care is taken at the time of designing a structure that it should be able to withstand the stresses, under the various load conditions, without failure. For doing so, it is very essential to have a complete information about the various properties of the selected material and its dimensions. This information can be obtained by experimental investigations in a well-equipped material testing laboratory.

11.2. Procedure

- Select some brick with uniform shape and size.
- Measure all dimensions. (LxBxH) Now fill the frog of the brick with fine sand. And
- Place the brick on the lower platform of compression testing machine and lower the spindle till the upper motion of ram is offered by a specimen the oil pressure start increasing the pointer start returning to zero leaving the drug pointer that is maximum reading which can be noted down.

11.3. Further probing questions

1. Measure the compressive strength of nonferrous material
2. Determine the compressive strength of the metallic column

12. Charpy impact test

12.1. Introduction

Impact test determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's toughness and acts as a tool to study temperature-dependent brittle-ductile transition.

12.2. Procedure

1. With the striking hammer (pendulum) in safe test position, firmly hold the steel specimen in impact testing machines vice in such a way that the notch faces the hammer and is half inside and half above the top surface of the vice.
2. Bring the striking hammer to its top most striking position unless it is already there, and lock it at that position.
3. Bring indicator of the machine to zero, or follow the instructions of the operating manual supplied with the machine as shown in figure below.

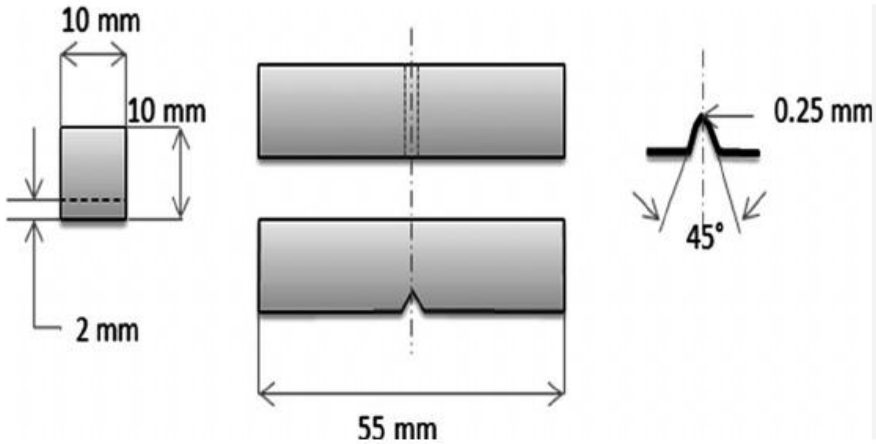


fig.12.1: Charpy Impact Test Specimen Dimensions

12.3 Further Probing Experiments

1. Calculate the impact strength of a unnotched specimens.
2. Determine the impact strength of a U-Notched specimens.

13. Izod impact test

13.1.Introduction

Impact test determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's toughness and acts as a tool to study temperature-dependent brittle-ductile transition.

13.2.Procedure

1. With the striking hammer (pendulum) in safe test position, firmly hold the steel specimen in impact testing machines vice in such a way that the notch faces the hammer and is half inside and half above the top surface of the vice.
2. Bring the striking hammer to its top most striking position unless it is already there, and lock it at that position.
3. Bring indicator of the machine to zero, or follow the instructions of the operating manual supplied with the machine.
4. Release the hammer. It will fall due to gravity and break the specimen through its momentum, the total energy is not absorbed by the specimen. Then it continues to swing.
5. At its topmost height after breaking the specimen, the indicator stops moving, while the pendulum falls back. Note the indicator at that topmost final position as shown in fig.13.1

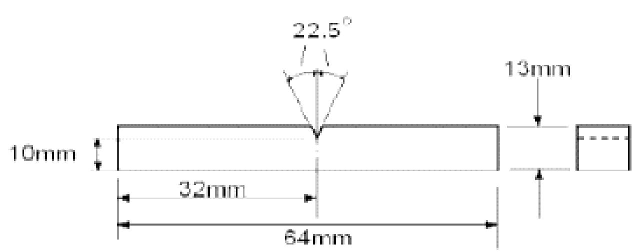


fig.13.1: Izod impact test specimen dimensions

13.3 Further Probing Experiments

1. Calculate the impact strength of unnotched specimens.
2. Determine the impact strength of U-Notched specimens.

14. Shear test

14.1. Introduction

Shear test determines the shear strength of the material during shear loading condition. This absorbed energy is a measure of a given material's toughness and acts as a tool to study temperature-dependent brittle-ductile transition.

14.2. Procedure

- Insert the specimen in position and grip one end of the attachment in the upper portion and one end in the lower portion.
- Switch on the main switch of universal testing machine machine.
- The drag indicator in contact with the main indicator.
- Select the suitable range of loads and space the corresponding weight in the pendulum and balance if necessary, with the help of small balancing weights.
- Operate (push) buttons for driving the motor to drive the pump.
- Gradually move the head control level in left-hand direction till the specimen shears.

14.3 Further Probing Experiments

- Determine the shear strength of the rectangular specimen
- Determine the shear strength of the brittle material

V. TEXT BOOKS:

1. William, Callister, "Material Science and Engineering", Wiley, 9th edition, 2014.
2. Egor V Popov, "Engineering Mechanics of Solids", Pearson, 2nd edition, 2015.

VI. WEB REFERENCES:

1. https://www.labtesting.com/about/capabilities/metal-and-material-analysis/metallurgical-analysis/

VII. Electronics References

1. .https://onlinecourses.nptel.ac.in/noc23_me140/preview
2. https://archive.nptel.ac.in/courses/105/105/105105108/
3. https://nptel.ac.in/courses/112107146

VIII. Materials Online

1. Course template
2. Lab manual

DATA STRUCTURES LABORATORY

III Semester: Common for all branches								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACSC10	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: Programming for Problem Solving using C and 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. 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

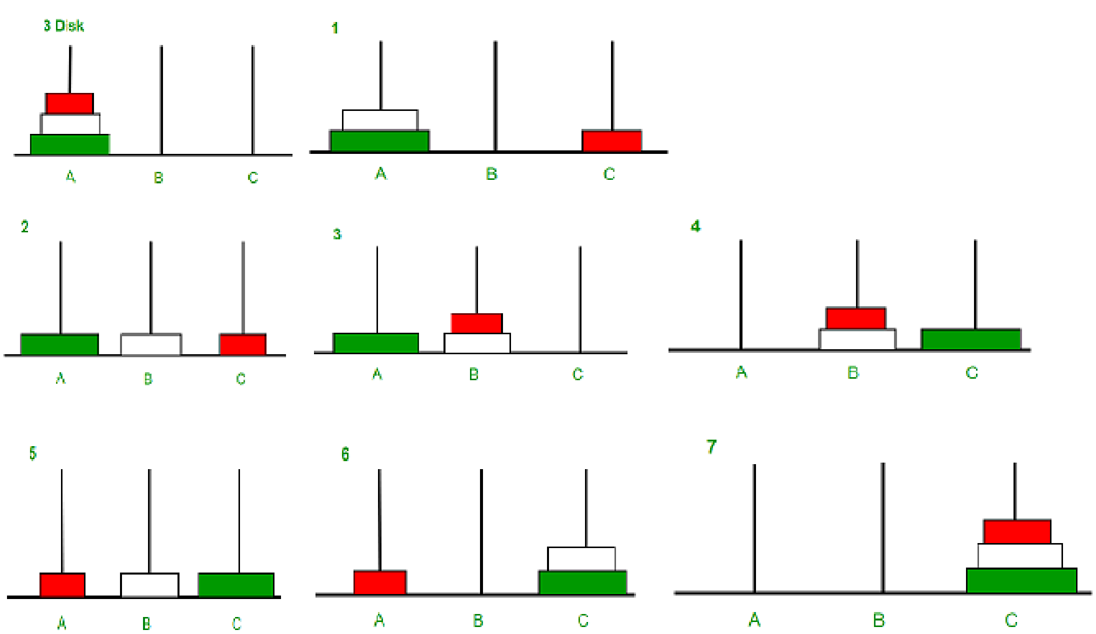
Tower of Hanoi using Recursion:

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"

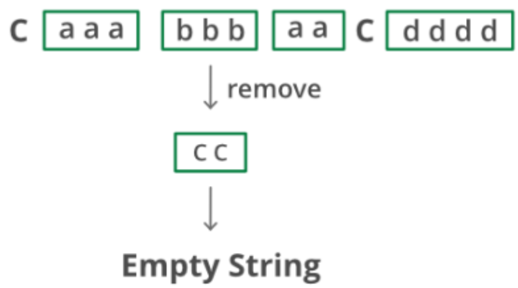
Output: Empty String

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?

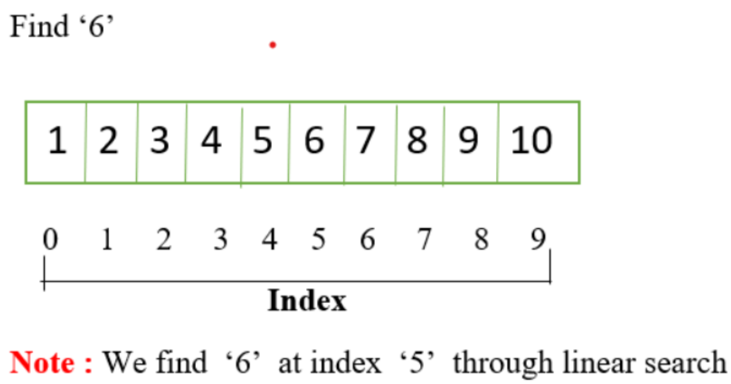
```
fp = 15
def fun(n):
    global fp
    if (n <= 2):
        fp = 1
        return 1

    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.

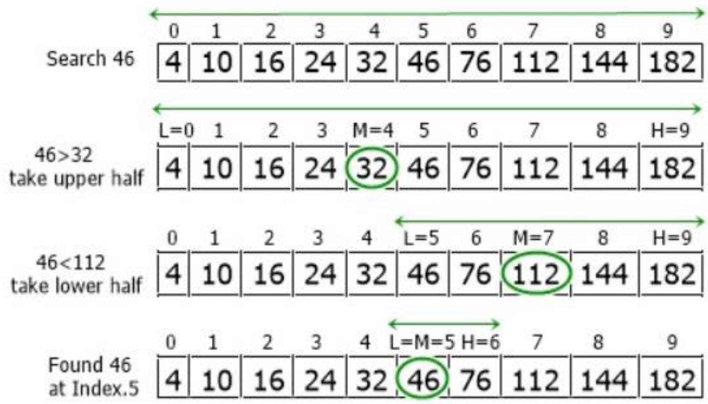
Input: arr[] = {10, 20, 80, 30, 60, 50, 110, 100, 130, 170}
x = 110;
Output: 6
Element x is present at index 6

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)
```

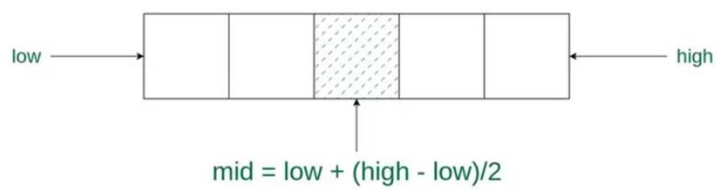
2.2 Binary Search

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)
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.

```
# 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

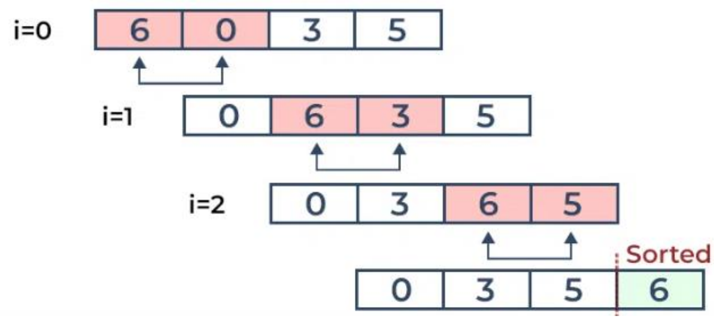
Bubble Sort is the simplest sorting algorithm that works by repeatedly swapping the adjacent elements if they are in the wrong order. This algorithm is not suitable for large data sets as its average and worst-case time complexity is quite high.

Bubble Sort Procedure:

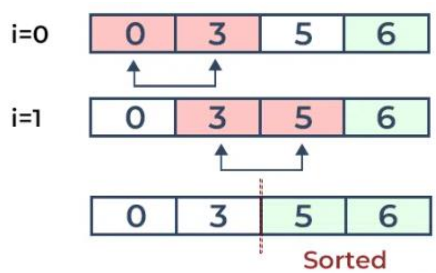
1. Traverse from left and compare adjacent elements and the higher one is placed at right side.
2. In this way, the largest element is moved to the rightmost end at first.

3. This process is then continued to find the second largest and place it and so on until the data is sorted.

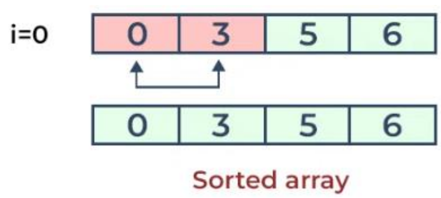
Input: arr = [6, 3, 0, 5]
Output:
First Pass:



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=" ")
```

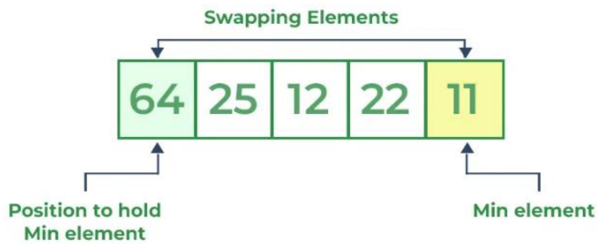
3.2 Selection Sort

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.

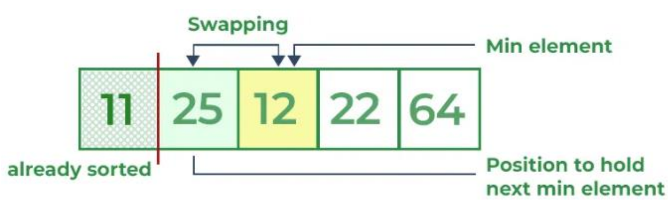
Input: arr = [64, 25, 12, 22, 11]

Output: arr = [11, 12, 22, 25, 64]

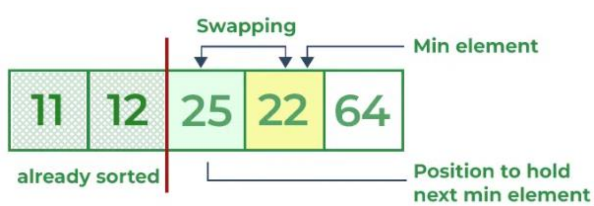
First Pass: For the first position in the sorted array, the whole array is traversed from index 0 to 4 sequentially. The first position where 64 is stored presently, after traversing whole array it is clear that 11 is the lowest value. Thus, replace 64 with 11. After one iteration 11, which happens to 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.

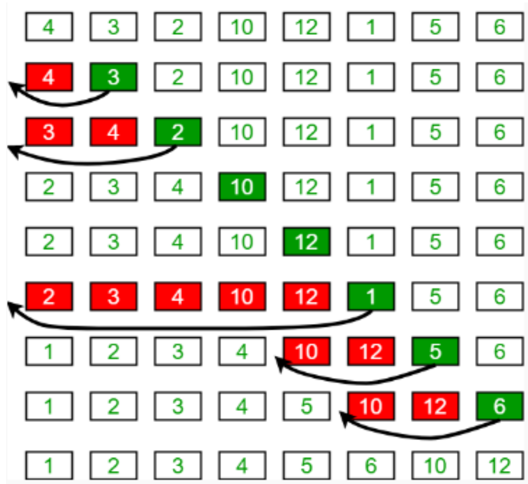

```
# Implementation of selection sort
import sys
A = [64, 25, 12, 22, 11]

# 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.



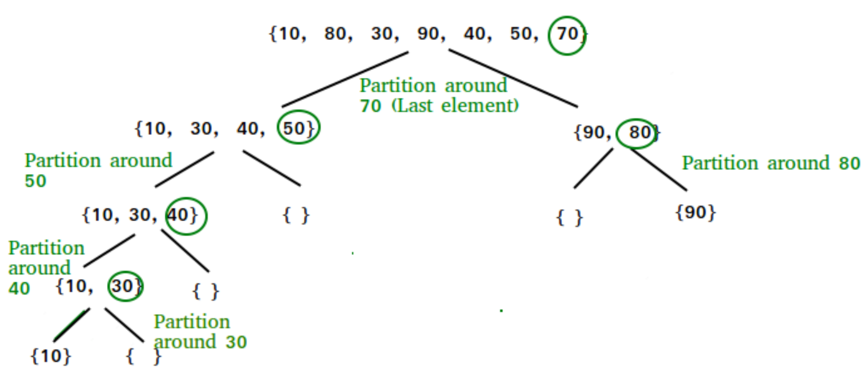
Input: arr = [4, 3, 2, 10, 12, 1, 5, 6]
Output: arr = [1, 2, 3, 4, 5, 6, 10, 12]

```
# 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)
}
```

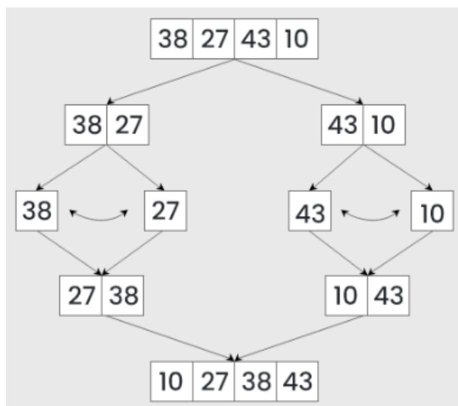
Input: arr = [10, 80, 30, 90, 40, 50, 70]
Output: arr = [10, 30, 40, 50, 70, 80, 90]

```
# 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

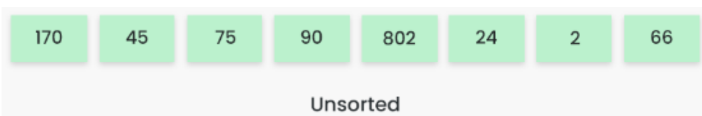
Radix Sort is a linear sorting algorithm that sorts elements by processing them digit by digit. It is an efficient sorting algorithm for integers or strings with fixed-size keys. Rather than comparing elements directly, Radix Sort distributes the elements into buckets based on each digit's value. By 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:



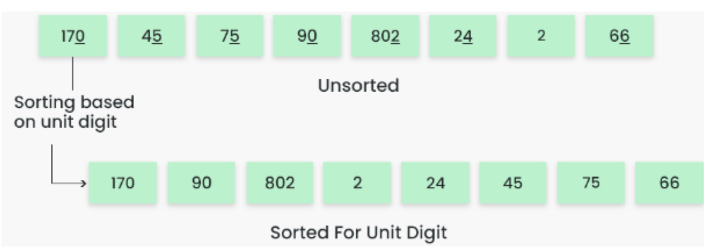
Step 1: Find the largest element in the array, which is 802. It has three digits, so we will iterate three times, once for each significant place.

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]

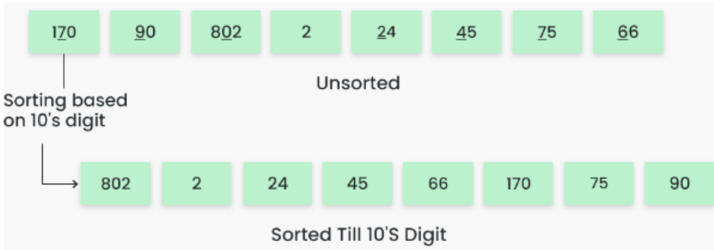


Step 3: Sort the elements based on the tens place digits.

Sorting based on the tens place:

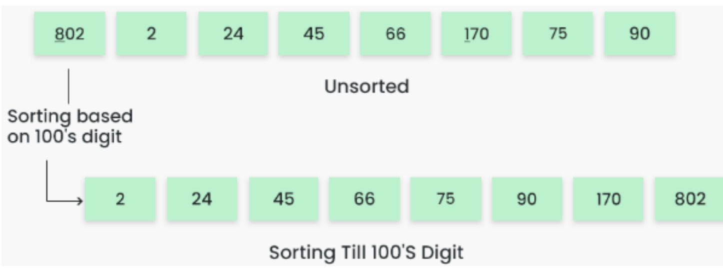
Perform counting sort on the array based on the tens place digits.

The sorted array based on the tens place is [802, 2, 24, 45, 66, 170, 75, 90]



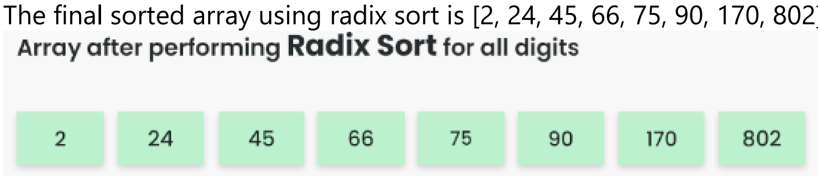
Step 4: Sort the elements based on the hundreds place digits.

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.

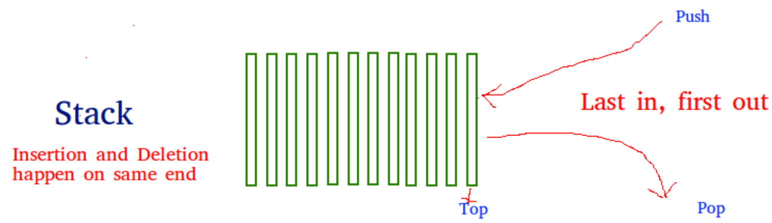
```
Procedure Shell_Sort(Array, N)
  While Gap < Length(Array) /3 :
              Gap = ( Interval * 3 ) + 1
  End While Loop
  While Gap > 0 :
     For (Outer = Gap; Outer < Length(Array); Outer++):
         Insertion_Value = Array[Outer]
              Inner = Outer;
         While Inner > Gap-1 And 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
```

```python
# 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.

```
# 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

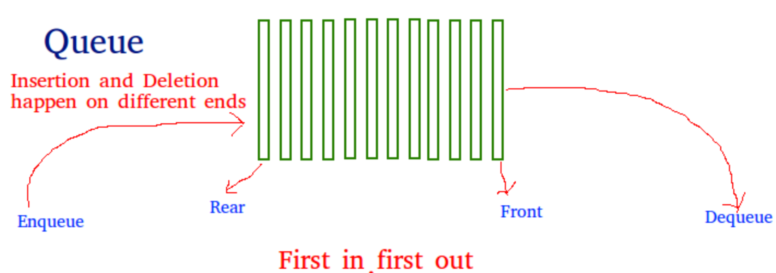
```
# create class for stack
class Stack:

    # 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
```

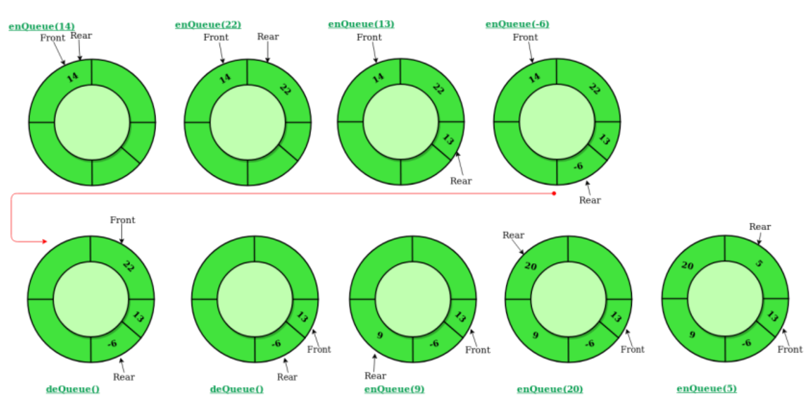
```
        …
# Your MyQueue object will be instantiated and called as such:
# obj = MyQueue()
# obj.push(x)
# param_2 = obj.pop()
# param_3 = obj.peek()
# param_4 = obj.empty()
```

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
```

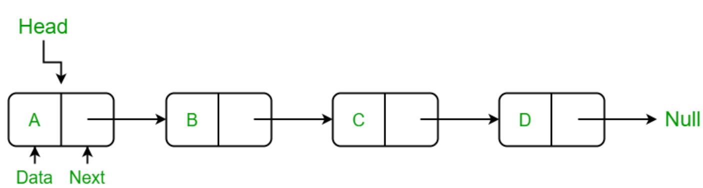
```
# Write code here

# 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

```
# 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:")
```

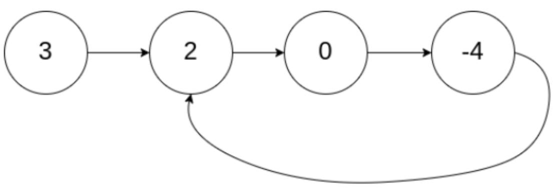
```
llist.printLL()
print("\nUpdate node Value")
llist.updateNode('z', 0)
llist.printLL()
print("\nSize of linked list :", end=" ")
print(llist.sizeOfLL())
```

7.2 Linked List Cycle

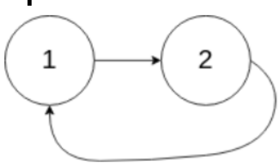
Given head, the head of a linked list, determine if the linked list has a cycle in it. There is a cycle in a linked list if there is some node in the list that can be reached again by continuously following the next pointer. Internally, pos is used to denote the index of the node that tail's next pointer 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.

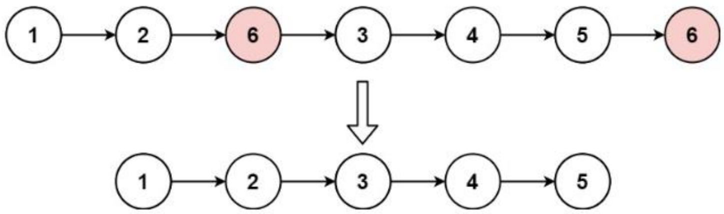
Input: head = [1], pos = -1
Output: false
Explanation: There is no cycle in the linked list.

```
# 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

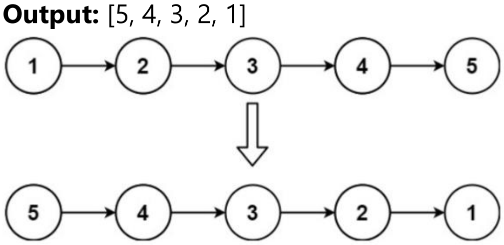
Output: [ ]

```
# 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
        …
```

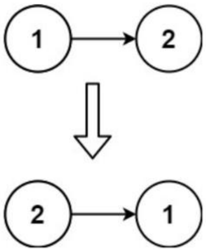
7.4 Reverse Linked List

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]



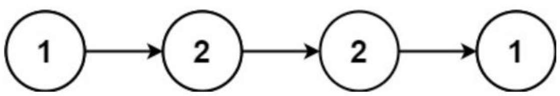
Input: head = [1, 2]
Output: [2, 1]




```
# 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
         …
```

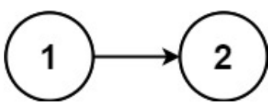
7.5 Palindrome Linked List

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



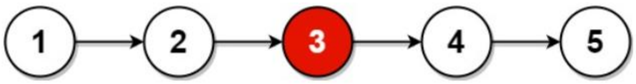
Input: head = [1, 2]

Output: false

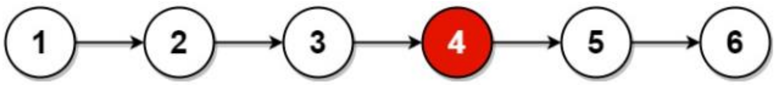
```
# Definition for singly-linked list.
class ListNode:
   def __init__(self, val=0, next=None):
       self.val = val
       self.next = next

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.



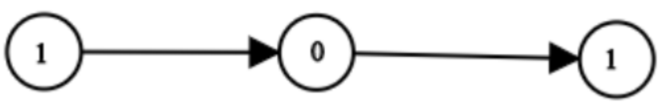
Input: head = [1, 2, 3, 4, 5, 6]
Output: [4, 5, 6]
Explanation: Since the list has two middle nodes with values 3 and 4, we return the second one.

```
# 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.



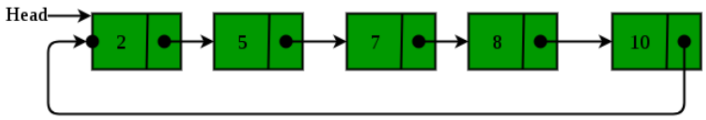
Input: head = [1, 0, 1]
Output: 5
Explanation: (101) in base 2 = (5) in base 10
Input: head = [0]
Output: 0

```
# 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
        …
```

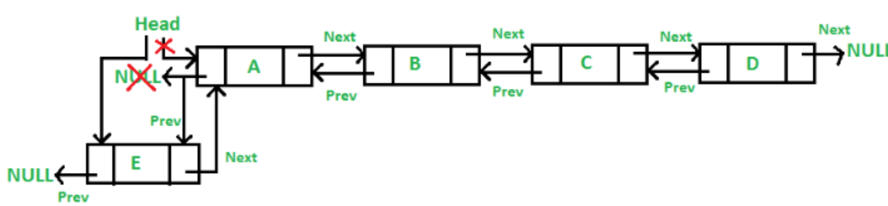
```python
    def traverse(self):
        # Write code here
        …
# Driver Code
cll = CircularLinkedList()

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

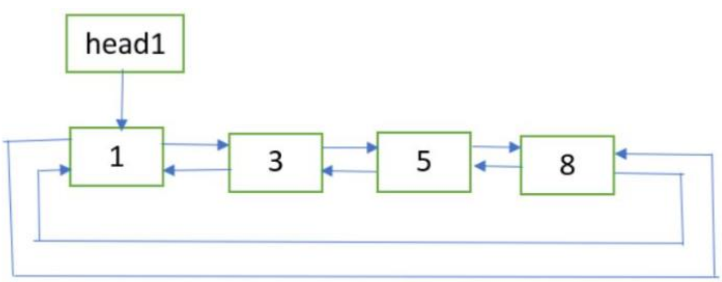
```python
# Implementation of doubly linked list
class Node:
    def __init__(self,data):
        self.data=data
        self.next=self.prev=None

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)
```

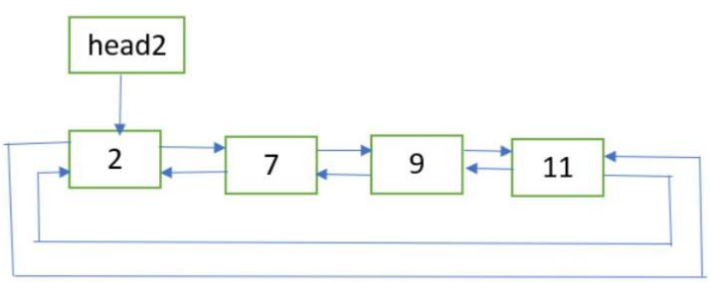
```
    elif ch==2:
        data=eval(input("Enter data:"))
        pos=int(input("Enter position:"))
        d.insert_pos(pos,data)

    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

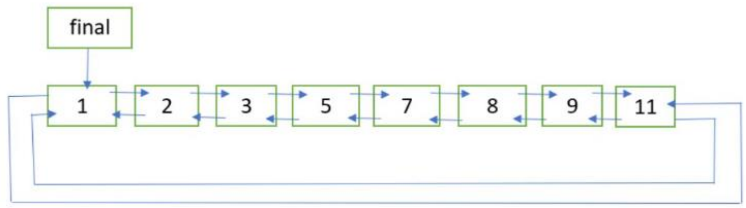
Given two sorted Doubly circular Linked List containing n1 and n2 nodes respectively. The problem is to merge the two lists such that resultant list is also in sorted order.

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
```

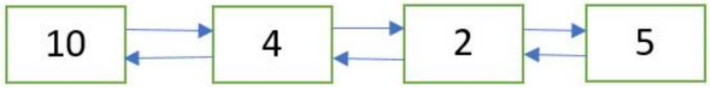
```
        self.prev = None

# 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.

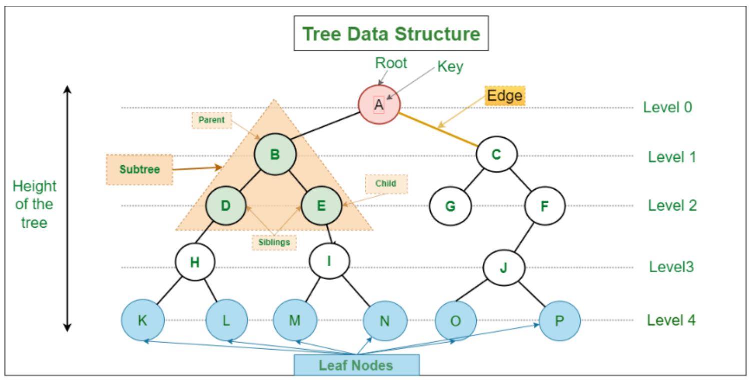
```
# Python implementation to delete a doubly Linked List node
# at the given position

# 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.

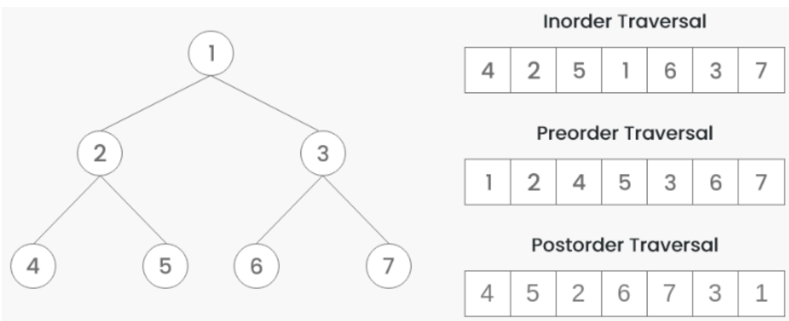
```python
# Demonstration of Tree Basic Terminologies
# Function to add an edge between vertices x and y

# 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
        …
```

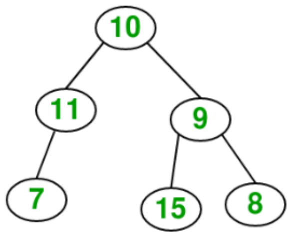
```
    def inorder(self,root):
        # Write code here
        …
```

```
# 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
```

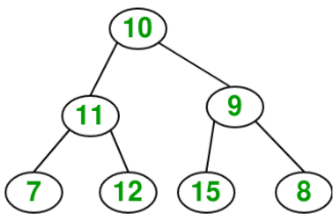
9.3 Insertion in a Binary Tree in Level Order

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)
```

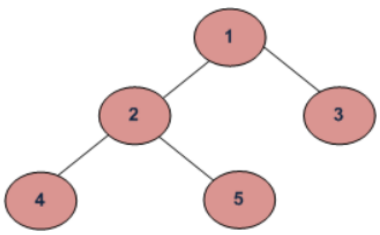
```
print()
print("Inorder traversal after insertion:", end = " ")
inorder(root)
```

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:

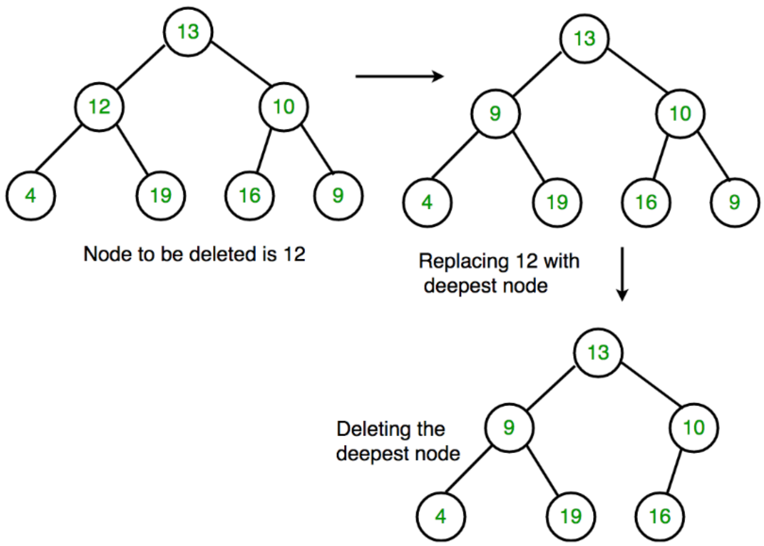
```
      10
    /    \
  40      30
```

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)

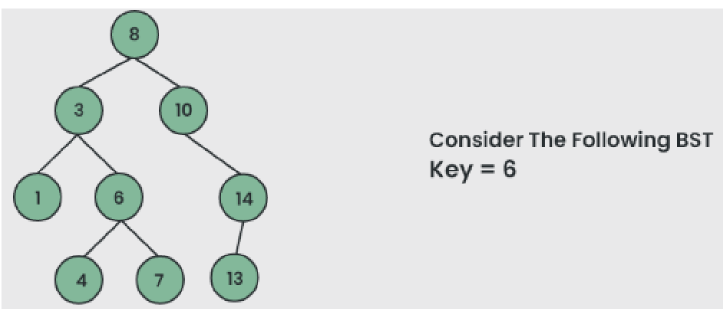
10.1 Searching in Binary Search Tree

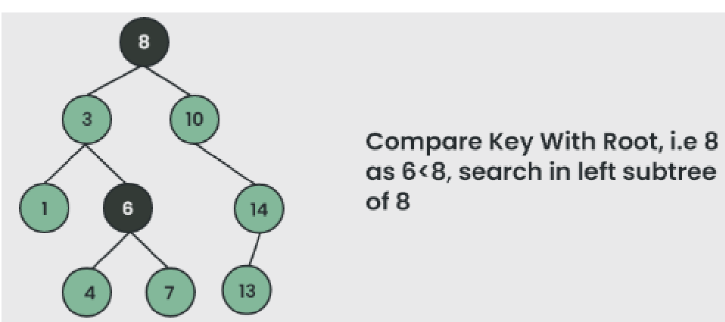
Given a BST, the task is to delete a node in this BST. For searching a value in BST, consider it as a sorted array. Perform search operation in BST using Binary Search Algorithm.

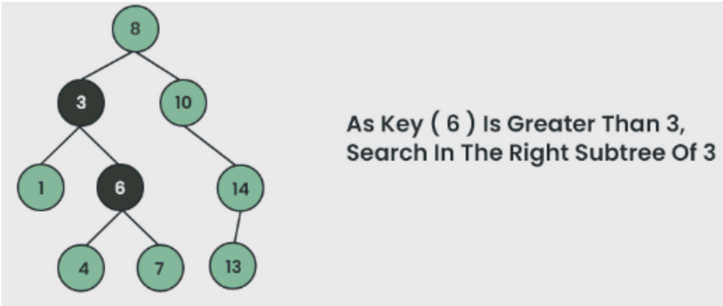
Algorithm to search for a key in a given Binary Search Tree:

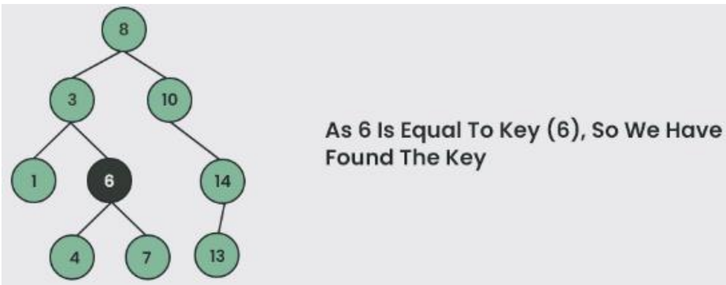
Let's say we want to search for the number **X,** We start at the root. Then:

- 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.









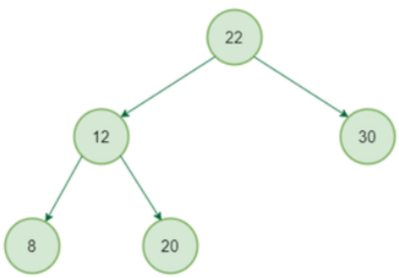

```
# Search a given key in a given BST

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

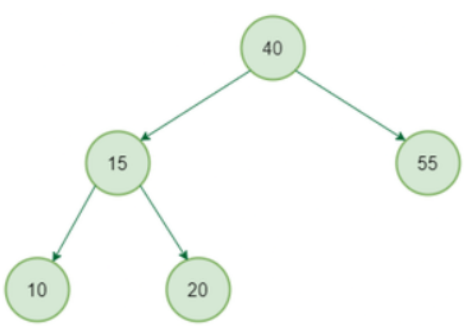
Write a function to find the node with minimum value in a Binary Search Tree.

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
```

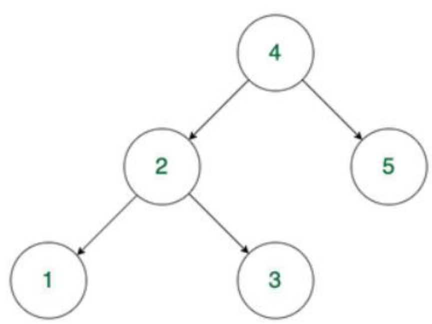
```
    …
# Given a non-empty binary search tree, inorder traversal for
# the tree is stored in the list sorted_inorder. Inorder is LEFT, ROOT, RIGHT.

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
```

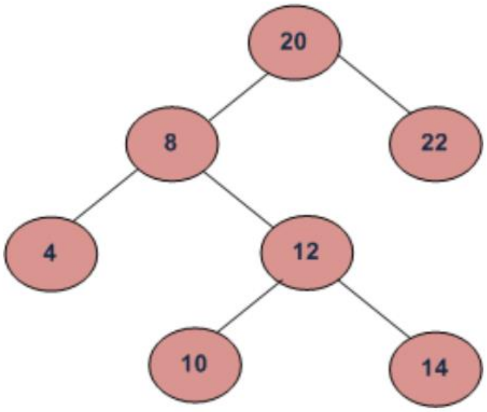
Output: 20

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:

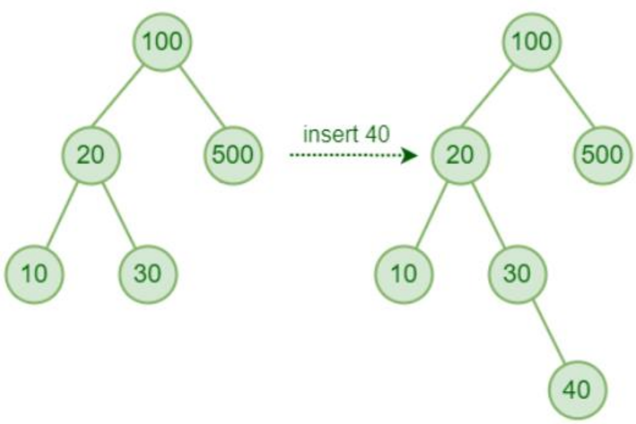
1. **Kth largest element in BST when modification to BST is not allowed:** Given a Binary Search Tree (BST) and a positive integer k, find the k'th largest element in the Binary Search Tree. For a given BST, if k = 3, then output should be 14, and if k = 5, then output should be 10.



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.

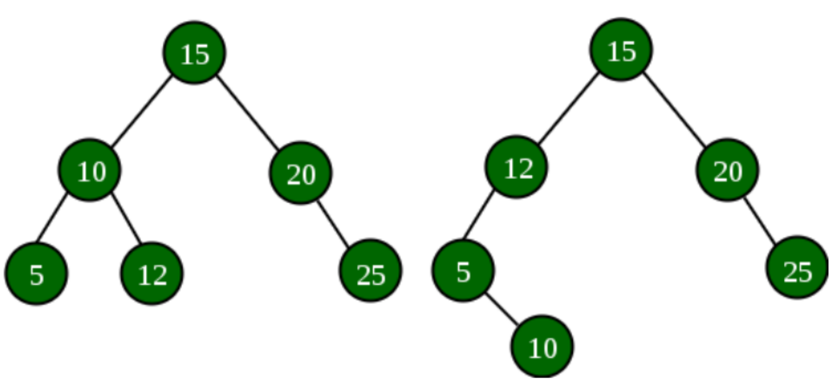
```
# insert operation in binary search tree
# A utility class that represents an individual node in a BST
class Node:
```

```
    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)

```python
# 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)

```python
# 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
```

```python
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
 # 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

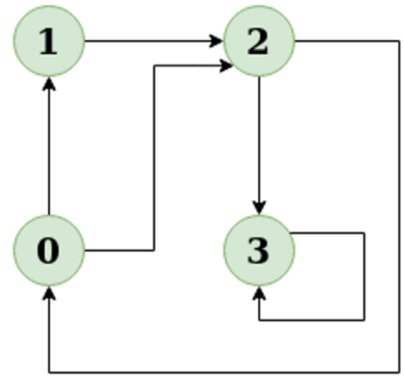
Depth First Traversal (or DFS) for a graph is similar to Depth First Traversal of a tree. The only catch here is, that, unlike trees, graphs may contain cycles (a node may be visited twice). To avoid processing a node more than once, use a boolean visited array. A graph can have more than one DFS traversal.

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

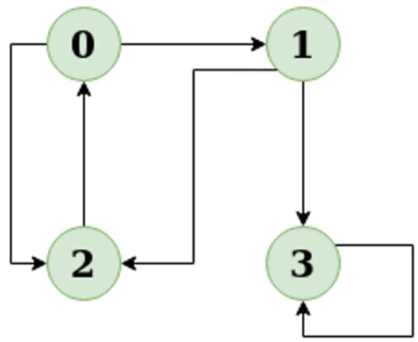
Explanation:
DFS Diagram:



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)

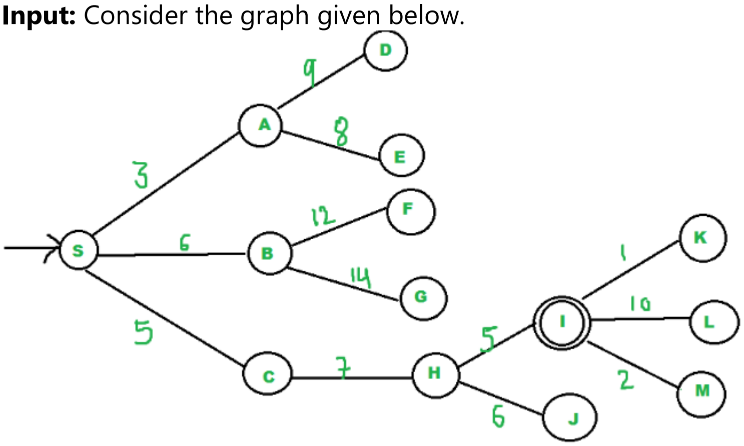
The idea of Best First Search is to use an evaluation function to decide which adjacent is most promising and then explore. Best First Search falls under the category of Heuristic Search or Informed Search.

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.

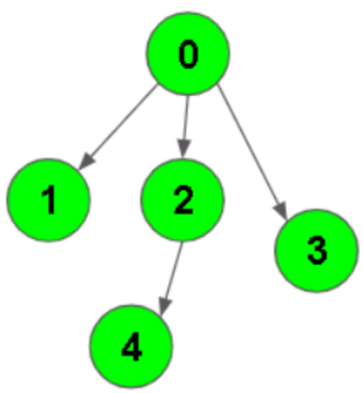
```
from queue import PriorityQueue
v = 14
graph = [[] for i in range(v)]

# 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)}



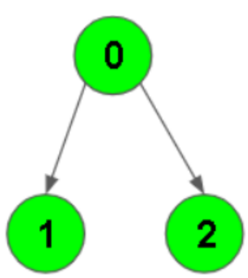
Output: 0 1 2 3 4

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)}



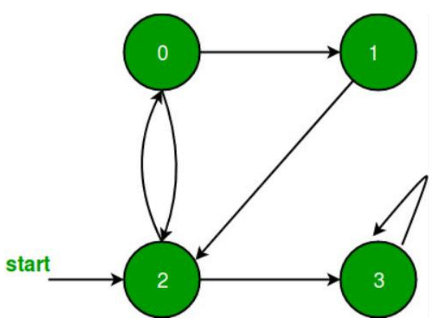
Output: 0 1 2
Explanation:
0 is connected to 1, 2. So starting from 0, it will go to 1 then 2, thus BFS will be 0 1 2.
Your task is to complete the function **bfsOfGraph()** which takes the integer V denoting the number of vertices and adjacency list as input parameters and returns a list containing the BFS traversal of the graph starting from the 0th vertex from left to right.

```python
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.

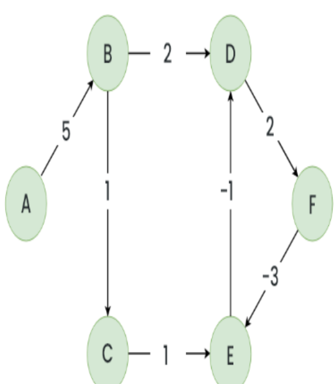
```python
# DFS traversal for complete graph
from collections import defaultdict

# 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:

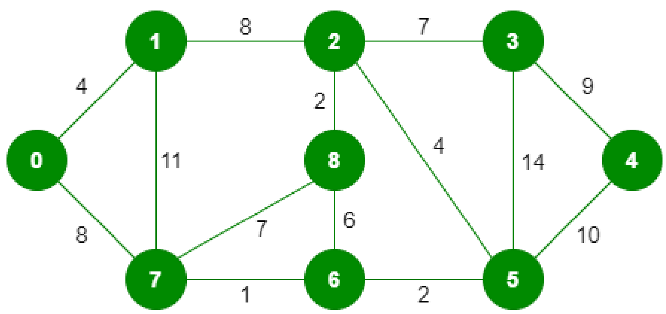
1. Sort all the edges in non-decreasing order of their weight.

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.



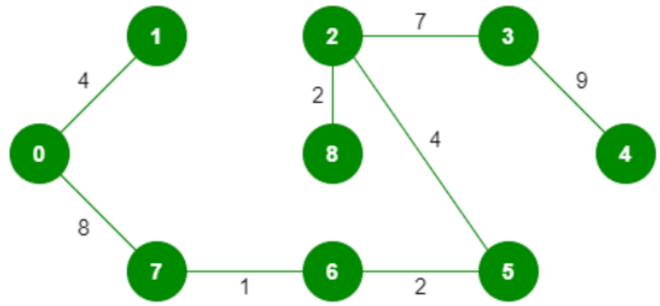
The graph contains 9 vertices and 14 edges. So, the minimum spanning tree formed will be having (9 – 1) = 8 edges.

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:




```
# 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

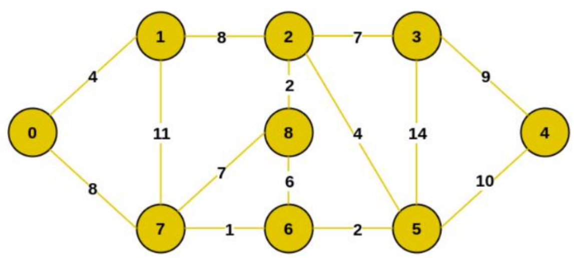
The Prim's algorithm starts with an empty spanning tree. The idea is to maintain two sets of vertices. The first set contains the vertices already included in the MST, and the other set contains the vertices not yet included. At every step, it considers all the edges that connect the two sets and picks 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:

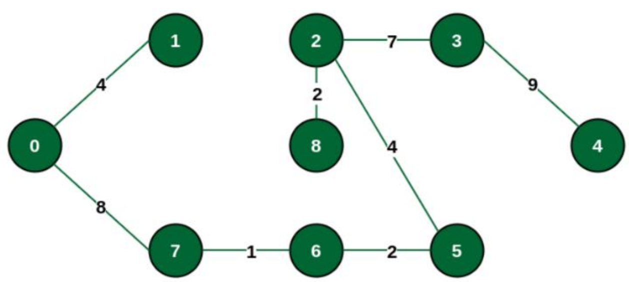
The working of Prim's algorithm can be described by using the following steps:

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

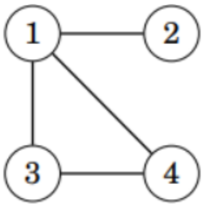
13.3 Total Number of Spanning Trees in a Graph

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.

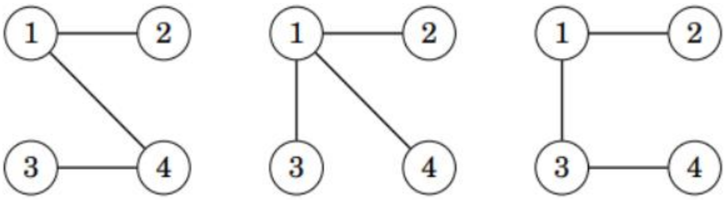
Laplacian matrix:

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,

$$\det(\begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix}) = 3.$$

The determinant is always the same, regardless of which row and column we remove from L.

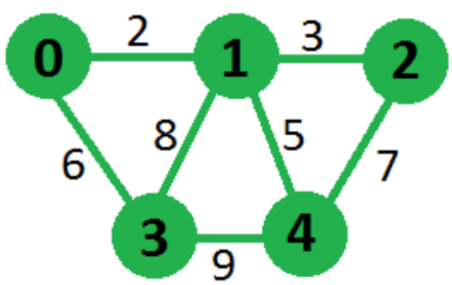
```
# Finds the number of spanning trees in a graph using Matrix Chain Multiplication.
MAX = 100
MOD = 1000000007

# 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.

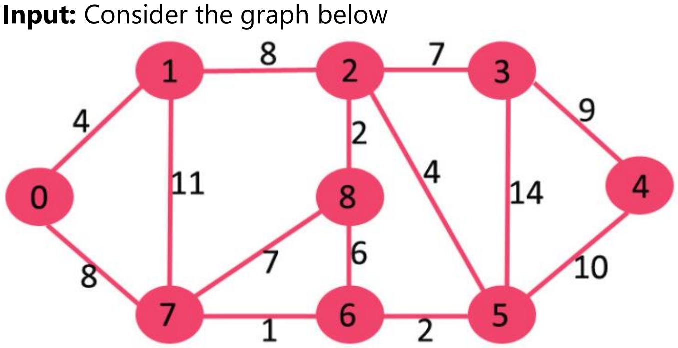
Algorithm:

1. Sort all edges of graph in non-increasing order of edge weights.

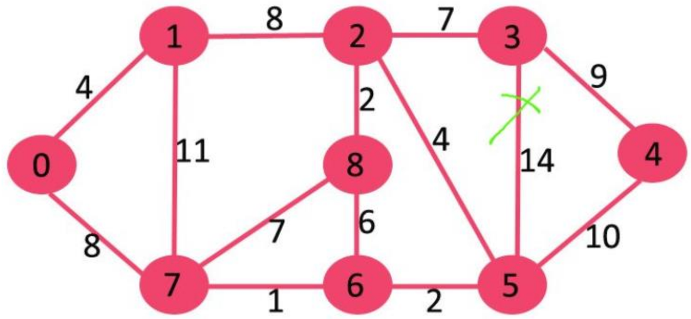
2. Initialize MST as original graph and remove extra edges using step 3.

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.

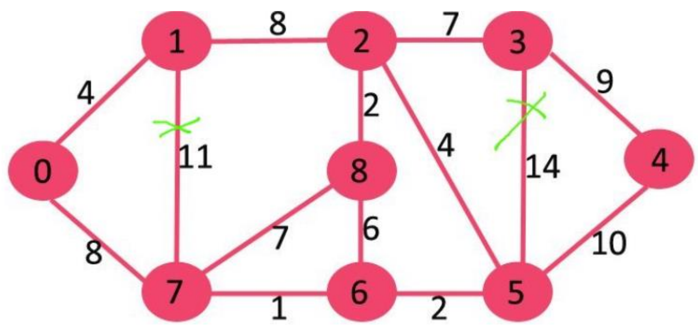
Input: Consider the graph below



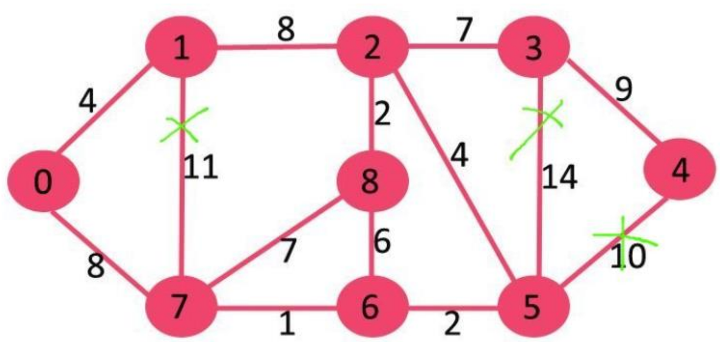
If we delete highest weight edge of weight 14, graph doesn't become disconnected, so we remove it.



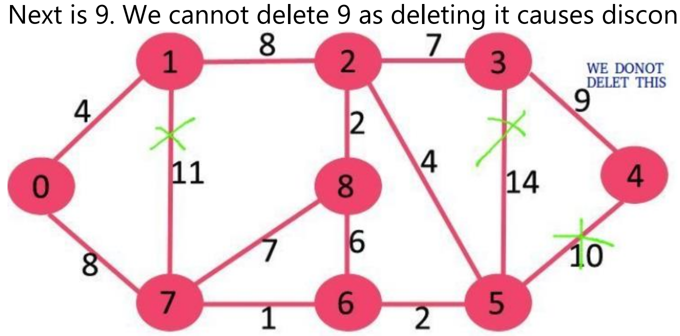
Next we delete 11 as deleting it doesn't disconnect the graph.



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)

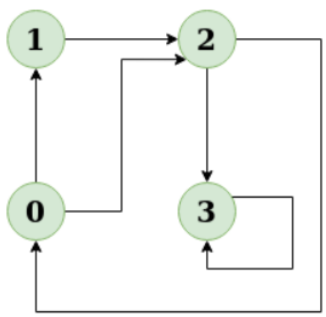
```
# Find Minimum Spanning Tree of a graph using Reverse Delete Algorithm

# 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

III Semester: **Common for all branches**

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AHSC10	Mandatory	L	T	P	C	CIA	SEE	Total
		-	-	-	-	-	-	-
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: Nil		

Prerequisite: **No Prerequisites**

COURSE OBJECTIVES:

The student will try to learn:

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

KINEMATICS OF MACHINERY

<table>
<tr><td colspan="9">IV Semester: ME</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">AMEC10</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="3">Practical Classes: Nil</td><td colspan="4">Total Classes: 60</td></tr>
<tr><td colspan="9">Prerequisite: Engineering Mechanics</td></tr>
</table>

I. COURSE OVERVIEW:

Mechanical devices are designed to have mobility to perform certain functions. The theory behind the study of Kinematics of Machine emphasizes to design machines by understanding the relationship between the geometry and the motion of various parts of machine. This course will provide the knowledge on how to analyze the motions and design synthesis of mechanisms to give required mobility. This includes relative motion analysis and design of gears, gear trains, cams, linkages and steering mechanism by adopting both graphical and analytical approaches to estimate displacement, velocity and acceleration of links in a machine.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The basic concepts of Machine design to develop Mechanisms and Machines by using type synthesis, number synthesis and dimensional synthesis.
II. Kinematics from the geometric point of view to determine mobility, velocity andacceleration using graphical methods.
III. Mechanisms with lower pairs to obtain steering, copying and straight line motions inautomobiles and other allied applications..
IV. Kinematic analysis and synthesis of cams(higher pairs) imparting motion to knifeedged ,roller andmushroom followers ,Gears and Gear trains.

III. COURSE SYLLABUS:

MODULE-I: MECHANISMS (09)

Mechanisms: Elements or links, classification, rigid link, flexible and fluid link, types of kinematic pairs types of constrained motion, kinematic chain, mechanism, machine, structure, inversion of mechanism, inversions of quadric cycle chain, single and double slider crank chains, mechanical advantage, Grubler's Criterion.

MODULE –II: KINEMATICS, PLANE MOTION OF BODY, ANALYSIS OF MECHANISMS (12)

Kinematics: Velocity and acceleration, motion of link in machine, determination of velocity and acceleration, Graphical method, application of relative velocity method, plane motion of body: Instantaneous center of rotation, centroids and axodes, three centers in line theorem, graphical determination of instantaneous center, determination of angular velocity of points and links by instantaneous center method. Klein's construction, Coriolis acceleration, determination of Coriolis component of acceleration.

MODULE –III: STRAIGHT LINE MOTION MECHANISMS, STEERING GEARS, HOOKE'S JOINT (12)

Introduction to Straight-line motion Mechanisms

Steering gears: Conditions for correct steering, Davis Steering gear, Ackerman's steering gear, Hooke's joint: Single and double Hooke's joint, velocity ratio, application, problems.

MODULE –IV: CAMS, ANALYSIS OF MOTION OF FOLLOWERS (12)

Cams: Definitions of cam and followers, their uses, types of followers and cams, terminology, types of follower motion, uniform velocity, simple harmonic motion and uniform acceleration; Maximum velocity and maximum acceleration during outward and return strokes in the above three cases; Analysis of motion of followers.

MODULE –V: HIGHER PAIRS, GEAR TRAINS (12)

Higher Pairs: friction wheels and toothed gears, types, law of gearing, condition for constant velocity ratio for transmission of motion, velocity of sliding, form of teeth, cycloidal and involute profiles, phenomena of interferences, methods of interference; Condition for minimum number of teeth to avoid interference, expressions for arc of contact and path of contact of pinion and gear pinion and rack arrangements; Introduction to helical, bevel and worm gearing; Gear trains: Introduction, types, simple and reverted gear trains, epicyclic gear train; Methods of finding train value or velocity ratio of epicyclic gear trains, differential gear for an automobile.

IV. TEXTBOOKS:

1. Mallik, A. K., Ghosh, A., & Dittrich, G. Kinematic analysis and synthesis of mechanisms: CRC Press. , 10th Edition, 2008.
2. Uicker, J. J., Pennock, G. R., & Shigley, J. E. Theory of machines and mechanisms: OUP. , 2nd Edition, 2008.
3. Norton, R. L. Design of machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines: McGrawHill, 2nd Edition, 2008.
4. Rattan.S.S. Theory of Machines: McGraw-Hill Education (India) Pvt Ltd, , 6th Edition, 2013.
5. Rao, J. S. The Theory of Machines Through Solved Problems: New Age International, 2nd Edition, 2008.

V. REFERENCEBOOKS:

1. Bevan, T. The theory of machines: A Text-Book for Engineering Students: Pearson Education, 4th Edition, 2013.
2. Vinogradov, O. G. Fundamentals of kinematics and dynamics of machines and mechanisms: CRC Press, 2nd Edition, 2014.
3. Ballaney PL, Theory of Machines and Mechanisms, Khanna Publications, 5th Edition, 2012.

VI. WEB REFERENCES:

1. http://www.uobabylon.edu.iq/uobColeges/ad_downloads/4_1293_515.pdf
2. http://ebooks.library.cornell.edu/k/kmoddl/toc_hartenberg1.html

VII. E-TEXTBOOKS:

1. https://drive.google.com/file/d/0B7raaoEF40D7eEJIR1VoODJodFE/edit
2. http://royalmechanicalbuzz.blogspot.in/2015/04/theory-of-machines-by-rs-khurmi-ebook-pdf.html
3. https://docs.google.com/file/d/0B5dLUIZfysmqMXBhakRyODhublU/edit
4. https://archive.org/details/theoryofmachines00mckarich

MANUFACTURING PROCESSES

IV Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC11	**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: Workshop Manufacturing Practices Laboratory								

I. COURSE OVERVIEW:

This course is to introduce the concept of manufacturing process with the help of various processes widely employed in the industries. This course consists of casting, welding, sheet metal forming, extrusion and forging processes with the related details of equipment and applications. It Introduces the different manufacturing processes and breakeven analysis. Engineering materials, laying emphasis on ferrous and non-ferrous materials along with the heat treatment of metals discusses the special casting processes and metal-forming processes respectively.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The Importance of manufacturing sciences in the day-to-day life, and study the basic manufacturing processes and tools used.

I. The knowledge in thermal, metallurgical aspects during casting and welding for defect free manufacturing components.

II. The design features that make each of this manufacturing process both harder, easier, assess design and manufacturing features on real products.

III. COURSE SYLLABUS:

MODULE-I: CASTING (09)

Casting: Steps involved in making a casting, its applications, patterns and types of patterns, pattern allowances, types of casting processes, solidification of casting, casting defects.

MODULE –II: WELDING (09)

Welding: Welding types, Oxy-fuel gas welding, Arc welding Process, Resistance welding, Inert gas welding, TIG welding, MIG welding, Friction welding, Induction pressure welding, Electron beam welding, Laser welding, Soldering and Brazing. Heat affected zone in welding, welding defects, causes and remedies.

MODULE –III: METAL FORMING (09)

Forming: Hot working, cold working, recovery, re-crystallization and grain growth, comparison of properties of cold and hot worked parts, rolling fundamentals, theory of rolling, types of rolling mills and products, stamping, forming.

Blanking and piercing, bending and forming, drawing and its types, wire drawing and tube drawing; coining; hot and cold spinning.

MODULE –IV: EXTRUSION AND RAPID PROTOTYPING (09)

Extrusion of Metals: Basic extrusion process and its characteristics, hot extrusion and cold extrusion, forward extrusion and backward extrusion, impact extrusion, tube extrusion and Pipe making, hydrostatic extrusion; Additive manufacturing: Rapid prototyping and rapid tooling.

MODULE –V: FORGING (09)

Forging operations and principles, tools, smith forging, drop forging, roll forging, rotary forging, forging defects, cold forging, swaging.

V. TEXT BOOKS

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials -Pearson India, 5th Edition 2014.

VI. REFERENCE BOOKS:

1. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems John Wiley & Sons Inc., 4th Edition, 2008.
2. Degarmo, Black &Kohser, Materials and Processes in Manufacturing (9th Edition) John Wiley & Sons Inc., 7th Edition, 2012.

VI. WEB REFERENCES:

1. https://books.google.co.in/books/about/Manufacturing_Processes_Reference_Guide.html?id=6x1sm

VII. E-TEXT BOOKS:

1. https://books.google.co.in/books?id=6wFuw6wufTMC&printsec=frontcover#v=onepage&q&f=false

FLUID MECHANICS AND HYDRAULIC MACHINES

IV Semester: ME								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC12	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 Mechanics and Thermodynamics								

I. COURSEOVERVIEW:

Fluid mechanics is that branch of science which deals with the behavior of the fluids (liquids or gases) at rest as well as in motion. Thus, this branch of science deals with the static, kinematics and dynamic aspects of fluids. The proper understanding of mechanics of fluids is critical in various branches of engineering. The primary motive of this course is to examine, through the laws of fluid mechanics and thermodynamics, the means by which the energy transfer is carried out in the turbomachinery, together with the differing behavior of individual types in operation.

II. COURSEOBJECTIVES:

The students will try to learn:

1. The fundamental knowledge of fluids, their properties and behavior under various conditions of closed conduit and external flow systems.
2. The development of various static and dynamic fluid flow governing equations from the fundamental conservation laws of motion studied under basic physics and classical mechanics.
3. The concepts and principles related to fluid mechanics, which are used in the applications of hydraulics and hydraulic machines.
4. The real world engineering problems and examples towards gaining the experience for how fluid mechanics is applied in engineering practice.

III. COURSESYLLABUS:

MODULE-I: FLUID STATICS (12)

Definition of fluid, Newton’s law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, application of continuity equation.

MODULE –II: FLUID KINEMATICS AND DYNAMICS (12)

Fluid Kinematics: Kinematics of fluid flow- Eulerian and Lagrangian descriptions, Stream line, path line, streak line and stream tube, classification and description of flows for one and three dimensions.

Fluid Dynamics: Euler's equation of motion, Bernoulli equation for flow along a stream line and applications, Measurement of flow and momentum equation.

MODULE –III: BOUNDARY LAYER CONCEPTS AND CLOSED CONDUIT FLOW (12)

Concept of boundary layer – Definition, characteristics along thin plate, laminar, transition and turbulent boundary layers, separation of boundary layer, measures of boundary layer thickness.

Closed conduit flow: – Darcy Weisbach equation, friction factor, Head loss in pipe flow, Moody’s diagram and introduction to dimensional analysis.

MODULE –IV: FLUID MACHINES (12)

Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines-Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed,unit quantities, performance curves for turbines – governing of turbines.

MODULE –V: PUMPS (12)

Theory of rotodynamic machines, various efficiencies, velocity components at entry and exit of the rotor, velocity triangles, Centrifugal pumps, working principle, work done by the impeller, performance curves– Cavitation in pumps- Reciprocating pump–working principle-indicator diagrams.

IV. TEXTBOOKS

1. Rajput, "Fluid Mechanics and Hydraulic Machines", S.Chand & Co, 6th Edition, 1998.
2. H Modi, Seth, "Hydraulics, Fluid Mechanics and Hydraulic Machinery", Rajsons Publications, 20th Edition, 2013.
3. M. White, Fluid Mechanics, 8th Edition, Tata McGraw Hill, 2016.

V. REFERENCEBOOKS:

1. D.S. Kumar, "Fluid Mechanics and Fluid Power Engineering", Kotaria & Sons, 9th Edition 2013.
2. Dr. R K Bansal, "A Text Book of Fluid Mechanics and Hydraulic Machines", Laxmi Publications, 9th Edition, 2015.
3. R. L. Panton, Incompressible Flow, Wiley-India, 3rd Edition, 2005.

VI. WEBREFERENCES:

1. https://nptel.ac.in/courses/112105171/
2. https://www.oreilly.com/library/view/fluid-mechanics-and/9788177583649/
3. https://books.google.co.in/books/about/A_Textbook_of_Fluid_Mechanics_and_Hydrau.html?id=nTMVnwEACAAJ&redir_esc=y

VII. E-TEXT BOOKS:

1. https://vscht.cz/uchi/ped/hydroteplo/materialy/introduction.fluid.mech.pdf
2. https://idoc.pub/documents/drrkbansal-fluid-mechanics-and-hydraulic-machines-pdf-6nq99jo6gqlw
3. https://www.pdfdrive.com/a-textbook-of-fluid-mechanics-hydraulic-machines-by-r-k-rajput-e184521268.html

APPLIED THERMODYNAMICS

IV Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC13	**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: Thermodynamics.								

I. COURSE OVERVIEW:

Applied Thermodynamics is science intended to introduce concepts and working principles of internal combustion engines which are widely used in different industrial applications such as automobile, agriculture, industry for transport, water pumping, electricity generation, earth moving and for supply mechanical power. This course also deals with working principles of compressors and refrigeration systems in various fields of engineering.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The concepts related to the operation of internal combustion engines based upon the fundamental engineering sciences of thermodynamics.

II. The techniques for improving the efficiencies and performance of compressors and refrigeration systems retained to practical applications such as irrigation, air conditioning and refining oil and gas.

III. The performance of Heat Engines in real-time applications by applying the various testing parameters of an engine.

III. COURSE SYLLABUS:

MODULE-I: IC ENGINES (09)

Four and two stroke engine, SI and CI engines, valve and port timing diagrams, fuel injection systems for SI and CI engines, ignition systems, cooling and lubrication system of IC engines.

MODULE –II: COMBUSTION IN SI ENGINES AND CI ENGINES (09)

Combustion in SI Engines: Normal combustion and abnormal combustion, importance of flame speed and effect of engine variables, type of abnormal combustion, pre-ignition and knocking, fuel requirements and fuel rating, anti-knock additives. Combustion in CI Engines: Four stages of combustion, delay period and its importance, effect of engine variables, diesel Knock.

MODULE –III: PERFOMANCE OF ENGINES AND COMPRESSORS (09)

Parameters of performance, measurement of cylinder pressure, fuel consumption, air intake, exhaust gas composition, brake power, determination of frictional losses and indicated power, performance test, heat balance sheet.

Classification of compressors: fans, blower and compressor, positive displacement and dynamic types, reciprocating and rotary types

MODULE –IV: CENTRIFUGAL AND AXIAL COMPRESSORS (09)

Centrifugal compressors: mechanical details and principle of operation, velocity and Pressure variation, Energy transfer, impeller blade shape-losses, slip factor, and power input factor, pressure coefficient and adiabatic coefficient, velocity diagrams, power. Axial flow compressors: Mechanical details and principle of operation, velocity triangles and energy transfer per stage degree of reaction, work done factor, isentropic efficiency, pressure rise calculations, poly-tropic efficiency.

MODULE –V: REFRIGERATION (09)

Mechanical refrigeration and types, units of refrigeration, air refrigeration system, details and principle of operation, applications of air refrigeration, vapor compression refrigeration systems, calculation of COP, effect of superheating and sub cooling, desired properties of refrigerants and common refrigerants, use of p-h charts for calculations.

VI. TEXT BOOKS

1. V. Ganesan, “I.C. Engines”, Tata McGraw-Hill, 3rd Edition, 2011.
2. B. John Heywood, “Internal Combustion Engine Fundamentals”, Tata McGraw-Hill, 2nd Edition, 2011.
3. R.K. Rajput, “Thermal Engineering”, Lakshmi Publications, 1st Edition, 2011P. K. Nag, “Engineering Thermodynamics”, Tata McGraw Hill, 4th Edition, 2008.

VI. REFERENCE BOOKS:

1. Mathur, Sharma, “IC Engines”, Dhanpat Rai & Sons, 3rd Edition, 2008.
2. Pulkrabek, “Engineering Fundamentals of IC Engines”, Pearson Education, 2nd Edition, 2008.
3. Rudramoorthy, “Thermal Engineering”, Tata McGraw-Hill, 5th Edition 2003.
4. C. P. Arora, “Refrigeration and Air Conditioning”, Tata McGraw-Hill Education, 3rd Edition, 2013.
5. J. B. Jones, R. E. Dugan, “Engineering Thermodynamics”, Prentice Hall of India Learning, 1st Edition, 2009.

V. WEB REFERENCES:

1. http://www.newworldencyclopedia.org/entry/Internal_combustion_engine
2. http://www.nptel.ac.in/courses/112106133/#
3. https://www.grc.nasa.gov/www/k-12/airplane/engopt.html

DESIGN OF MACHINE ELEMENTS

IV Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC14	**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: Materials and Mechanics of Solids, Kinematics of Machinery, Dynamics of Machinery								

I. COURSE OVERVIEW:

Machine design emphasizes for influence the failsafe design in the mechanical systems using different theories of failure modes. The design of machine members focuses mainly on design of machine elements subjected to various types of loads and components include joints; Riveted, Welded, threaded joints, shafts and springs using Design standards, B.I.S codes of steels. The Design philosophy is based on strength, stiffness and material selection for manufacture of machine elements.

II. COURSE OBJECTIVES:

The students will try to learn:

- **I.** The machine element design process that achieves desired constraints for strength, rigidity and reliability.
- **II.** The nature of loading for the application of theories of failure for mechanical machine elements under different loading conditions.
- **III.** The various permanent and temporary joints in engineering applications subjected to various loading conditions.
- **IV.** The design procedure for the various power transmission elements on the basis of strength and rigidity.

III. COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO THEORY OF FAILURES (12)

Introduction: General considerations in the design of engineering materials and their properties, selection, manufacturing consideration in design, tolerances and fits, BIS codes of steels; Theories of failures, factor of safety design for strength and rigidity, Fatigue loading : Stress concentration, theoretical stress concentration factor, fatigue stress concentration factor, notch sensitivity, design for fluctuating stresses, endurance limit, estimation of endurance strength, Goodman"s life, Soderberg"s line.

MODULE –II:DESIGN OF FASTENERS(12)

Design of fasteners: Riveted joints, methods of failure of riveted joints, strength equations, efficiency of riveted joints, eccentrically loaded riveted joints; Welded Joints: Design of fillet welds, axial loads, circular fillet welds.

MODULE –III:DESIGN OF KEYS AND JOINTS (12)

Keys, cotters and knuckle joints: Design of keys, stress in keys, cotter joints, spigot and socket.
Sleeve and cotter, jib and cotter joints, Knuckle joints.

MODULE –IV:DESIGN OF SHAFTS (12)

Design of Shafts: Design of solid and hollow shafts for strength and rigidity, design of shafts for complex loads, Shaft sizes, BIS code, design of shafts for gear and belt drives; Shaft couplings: Rigid couplings, and, flexible couplings.

MODULE –V:DESIGN OF SPRINGS (12)

Mechanical Springs: Stresses and deflections of helical springs, extension compression springs, springs for static and fatigue loading, natural frequency of helical springs, energy storage capacity, helical torsion springs, co-axial springs.

IV. TEXTBOOKS

1. P. Kannaiah, “Machine Design”, 2nd Edition, Scitech Publications India Pvt. Ltd, New Delhi,2012.
2. V.B. Bandari, “A Text Book of Design of Machine Elements”, 3rd edition, Tata McGraw hill,2011.

V. REFERENCEBOOKS:

1. Richard G. Budynas, J. Keith Nisbett, "Shiegly‟s Mechanical Engineering Design", 10th Edition, 2014.
2. R.L. Norton, "Machine Design-An Integrated approach", Person Publisher, 2nd Edition, 2006.
3. U.C. Jindal, "Machine Design", Pearson, 1st Edition, 2010.
4. R.S. Khurmi, A. K. Gupta, "Machine Design", S. Chand & Co, New Delhi, 1st Edition, 2014.

VI. WEBREFERENCES:

1. http://nptel.ac.in/courses/Webcourse- contents/IIT%20Kharagpur/Machine%20design1/New_index1.html
2. http://nptel.ac.in/downloads/112105125/
3. http:/alljntuworld.in/download/design-machine-members-1-dmm-1-materials-notes/
4. http:/scoopworld.in/2015/03/design-of-machine-members-dmm-mech.html

VII. E-TEXT BOOKS:

1. http://faadooengineers.com/threads/26687-Machine-design-by-shigley-ebook-download-pdf
2. http://freepdfbook.com/design-of-machine-elements-by-v-b-bhandari/
3. http:/only4engineer.com/2014/10/a-textbook-of-machine-design-by.html

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

MANUFACTURING PROCESS LABORATORY

IV Semester: ME								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC15	Core	L	T	P	C	CIA	SEE	Total
		0	0	2	1	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 26				Total Classes: 26		
Prerequisite: Workshop Practices Laboratory								

I. COURSE OVERVIEW:

This course is to introduce the concept of manufacturing process with the help of various processes widely employed in the industries. This course consists of casting, welding, sheet metal forming, extrusion and forging processes with the related details of equipment and applications. It Introduces the different manufacturing processes and breakeven analysis. Engineering materials, laying emphasis on ferrous and non-ferrous materials along with the heat treatment of metals discusses the special casting processes and metal-forming processes respectively.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The Importance manufacturing sciences in the day-to-day life, and study the basic manufacturing processes and tools used.
II. The knowledge in thermal, metallurgical aspects during casting and welding for defect free manufacturing components.
III. The design features that make each of this manufacturing process both harder, easier, assess design and manufacturing features on real products.

III. LIST OF EXPERIMENTS

Week-1: PATTERN MAKING
Batch I: Pattern design and making
Batch II: Pattern design and making

Week-2 SAND CASTING
Batch I: Moulding, melting and casting
Batch II: Moulding, melting and casting

Week-3 METAL CASTING
Batch I: Moulding, melting and casting
Batch II: Moulding, melting and casting

Week-4 ARC WELDING
Batch I: ARC welding lap and butt joint
Batch II: ARC welding lap and butt joint

Week-5 SPOT WELDING
Batch I: Spot welding lap and butt joint
Batch II: Spot welding lap and butt joint

Week-6 GAS WELDING
Batch I: Gas Welding lap and butt joint
Batch II: Gas Welding lap and butt joint

Week-7 BRAZING
Batch I: Brazing lap and butt joint
Batch II: Brazing lap and butt joint

Week-8 APPLICATION OF SIMPLE DIE
Batch I: Blanking and piercing
Batch II: Blanking and piercing

Week-9 APPLICATION OF COMPOUND DIE
Batch I: Blanking and piercing
Batch II: Blanking and piercing

Week-10 PROCESSING OF PLASTICS
Batch I: Injection moulding
Batch II: Injection moulding

WeeK-11 PROCESSING OF PLASTICS
Batch I: Blow moulding
Batch II: Blow moulding

Week-12 RIVETING
Batch I: Riveting of a plates
Batch II: Riveting of a plates

Week-13 SAND PROPERTIES TESTING
Batch I: Sand properties testing for strengths and permeability
Batch II: Sand properties testing for strengths and permeability

IV. REFERENCE BOOKS:

1. R. K. Jain, "Production Technology", Khanna Publishers, 18th Edition, 2013.
2. T. V. Ramana Rao, "Metal Casting", New Age, 1st Edition, 2010.
3. Philips Rosenthal, "Principles of Metal Castings", TMH, 2nd Edition, 2001.
4. B. S.Raghuwamshi, "A Course in Workshop Technology", Dhanpat Rai & Sons, 2014.
5. Kalpakjin S, "Manufacturing Engineering and Technology", Pearson Education, 7th Edition,2014.
6. HMT, "Production Technology", McGraw-Hill Education, 1st Edition, 2013.

VI. WEB REFERENCES:

1. https://books.google.co.in/books/about/Manufacturing_Processes_Reference_Guide.html?id=6x1sm

FLUID MECHANICS AND HYDRAULIC MACHINES LABORATORY

IV Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC16	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: There are no prerequisites to take this course.								

I. COURSEOVERVIEW:

The purpose of this laboratory is to strengthen and enhance the understanding of the basics of fluid mechanics and Hydraulic machines. The experiments here are designed to demonstrate the applications of the basic mechanics principles and to provide a lot of intuitive and physical understanding of the theory. The most objective is to introduce a spread of classical experimental and diagnostic techniques, and also the principles behind these techniques. This laboratory exercise additionally provides practice in making engineering judgments, estimates and assessing the reliability of your measurements, skills that are important in all engineering disciplines.

II.COURSEOBJECTIVES:

The students will try to learn:

I. The effects of fluid properties on a flow system.
II. Fluid flow patterns and describe continuity equation.
III. The utilization of measuring devices and fluid mechanics principles in design.
IV. Performance parameters of a given hydraulic turbine, centrifugal and reciprocatingpump.

III. COURSE SYLLABUS:

Week-1:DETERMINATION OF COEFFICIENT OF DISCHARGE OF VENTURI METER

Week-2:DETERMINATION OF COEFFICIENT OF DISCHARGE OF ORIFICE METER

Week-3: DETERMINATION OF FRICTION FACTOR

Week-4: VERIFICATION OFBERNOULLI'S THEOREM

Week-5: PERFORMANCE TEST ON PELTON WHEEL TURBINE

Week-6: PERFORMANCE TEST ON FRANCISTURBINE

Week-7: PERFORMANCE TEST ON KAPLANTURBINE

Week-8: PERFORMANCE TEST ON RECIPROCATING PUMP

Week-9: PERFORMANCE TEST ON CENTRIFUGAL PUMP

Week-10: IMPACT OF JET ON VANES

Week-11: PERFORMANCE TEST ON MULTI STAGE CENTRIFUGAL PUMP

Week-12: LOSS OF HEAD DUE TO SUDDEN CONTRACTION

IV. REFERENCE BOOKS:

1. D.S. Kumar,"Fluid Mechanics and Fluid Power Engineering", Kotaria& Sons, Reprint, 2013.
2. D. Rama Durgaiah, "Fluid Mechanics and Machinery", New Age International, 1st Edition, 2002.
3. Banga, Sharma, "Hydraulic Machines", Khanna Publishers, 6th Edition, 2001.
4. Dr. R K Bansal, "A Text Book of Fluid Mechanics and Hydraulic Machines", Laxmi Publications, 9th Edition, 2015.

V. WEB REFERENCES:

1. http://www.iare.ac.in
2. https://cphbooks.in/pdf/Flued_Mechanics_Machinery.pdf

APPLIED THERMODYNAMICS LABORATORY

IV Semester: ME								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC17	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: There are no prerequisites to take this course.								

I. COURSE OVERVIEW:

Applied Thermodynamics is science intended to introduce concepts and working principles of internal combustion engines which are widely used in different industrial applications such as automobile, agriculture, industry for transport, water pumping, electricity generation, earth moving and for supply mechanical power. This course also deals with working principles of compressors and refrigeration systems in various fields of engineering.

II COURSE OBJECTIVES:

The students will try to learn:

I. The concepts related to the operation of internal combustion engines based upon the fundamental engineering sciences of thermodynamics.

II. The techniques for improving the efficiencies and performance of compressors and refrigeration systems retained to practical applications such as irrigation, air conditioning and refining oil and gas.

III. The performance of Heat Engines in real-time applications by applying the various testing parameters of an engine.

III LIST OF EXPERIMENTS:

Week-1: Valve timing diagram of an IC engine.

Batch 1 & Batch2: Draw the Valve timing diagram of IC engine.

Week-2: Port timing diagram of an IC engine

Batch 1 & Batch2: Draw the Port timing diagram of IC engine.

Week-3: performance test for 2 stroke SI engine

Batch 1 & Batch2: Conduct Performance for 2-strole petrol engine.

Week-4: performance test for 4 stroke SI engine

Batch 1 & Batch2: Conduct Performance for 4-stroke petrol engine.

Week-5: IC engine Morse and motoring tests

Batch 1 & Batch2: Conduct Morse test on 4-stroke Multi cylinder SI engine.

Week-6: heat balance on SI engine

Batch 1 & Batch2: Prepare Heat balance sheet for 4-stroke Multi cylinder SI engine

Week-7: Performance test on variable compression ratio engine

Batch 1 & Batch2: Conduct Performance for 4-stroke CI engine

Week-8: Performance test on diesel engine (mechanical loading)

Batch 1 & Batch2: Conduct Performance for 4-stroke CI engine.

Week-9: Heat balance on CI engine

Batch 1 & Batch2: Prepare Heat balance sheet for CI engine.

Week- 10: Volumetric efficiency of a reciprocating air compressor

Batch 1 & Batch2: Determine volumetric efficiency of an air compressor.

WeeK-11: Assembling and dis Assembling IC engine

Batch 1 & Batch2: Assemble and dissemble the components of an IC engine.

Week-12: Study of boilers

Batch 1 & Batch2: Understand and observe the working of boilers from prototype models.

II. REFERENCE BOOKS:

7. V. Ganesan, "I.C. Engines", Tata McGraw-Hill, 3rd Edition, 2011
8. B. John Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw-Hill, 2nd Edition,2011.
9. K. Rajput, "Thermal Engineering", Lakshmi Publications, 1st Edition, 2011.

WEB REFERENCES:

1. https://nptel.ac.in/courses/112102103/16
2. https://nptel.ac.in/courses/112107078/37

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, 4th Edition, 2002.

V. REFERENCE BOOKS:

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamental Database Systems", Pearson Education, 3rd Edition, 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

DYNAMIC OF MACHINERY

V Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AMEC18	Core	3	1	0	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

Prerequisite: Basic principles of Engineering Mechanics

I. COURSE OVERVIEW:

This course focuses on mechanical devices that are designed to have mobility to perform certain functions. In this process they are subjected to some forces. The study of Dynamics of machinery leads us to design machines by understanding the relationship between the movement of various parts of machine and the different forces that are acting on them. This course will provide the knowledge on how to analyze the motions of mechanisms and design mechanisms to give required strength. This includes relative static and dynamic force analysis and consideration of gyroscopic effects on aero planes, ships, automobiles like two wheelers and four wheelers.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The concepts of precision, static and dynamic forces of planer mechanisms by neglecting friction of aero planes, sea vessels, auto mobiles and various force members.
II. The knowledge of engineering mechanics for identifying the coefficient of friction and engine speed of the various contact bodies (Clutches and Brakes) and speed-controlled devices, variations of torques and fluctuation of speeds of IC engines.
III. The magnitude and direction of balanced mass for unbalanced rotary and reciprocating engines with the fundamentals of applied physics.
IV. Mathematical modeling of various degree of freedom systems to interpret the various vibration parameters.

III. COURSE SYLLABUS:

MODULE-I: PRECESION, STATIC AND DYNAMIC FORCE ANALYSIS (12)

Precession: Gyroscopes, effect of processional motion on the stability of moving vehicles such as motor car, motor cycle, aero-planes and ships, static and dynamic force analysis of planar mechanisms: Two and three force members, inertia forces and D'Alembert's principle, planar rotation about a fixed centre.

MODULE –II: CLUTCHES AND BRAKES (12)

Clutches: Friction clutches, Single disc or plate clutch, multiple disc clutches, cone clutch and centrifugal clutch; Brakes : Simple block brakes, internal expanding brake, band brake of vehicle.

MODULE –III: TURNING MOMENT AND GOVERNORS (12)

Turning moment diagrams and flywheels: turning moment: Inertia torque, angular velocity and acceleration of connecting rod, crank effort and torque diagrams, fluctuation of energy.

Design of flywheels. Governors: Dead weight type and spring loaded governors, sensitiveness, iso-chronism and hunting.

MODULE –IV: BALANCING (12)

Balancing: Balancing of rotating masses, single and multiple-single and different planes-balancing of reciprocating masses, primary and secondary balancing-analytical and graphical methods; unbalanced forces and couples, Locomotive balancing.

MODULE –V: MECHANICAL VIBRATIONS (12)

Vibrations: Free vibration, Damped Vibration, Forced vibration; Vibration isolation and transmissibility, whirling of shafts, critical speeds, Torsional vibrations, two and three rotor systems.

V.TEXT BOOKS:

3. Thomas Bevan, “Theory of Machines”, Pearson Education, 3rd Edition, 2009.
4. S.S Ratan, “Theory of Machines”, Tata McGraw-Hill, 4th Edition, 2014.
5. R. L. Norton, “Kinematics and Dynamics of Machinery”, McGraw-Hill, 1st Edition, 2009.
6. P.L. Balleny, “Theory of Machines and Mechanisms”, Khanna publishers, 49th Edition, 2013.

VI.REFERENCE BOOKS:

1. J. S. Rao, R.V. Dukkipati, “Mechanism and Machine Theory”, New Age Publication, 1st Edition, 2013.
2. Uiker, Penock, Shigley, “Theory of Machines and Mechanisms”, Oxford University Press, 4th Edition, 2013.
3. R.S. Khurmi, Gupta, “Theory of Machines”, S.Chand & Co, New Delhi, 14th Edition, 2013.

VII.WEB REFERENCES:

1. http://www.uobabylon.edu.iq/uobcolleges/ad_downloads/4_1293_515.pdf
2. http://ebooks.library.cornell.edu/k/kmoddl/toc_hartenberg1.html

MACHINE TOOLS AND METROLOGY

V Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC19	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: Manufacturing Processes

I. COURSE OVERVIEW:

Manufacturing Technology is an instructional program that prepares individuals to shape metal parts on machines such as lathes, grinders, drill presses, milling machines and shapers. This program includes instruction in safety, making computations related to work dimensions testing feeds and speeds of machines using precision measuring instruments. Metrology is highly valuable for the students and practitioners, specifically from mechanical and allied engineering stream.

II. COURSE OBJECTIVES:

The students will try to learn:

V. The fundamental concepts of the metal cutting principles to study the behavior of various machining processes.

VI. The importance of tool materials, cutting parameters, cutting fluids and tool wear mechanisms for optimized machining.

VII. The principles of linear and angular measuring instruments for accurate measurement of a given component.

VIII. The mechanics of machining process and optimization of various significant parameters in order to yield the optimum machining.

III.COURSE SYLLABUS:

MODULE-I: BASIC MECHANISM OF METAL CUTTING (12)

Elementary treatment of metal cutting theory, element of cutting process, geometry of single point tool and angles chip formation and types of chips, built up edge and its effects, chip breakers: Mechanics of orthogonal cutting, Merchant's force diagram, cutting forces, cutting speeds, feed, depth of cut, tool life, coolants, machinability, tool materials.

MODULE –II: MACHINE TOOL-I (12)

Engine lathe, Principle, specification, types, work and tool holding devices, Automatic lathes, classification: Single spindle and multi-spindle automatic lathes and its tool layouts; Shaping, slotting and planning machines, Principles of working, specification, operations performed, Kinematic scheme.

MODULE –III: MACHINE TOOL-II (12)

Milling machine, classifications, specifications, working principles of milling machines; Geometry of milling cutters, methods of indexing, kinematic scheme of milling machines.

Drilling and boring machines, principles of working, specifications, types, operations performed, twist drill; Kinematics scheme of the drilling and boring machines

MODULE –IV: GEOMETRICAL DIMENSIONING AND TOLERANCES (12)

Systems of Limits and Fits: Introduction, normal size, tolerance limits, deviations, allowance, fits and their types, unilateral and bilateral tolerance system, hole and shaft basis systems, Interchangeability and selective assembly; Linear Measurement: Slip gauges, dial indicator, micrometers; Measurement of angles and tapers: Bevel protractor and sine bar.

MODULE –V: MEASURING INSTRUMENTS (12)

Optical measuring instruments: Tool maker's microscope and its uses, collimators, optical projector, interferometer; Screw thread measurement: Element of measurement, errors in screw threads, measurement of effective diameter; Surface roughness measurement: Numerical assessment of surface finish: CLA, R.M.S Values, Rz values.

V.TEXT BOOKS:

1. R. Kesavan, Dr. R. Kesavan, "Machine Tools" Laxmi publications, 2nd Edition, 2016.
2. N. K Mehta, "Metal Cutting and Design of Cutting Tools, Jigs & Fixtures", McGraw-Hill Education, 1st Edition, 2014.
3. R. K. Jain, Engineering Metrology, Khanna Publishers, 1st Edition, 2013.

VI.REFERENCE BOOKS:

1. B.L. Juneja, G.S. Sekhon, Nitin Seth, "Fundamentals of Metal Cutting and Machine Tools ", New Age Publishers, 2nd Edition, 2014.
2. Geofrey, "Fundamentals of metal machining and machine tools", Tata McGraw Hill Education, 1st Edition, 2013.
3. R. S. Sirohi, H. C. Radha Krishna, "Mechanical Measurements", New Age Publishers, 3rd Edition, 2011.
4. M.Mahajan "A Textbook of Metrology ", Dhanpatrai and Co, 2nd Edition, 2013.

VII.WEB REFERENCES:

1. https://www.ocw.mit.edu/courses/mechanical-engineering/
2. http://www.nptel.ac.in/courses/112106138.

THERMAL ENGINEERING

V Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC20	**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: Thermodynamics								

I. COURSE OVERVIEW:

Thermal Engineering is science intended to introduce concepts and working principles of boilers, turbines, condensers and nozzles which are widely used in different industrial applications such as automobile, agriculture, industry for transport, water pumping, electricity generation, earth moving and for supply mechanical power. This course also deals with working principles of aircraft systems such as propulsion systems and rockets in various fields of engineering.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The usage of knowledge on thermodynamic cycles and fluid dynamics phenomena presents in turbomachinery and combustion for producing electric and mechanical energy/power.
II. The operational concepts, principles, features, procedures and detailed thermodynamic analyses related to components of power cycles, rocket propulsion as well as steam and power generators.
III. The real-world engineering problems and examples towards gaining the experience for designing and developing power generating systems in engineering practice.

III.COURSE SYLLABUS:

MODULE-I: BASIC CONCEPTS (12)

Rankine cycle schematic layout, thermodynamic analysis, concept of mean temperature of heat addition, methods to improve cycle performance, regeneration and reheating.

MODULE –II: BOILERS AND STEAM NOZZLES (12)

Boilers: Classification, working principles with sketches, boilers mountings and accessories.
Basics of compressible flow, Isentropic flow of a perfect gas through nozzle, subsonic, supersonic and choked flow- normal shocks, flow of steam through nozzles, thermodynamic analysis of nozzle.

MODULE –III: STEAM TURBINES AND STEAM CONDENSERS (12)

Steam Turbines: Classification, Impulse turbine-velocity diagrams, pressure and velocity compounding.
Reaction turbine-principle of operation, thermodynamic analysis of a stage, degree of reaction, velocitydiagrams.

Steam Condensers: Requirements of steam condensing plant, classification of condensers, working principle ofdifferent types.

MODULE –IV: GAS TURBINES (12)

Gas turbines: Simple gas turbine plant, ideal cycle, essential components, parameters of performance, actualcycle, regeneration, inter cooling and reheating, closed and Semi-closed cycles, merits and demerits, briefconcepts of combustion chambers of gas turbine plant.

MODULE –V: JET PROPULSION AND ROCKETS (12)

Jet propulsion: Principle of operation, classification of jet propulsive engines, working Principles with schematic diagrams and representation on T-S diagram, thrust, thrust power and propulsion efficiency, turbo jet engines, needs and demands met by turbo jet, schematic diagram, thermodynamic cycle, performance evaluation; Rockets: Application, working Principle, classification, propellant type, thrust, propulsive efficiency, specific impulse, solid and liquid propellant rocket engines.

V.TEXT BOOKS:

1. P.K Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 6th Edition, 2017.
2. R. K. Rajput, "Thermal Engineering", Lakshmi Publications, 8th Edition, 2015.

VI. REFERENCE BOOKS:

1. P. Khajuria, S. P Dubey, "Gas Turbines and Propulsive systems", Dhanpat Rai Publishers., 1st Edition, 2012.
2. Ballaney, "Thermal Engineering", Khanna Publishers, 1st Edition, 2012.
3. R. Yadav, "Thermodynamics and Heat Engines", Central Book Depot, 1st Edition, 2002

VII. WEB REFERENCES:

1. https://nptel.ac.in/courses/112/106/112106133
2. https://nptel.ac.in/courses/112/103/112103281/

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	Core	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

MECHANICAL VIBRATIONS

V Semester: ME								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC21	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: Basic principles of Engineering Mechanics								

I. COURSE OVERVIEW:

Vibration is a common phenomenon occurring in a mechanical system. For example, vibration of a rotordue to unbalanced mass, vibration of a vehicle engine at varying speed The study of a dedicated course is required to understand the fundamental and advance concepts of mechanical vibrations for engineers and designers. This course is of basic level. It introduces fundamentals of vibration, vibration of single Degree of Freedom (DoF) system, 2-DoF and multi-DoF systems, continuous systems such as bars and beams, and whirling of shafts.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basic concepts of mechanical vibrations and phenomena of transmissibility
II. The mechanical systems with/ without damping for 1/ multi degrees of freedom environment for anlayse.
III. The vibration measuring instruments and machine monitoring systems.
IV. The competency develops in analytical methods in solving problems of vibrations along with mode shape.

III.COURSE SYLLABUS:

MODULE-I: SINGLE DEGREE OF FREEDOM SYSTEMS (09)

Single degree of freedom systems: Undamped and damped free vibrations; forced vibrations coulomb damping; Response to excitation; rotating unbalance and support excitation; vibration isolation and transmissibility, response to non-Periodic Excitations: MODULE impulse, MODULE step and MODULE ramp functions; response to arbitrary excitations, the convolution integral; shock spectrum; System response by the Laplace transformation method.

MODULE –II: TWO DEGREE FREEDOM SYSTEMS (09)

Two degree freedom systems: Principal modes, undamped and damped free and forced vibrations; undammed vibration absorber.

MODULE –III: MULTI DEGREE FREEDOM SYSTEMS (09)

Multi degree freedom systems: Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis.

Method of matrix inversion; Torsional vibrations of multi-rotor systems and geared systems; Discrete- Time systems; Vibration measuring instruments: Vibrometer, velocity meters and accelerometers.

MODULE –IV: FREQUENCY DOMAIN VIBRATION ANALYSIS (09)

Frequency domain vibration analysis: Overview, machine train monitoring parameters, data base development, vibration data acquisition, trending analysis, failure node analysis, root cause analysis.

MODULE –V: NUMERICAL METHODS (09)

Numerical methods: Raleigh‟s stodola's, Matrix iteration, Rayleigh- Ritz Method and Holzer's methods.

V.TEXT BOOKS:

1. Singiresu S Rao, “Mechanical Vibration”, Pearson, 4th Edition, 2013.
2. G. K. Grover, “Mechanical Vibration”, Nemchand& Brothers, 8th Edition, 2009.
3. J.S. Rao and K. Gupta, “Introductory Course On Theory & Practice Of Mechanical Vibrations”, New Age International (p) Ltd , 2nd Edition,2012
4. Leonard Meirovitch, “Elements of vibration analysis”, Tata McGraw-Hill, 2nd Edition, 2007.
5. John S. Mitchell, “Introduction to Machinery Analysis and Monitoring”, Pennwell books, 2nd Edition, 1993

VI.REFERENCE BOOKS:

1. V.P.Singh,"Mechanical Vibration", Dhanpat Rai& Co (p) Ltd, 3rd Edition, 2012.
2. A.D. Dimarogonas, S. A. Paipetis, "Analytical Methods in Rotor Dynamics", Applied Science Publishers London, 1983.
3. J. S. Rao, "Rotor Dynamics", New Age International (p) Ltd., 3rd Edition, 2012.
4. B.C. Nakra and K. K. Chowdary, "Mechanical Measurements", Tata McGraw-Hill, New Delhi, 2nd Edition, 2004
5. R. A. Collacott, "Mechanical Fault Diagnosis and Condition Monitoring", Chapman and Hall, London, 1st Edition, 1977.

IV. WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc20_me43

TOOL DESIGN

V Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC22	**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: **Manufacturing Technology**								

I. COURSE OVERVIEW:

The primary objective of this course is to introduce the concept of tool design technology selection of tooling materials for cutting operations with the help of various processes widely employed in industries. To design Jigs and Fixtures and selection of drills for various operations are studies in this course. The course consists of tool material, design of cutting tools, design of jigs and fixtures, design of sheet metal forming-I and design of sheet metal forming- II.

II.COURSE OBJECTIVES:

The students will try to learn:

I. The characteristics of various tool materials for cutting operations.
II. The design of cutting tools and its importance in manufacturing industry.
III. The design of jigs and fixtures for holding different components.
IV. The design for sheet metal forming-I and II in the field of design aspects in the manufacturing industry.

III.COURSE SYLLABUS:

MODULE-I: TOOL MATERIAL (09)

Tool materials: Properties of materials: Tools steels, Cast Iron, Mild or low carbon steels, Non metallic and nonferrous materials, Heat treating.

MODULE –II: DESIGN OF CUTTING TOOLS (09)

Design of cutting tools: Point cutting tools: Milling cutters, drills, selection of carbide steels, determination of shank size for single point carbide tools, determining the insert thickness for carbide tools.

MODULE –III: DESIGN OF JIGS AND FIXTURES (09)

Design of jigs and fixtures: Basic principles of location and clamping; Locating methods and devices,jigs, definition types.

General considerations in the design of drill jigs, drill bushing, methods of construction; Fixtures, vice fixtures, milling, boring lathe grinding fixtures.

MODULE –IV: DESIGN FOR SHEET METAL FORMING – I (09)

Design of sheet metal blanking and piercing dies: Fundamentals of die cutting operation, power press types, general press information, materials handling equipment, cutting action in punch and die operations, die clearance, types of die construction, die design fundamentals, blanking and piercing die construction, pilots, stripper and pressure pads presswork material, strip layout, short run tooling for piercing.

MODULE –V: DESIGN FOR SHEET METAL FORMING – II (09)

Design of sheet metal bending, forming and drawing dies: Bending dies, drawing dies, forming dies,drawing operations, variables that effect metal flow during drawing, determination of blank size,drawing force, single and double action draw dies.

V. TEXT BOOKS:

1. Donaldson, "Tool Design", Tata McGraw-Hill, 1st Edition, 2013.
2. HMT, "Production Technology", Tata McGraw-Hill, 1st Edition, 2012.
3. R.K. Jain, S. C. Gupta, "Production Technology", Tata McGraw-Hill, 1st Edition, 2013

VI. REFERENCE BOOKS:

1. George F Dieter, "Mechanical Metallurgy", Tata McGraw-Hill, 1st Edition, 2015.
2. C. Elanchezhian, M.Vijayan, "Machine Tools", Anuradha Publications, 1st Edition, 2010

VII. WEB REFERENCES:

1. http://www.industrial-electronics.com/engineering-industrial/fund-tool_1.html
2. https://www.engineeringclicks.com/tooling-design-basics/

VIII. E-TEXT BOOKS:

1. https://www.e-booksdirectory.com/details.php?ebook=8139
2. https:// bookboon.com/en/engineering-ebooks

EXPERIMENTAL STRESS ANALYSIS

V Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC23	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: 0	Practical Classes: Nil				Total Classes: 45		

Prerequisite: **Mechanics of Solids, Kinematics of Machinery, Design of Machine Elements.**

I. COURSE OVERVIEW:

perimental methods exploit a particular physical phenomenon to make measurements and hence only certain information that can be recorded by an experimental technique. The course introduces the physical principle used by various experimental techniques and also provides a guideline to select an experimental technique for a given application. The role of analytical, numerical and experimental methods in solving a problem in solid mechanics is discussed. Stress and strain at a point is discussed in most courses on solid mechanics but little attention is paid on the variation of these quantities over the field of the model. Attention is drawn on the richness of whole field information provided by most of the optical techniques.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The various experimental techniques involved for measuring displacements and stresses.
II. The strain analysis of measuring circuits.
III. The Different types of coatings.

III.COURSE SYLLABUS:

MODULE-I : EXTENSOMETERS AND DISPLACEMENT SENSORS (09)

Principles of Measurements, Accuracy, Sensitivity and Range of Measurements, Mechanical, Optical, Acoustical and Electrical Extensometers and Their Uses, Advantages and Disadvantages, Laser Displacement Sensors.

MODULE –II : ELECTRICAL RESISTANCE STRAIN GAUGES (09)

Principle Of Operation and Requirements, Types and Their Uses, Materials For Strain Gauges, Wheatstone Bridge And Potentiometer Circuits For Static And Dynamic Strain Measurements, Strain Indicators, Rosette Analysis, Stress Gauges, Load Cells.

MODULE –III : PHOTO ELASTICITY (09)

Two Dimensional Photo Elasticity, Photo Elastic Materials, Concept Of Light – Photo elastic Effects, Stress Optic Law.

Transmission Photo elasticity, introduction to three dimensional photo elasticity.

MODULE –IV: BRITTLE COATING AND MOIRE TECHNIQUES (09)

Relation Between Stresses in Coating and Specimen, Use of Failure Theories in Brittle Coating, Moire Method Of Strain Analysis.

MODULE –V: NON – DESTRUCTIVE TESTING (09)

Fundamentals of NDT, Acoustic Emission Technique, Radiography, Thermography, Ultrasonics, Eddy Current Testing, and Fluorescent Penetrate Testing.

V. TEXT BOOKS:

1. Dally, J.W., And Riley, W.F., "Experimental Stress Analysis", McGraw Hill Inc., New York 1998.
2. L.S.Srinath, M.R.Raghava, K.Lingaiah, G.Garagesha, B.Pant B, and K.Ramachandra, "Experimental Stress Analysis", Tata McGraw Hill, New Delhi, 1984.

VI. REFERENCE BOOKS:

1. Abdul Mubeen, “Experimental Stress Analysis”, Dhanpat Rai & Co (P) Ltd.
2. U. C. Jindal, “Experimental Stress Analysis” , Pearson India Publishers.

VII. WEB REFERENCES:

1. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/New_index1.html
2. http://nptel.ac.in/downloads/112105125/
3. http:/alljntuworld.in/download/design-machine-members-1-dmm-1-materials-notes/
4. http:/scoopworld.in/2015/03/design-of-machine-members-dmm-mech.html

VIII. E-TEXT BOOKS:

1. http://faadooengineers.com/threads/26687-Machine-design-by-shigley-ebook-download-pdf
2. http://freepdfbook.com/design-of-machine-elements-by-v-b-bhandari/
3. http:/only4engineer.com/2014/10/a-textbook-of-machine-design-by.html

ENGINEERING TRIBOLOGY

<table>
<tr><td colspan="9">V Semester: ME</td></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Category</th><th colspan="3">Hours / Week</th><th>Credits</th><th colspan="3">Maximum Marks</th></tr>
<tr><th>L</th><th>T</th><th>P</th><th>C</th><th>CIA</th><th>SEE</th><th>Total</th></tr>
<tr><td rowspan="1">AMEC24</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: 0</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 45</td></tr>
<tr><td colspan="9">Prerequisite: Materials and Mechanics of solids, Fluid Mechanics And Hydraulic Machines</td></tr>
</table>

I.COURSE OVERVIEW:

This course addresses the design of tribological systems: the interfaces between two or more bodies in relative motion. Fundamental topics include: geometric, chemical, and physical characterization of surfaces; friction and wear mechanisms for metals, polymers, and ceramics, including abrasive wear, delamination theory, tool wear, erosive wear, wear of polymers and composites; and boundary lubrication and solid-film lubrication. The course also considers the relationship between nano-tribology and macro-tribology, rolling contacts, tribological problems in magnetic recording and electrical contacts, and monitoring and diagnosis of friction and wear. Case studies are used to illustrate key points.

II.COURSE OBJECTIVES:

The students will try to learn:

I. The different methods of surface modification and surface treatment.
II. In-depth understanding of how different material structures affect the surface properties.
III. Different physical laws and chemical reactions which affects the physical and mechanical properties of material surfaces.
IV. The In-depth of tribological processes and knowledge of other aspects of the surface performance.

III. COURSE SYLLABUS:

MODULE-I: SURFACE INTERACTION AND FRICTION (09)

Topography of Surfaces, Surface features-Properties and measurement, Surface interaction, Adhesive Theory of Sliding Friction, Rolling Friction, Friction properties of metallic and non-metallic materials, friction in extreme conditions, Thermal considerations in sliding contact

MODULE –II: WEAR AND SURFACE TREATMENT (09)

Types of wear, Mechanism of various types of wear, Laws of wear, Theoretical wear models, Wear of Metals and Non metals, Surface treatments, Surface modifications, surface coatings methods, International standards in friction and wear measurements

MODULE –III: LUBRICANTS AND LUBRICATION REGIMES (09)

Lubricants and their physical properties, Viscosity and other properties of oils, Additives-and selection of Lubricants, Lubricants standards ISO, SAE, AGMA, BIS standards.

Lubrication Regimes, Solid Lubrication, Dry and marginally lubricated contacts, Boundary Lubrication Hydrodynamic lubrication, Elasto and plasto hydrodynamic, Hydro static lubrication.

MODULE –IV : CORROSION (09)

Introduction, Principle of corrosion , Classification of corrosion, Types of corrosion, Factors influencing corrosion, Testing of corrosion, Evaluation of corrosion, Prevention of Corrosion, Material selection, Alteration of environment, Cathodic and Anodic Protection.

MODULE –V: ENGINEERING MATERIALS (09)

Introduction, Advanced alloys, Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys, Ceramics, Polymers, and Applications.

V. TEXT BOOKS:

1. G.W.Stachowiak& A.W .Batchelor , “Engineering Tribology”, Butterworth-Heinemann, UK,2005.
2. E.Rabinowicz, “Friction and Wear of materials”, John Willey & Sons,UK,1995.

VI. REFERENCE BOOKS:

1. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,"Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd , New Delhi, 2005.
2. J.A.Williams,"Engineering Tribology", Oxford Univ. Press, 1994.

VII. WEB REFERENCES:

1. http://www.tribology-abc.com/
2. https://ocw.mit.edu/courses/mechanical-engineering/2-800-tribology-fall-2004/index.htm

VIII. E-TEXT BOOKS:

1. http://www.asminternational.org/documents/10192/3454476/ACFAA73.pdf/cdfc952b-62aa-477d-9bb2-3abb823a652d
2. http://as.wiley.com/WileyCDA/WileyTitle/productCd-047063927X.html

<table>
<tr><td colspan="9">V 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">ACSC20</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>2</td><td>-</td><td>-</td><td>1</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>Contact Classes: 36</td><td>Tutorial Classes: Nil</td><td colspan="4">Practical Classes: Nil</td><td colspan="3">Total Classes: 36</td></tr>
<tr><td colspan="9">Prerequisite: There are no prerequisites to take this course</td></tr>
</table>

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

MACHINE TOOLS AND METROLOGY LABORATORY

V Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC25	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: Machine Tools and Metrology

I. COURSE OVERVIEW:

Manufacturing is the production of goods through the use of labour, machinery and tools. This course introduces the mechanism of metal cutting of different geometrical shapes using wide variety of cutting tools. This emphasizes on the development/ demand of the newer materials with cutting edge technology tools. It is designed to impart the practical knowledge about the various machining processes like turning, shaping, planning, drilling, milling and grinding to produce desired shape of a product. This course introduces the metrological equipment to measure form and positional accuracy of manufactured/machined components and to interpret the results.

II. COURSEOBJECTIVES:

The students will try to learn:

I. The empirical knowledge on machine tools so that they can identify, manipulate and control various process parameters during machining processes in the manufacturing industry.
II. The details related to thermal aspects during machining for defect free manufacturing components.
III. The mechanics of machining process and significance of various process parameters in order to yield the optimum machining.
IV. The principles of linear and angular measuring instruments for accurate measurement of a given component.

III.LIST OF EXPERIMENTS:

Week – 1: LATHE MACHINE
Step turning, taper turning, Thread cutting and knurling using lathe machine

Week – 2: DRILLING AND STEP BORING
Drilling, tapping and step boring using drilling machine.

Week – 3: PLANNING AND SHAPING
Shaping of V-groove using shaper

Week – 4: SLOTTING
Slotting of a keyway using slotter machine.

Week – 5: MILLING AND SURFACE GRINDING
Milling of gear and surface grinding.

Week –6: VERNIER CALIPERS AND MICROMETER
Length, depth, diameter measuring using vernier calipers and micrometer.

Week –7: SCREW THREAD MEASUREMENT
Screw thread measurement by three wire method.

Week –8: SURFACE ROUGHNESS MEASUREMENT
Surface roughness by talysurf

Week –9: BORE GAUGE
Bore measurement using bore gauge.

Week –10: GEAR TEETH CALIPER/MICROMETER
Use of gear teeth caliper for checking the chordal addendum and chordal height of spur gear.

Week – 11: ANGLE MEASUREMENTS
Tool angle measurements using bevel protractor, sine bar, slip gauges

Week – 12: TAPER MEASUREMENTS
Taper measurements using Tool Maker 's microscope.

V.TEXT BOOKS:

1. R. K. Jain, "Production Technology", Khanna Publishers, 18th Edition, 2013.
2. B. S. Raghu Vamshi, "Workshop Technology Vol – II", 9th Edition, Dhanpat Rai Publishers, New Delhi, India. 2010.
3. Jain R.K., "Engineering Metrology", Khanna Publishers, 1st Edition, 2005.

VI.REFERENCE BOOKS:

1. B.L. Juneja, G.S. Sekhon, Nitin Seth "Fundamentals of Metal Cutting and Machine Tools ", New Age Publishers, 2nd Edition, 2014.
2. Geofrey, "Fundamentals of metal machining and machine tools", Tata McGraw Hill Education, 1st Edition, 2013.
3. M Mahajan "A Textbook of Metrology ", Dhanpatrai and Co, 2nd Edition, 2013

VII.WEB REFERENCES:

1. https://www.ocw.mit.edu/courses/mechanical-engineering/
2. http://www.nptel.ac.in/courses/112106138/
3. http://www.nptel.ac.in/courses/112106139/

THEORY OF MACHINES LABORATORY

V Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC26	Core	L	T	P	C	CIA	SEE	Total
		0	0	3	1.5	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 24				Total Classes: 24		
Prerequisite: Dynamics of Machinery								

II. COURSE OVERVIEW:

This Theory of machines course provides hand on experience on the mechanisms and machines and also enriches design thinking for simple and critical applications of mechanical system which include automobile, aero planes, machine tools and inter disciplinary applications. It provides platform for kinematics and kinetics.

III. COURSE OBJECTIVES:

The students will try to learn:

I. The importance of theory of machines and mechanisms involved in the day-to-date life and study of basic mechanisms and inversion mechanisms to form a machine.
II. The vibration control and determine natural frequencies for design of mechanical system.
III. The effect of friction in journal and antifriction bearing.
IV. Discriminate mobility; enumerate links and joints in the mechanisms.

III. LIST OF EXPERIMENTS:

Week-1: GOVERNORS
Governor apparatus.

Week-2: GYROSCOPE
Gyroscope apparatus.

Week-3: STATIC FORCE ANALYSIS
Static Force analysis.

Week-4: DYNAMIC FORCE ANALYSIS
Dynamic Force analysis.

Week-5: BALANCING
Balancing of reciprocating masses.

Week-6: BEARINGS
Journal bearing apparatus.

Week-7: VIBRATIONS
Universal vibration apparatus.

Week-8: WHIRLING
Whirling of shaft apparatus.

Week-9: MECHANISMS
Various commonly used mechanisms and its inversions in machines.

Week-10: DIFFERENTIAL
Demonstration of automobile differential gear box.

Week-11: INDEXING
Geneva indexing mechanism.

IV. TEXT BOOKS:

1. Joseph E. Shigley, “Theory of Machines and Mechanisms”, Oxford University Press, 4th Edition, 2010.
2. Thomas Bevan, “Theory of Machines”, Pearson, 3rd Edition, 2009.
3. Anderson, D.A., Tannehill, J.C., and Pletcher, R.H., “Computational Fluid Mechanics and Heat Transfer”, Tata McGraw Hill Book Company, 2002.

VI.REFERENCE BOOKS:

1. J. S. Rao, R.V. Dukkipati, “Mechanism and Machine Theory”, New Age Publication, 1st Edition, 2013.
2. Uiker, Penock, Shigley, “Theory of Machines and Mechanisms”, Oxford University Press, 4th Edition, 2013.

VII.WEB REFERENCES:

1. https://drive.google.com/file/d/ob7raaoEF40D7eEJIR1voODJodFE/edit
2. http://royalmechanicalbuzz.blogspot.in/2015/04/theory-of-machines-by-rs-khurmi-ebook-pdf.html
   http://archive.org/details/theoryofmachinesOOmckarich

FINITE ELEMENT METHODS

VI Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC27	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: Mechanics of Solid, Heat Transfer								

I. COURSE OVERVIEW:

The finite element analysis (FEA) is a numerical method widely used for modeling and analyzing structures. This course introduces the mathematical modeling concepts of the Finite Element Method forsolving structural, thermal and dynamics problems that are too complicated to be solved by analytical methods.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basic concepts of Finite Element methods and its applications to complex engineering problems.
II. The characteristics and selection of different finite elements used in finite element methods.
III. The equilibrium equations and stress-strain relations for different boundary conditions encountered in structural and heat transfer continuum problems.
IV. The application of the FEM technique to dynamic problems and validate the solutions through simulation software for real time applications.

III. COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO FEM (10)

Introduction to FEM, FEA softwares, Stress–strain and strain-displacement relations for 2D-3D elastic problems, Boundary conditions, One Dimensional problem - Finite element modeling coordinates and shape functions. Assembly of Global stiffness matrix and load vector.

MODULE –II: ANALYSIS OF TRUSSES AND BEAMS (08)

Analysis of Trusses - Stiffness matrix for plane Truss Elements, stress calculations and problems;
Analysis of beams - Element stiffness matrix for two nodes, two degrees of freedom per node beam element and simple problems.

MODULE –III: 2-D & 3-D ANALYSIS(10)

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, Estimation of load Vector, stresses;

Finite element modeling of Axisymmetric solids subjected to Axisymmetric loading with triangular elements. Two dimensional four nodded isoparametric elements.

MODULE –IV: STEADY STATE HEAT TRANSFER ANALYSIS (08)

Steady state Heat Transfer Analysis - 1D Heat conduction of slab and fin elements, 2D heat conduction - analysis of thin plates, Analysis of a uniform shaft subjected to torsion.

MODULE –V: DYNAMIC ANALYSIS (09)

Dynamic Analysis - Dynamic equations, formulation of lumped and consistent mass matrices, Eigen Values and Eigen Vectors for a stepped bar, beam; Finite element formulation to 3D problems in stress analysis.

V.TEXT BOOKS:

1. Tirupathi K. Chandrupatla and Ashok D. Belagundu, “Introduction to Finite Elements in Engineering”, Pearson, 4th Edition, 2011.
2. S.S. Rao, “The Finite Element Methods in Engineering”, Elsevier, 4th Edition 2009.

VI.REFERENCE BOOKS:

1. O.C. Zienkowitz, “The Finite Element Method in Engineering Science”, McGraw Hill. 4th Edition, 2009.
2. Robert Cook, “Concepts and Applications of Finite Element Analysis”, Wiley, 4th Edition, 2010.
3. S.Md.Jalaludeen, “Introduction of Finite Element Analysis” Anuradha publications, 4th Edition, 2010.
4. J. N. Reddy, “An Introduction to Finite Element Methods”, McGraw Hill, 4th Edition 2009.

VII.WEB REFERENCES:

1. https://www.google.co.in/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=fem%20notes
2. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=0ahUKEwj8l5D3hqDQAhUJMI8KHVt1DDsQFggpMAI&url=http%3A%2F%2Ffaculty.ksu.edu.sa%2Frizwanbutt%2Fdocuments%2Ffem_lecture_notes.pdf&usg=AFQjCNEN0EUu9fHFOCd0vbEFwn0_sQxjsw&sig2=vrVKeosgduzEv22yxKaC3A&bvm=bv.138493631,d.c2I
3. https://www.kth.se/social/upload/5261b9c6f276543474835292/main.pdf.

MACHINE DESIGN

VI Semester: ME								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC28	Core	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: Design of Machnie Elements								

IV. COURSE OVERVIEW:

Machine designemphasizes for influence the failsafe design in the mechanical systems using different theories of failure modes. The Design philosophy is based on strength, stiffness and material selection for manufacture of machine elements. The main objective of this course is to provide rules for the design of general-purpose machine elements such as roller contact and sliding bearings and transmissionsystems, enginepistons etc, which are covered in specialized courses. After the successful completion of the course, the student shall be able to cover all steps of the analysis stage of the design process with a special stress on its embodiment (detailed) phase, i.e.the selection of form and dimensions.

V. COURSE OBJECTIVES:

The students will try to learn:

I. The different types of rollingcontactbearings, their basic features, related terminology and designations
II. The selection of rolling contact bearings for a given application
III. The basic features of prime movers and the means of power transmission commonly used in mechanical engineering
IV. The ability to analyze and design all types of gears for given application.

III.COURSE SYLLABUS:

MODULE-I: BEARINGS (10)

Bearings: Types of bearings, basic modes of lubrication, bearing modulus, full and partial bearings, Clearance ratio, Heat dissipation of bearings, bearing materials, Journal bearing design. Ball and roller bearing, Static load-dynamic load, equivalent radial load-design and selection of ball and roller bearings.

MODULE –II:DESIGN OF IC ENGINE PARTS (08)

Connecting rod: thrust in connecting rod-stress due to whipping action on connecting rod ends-cranks and crankshafts, forces acting on Piston-construction design and proportions of piston.

MODULE –III:POWER TRANSMISSION SYSTEMS (09)

Transmission of power by belt and rope drives, transmission efficiencies, Belts-Flat and V belts

Ropes- materials-chaindrives.

MODULE –IV: GEARS (10)

Spur Gears: Load concentration factor-dynamic load factor, surface compressive strength-bending strength-design analysis of spur gear, check for dynamic and wear considerations. Helical and Bevel Gear: Load concentration factor-dynamic load factor, Analysis of helicaland bevelgears, check for dynamic and wear considerations. Design of Worm gears: properties of wormgears-selections of materials-strength and wear rating of wormgears- Force analysis-friction in worm gears-thermal Considerations.

MODULE –V POWER SCREWS (08)

Power screw, design of nut, compound screw, differential screw, ball screw- possible failures.

V.TEXT BOOKS:

1. Richard G. Budynas, J. Keith Nisbett, "Shiegly"s Mechanical Engineering Design", 10th Edition, 2014.
2. V.B. Bandari, "A Text Book of Design of Machine Elements", 3rd edition, Tata McGraw hill, 2011.

VI.REFERENCE BOOKS:

1. P. Kannaiah, “Machine Design”, Scitech Publications India Pvt. Ltd, 2nd Edition, New Delhi, 2012.
2. R.L. Norton, “Machine Design-An Integrated approach”, Person Publisher, 2nd Edition, 2006.
3. U.C. Jindal, “Machine Design”, Pearson, 1st Edition, 2010.
4. R.S. Khurmi, A. K. Gupta, “Machine Design”, S. Chand & Co, 1st Edition, New Delhi, , 2014.

VII.WEB REFERENCES:

1. http://nptel.ac.in/courses/Webcourse- contents/IIT%20Kharagpur/Machine%20design1/New_index1.html
2. http://nptel.ac.in/downloads/112105125/
3. http:/alljntuworld.in/download/design-machine-members-1-dmm-1-materials-notes/
4. http:/scoopworld.in/2015/03/design-of-machine-members-dmm-mech.html

VIII. E-TEXT BOOKS:

1. http://faadooengineers.com/threads/26687-Machine-design-by-shigley-ebook-download-pdf
2. http://freepdfbook.com/design-of-machine-elements-by-v-b-bhandari/
3. http:/only4engineer.com/2014/10/a-textbook-of-machine-design-by.html

HEAT TRANSFER

VI Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC29	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: Thermodynamics								

I. COURSE OVERVIEW:

Heat transfer is the flow of thermal energy due to temperature difference and the subsequent temperature distribution changes commonly measured as heat flux. This course focuses on heat transfer modes such as conduction, convection and radiation, boundary conditions, one dimensional steady and unsteady state condition and heat exchangers applied to modern electric and electronic plants require efficient dissipation of thermal losses. Thus there is great relevance for this course in modeling heat exchangers, heat treatment of fins and complex mechanical systems.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The governing equations and performance relations of various modes of heat transfer using the three types of coordinate systems.

II. The concepts for validating heat transfer parameters during internal and external flows based on non-dimensional numbers and convective mode heat transfer.

III. The performance and analysis of heat exchangers for real-time applications using logarithmic mean temperature difference and number of transfer unit methods.

IV. The design methodologies for enhancing heat transfer among a wide variety of practical engineering problems.

III. COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO HEAT TRANSFER (12)

Modes of heat transfer, basic laws of heat transfer, applications of heat transfer; conduction heat transfer: Fourier rate equation, general three dimensional heat conduction equations in cartesian, cylindrical and spherical coordinates system; steady, unsteady and periodic heat transfer, initial boundary conditions.

MODULE –II: CONDUCTION HEAT TRANSFER (12)

One dimensional steady state conduction heat transfer: Homogeneous slabs, hollow cylinders and spheres, overall heat transfer coefficient, electrical analogy, Critical radius of insulation; one dimensional steady state conduction; heat transfer: with variable thermal conductivity, extended surfaces (Fins) long, short and insulated tips; significance of Biot and Fourier numbers, chart solutions of transient conduction systems.

MODULE –III: CONVECTIVE HEAT TRANSFER (12)

Buckingham Pi Theorem and method, application for developing semi, empirical non-dimensional correlation for convection heat transfer, significance of non-dimension numbers, concepts of continuity, momentum and energy equations; free convection: Development of hydrodynamic and thermal boundary layer along a vertical plate, use of empirical relations for vertical plates and pipes.

Forced convection: external flows: Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer, flat plates and cylinders; Internal flows, Concepts about Hydrodynamic and thermal entry lengths, division of internal flows based on this, use of empirical correlations for horizontal pipe flow and annulus flow.

MODULE –IV: RADIATION HEAT TRANSFER (12)

Emission characteristics, laws of black-body radiation, Irradiation, total and Monochromatic quantities, laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann, heat exchange between two black bodies, concepts of shape factor, emissivity, heat exchange between grey bodies, radiation shields, electrical analogy for radiation networks.

MODULE –V: HEAT EXCHANGERS AND PHASE CHANGE (12)

Classification of heat exchangers, overall heat transfer Coefficient and fouling factor, Concepts of LMTD and NTU methods, Problems using LMTD and NTU methods. Boiling: Pool boiling-regimes Calculations on Nucleate boiling, Critical heat flux, Film boiling; Condensation: Film wise and drop wise condensation, Nusselts theory of condensation on a vertical plate Film condensation on vertical and horizontal cylinders using empirical correlations.

V.TEXT BOOKS:

1. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw hill Education (P) Ltd, New Delhi, India. 4th Edition, 2012.
2. R. C. Sachdeva, "Fundamentals of Engineering, Heat and Mass Transfer", New Age, New Delhi, India, 3rd Edition, 2012.

VI.REFERENCE BOOKS:

1. Holman, "Heat Transfer", Tata McGraw-Hill education, 10th Edition, 2011.
2. P. S. Ghoshdastidar, "Heat Transfer", Oxford University Press, 2nd Edition, 2012.
3. D. S. Kumar, "Heat and Mass Transfer", S.K. Kataria & Sons, 9th Edition 2015.

VII.WEB REFERENCES:

1. https: //nptel.ac.in/courses/112108149/
2. https://www.wisc-online.com/learn/natural-science/earth-science/sce304/heat-transfer-conduction-convection-radiation

VIII. E-TEXT BOOKS:

1. https://www.e-booksdirectory.com/details.php?ebook=8139
2. https:// bookboon.com/en/engineering-ebooks

AUTOMATION IN MANUFACTURING

VI Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC30	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: Manufacturing Processes								

I COURSE OVERVIEW:

This course provides theoretical and practical aspects of implementing automation in industry using automated flow lines, automated line balancing and automated material handling like automated AG/RS system, automated guided vehicles and control system for monitoring the whole transfer line.

II COURSE OBJECTIVES:

The students will try to learn:

I. Explain the principles and strategies of automation in different manufacturing systems
II. Learn principles of assembly systems and material handling systems.
III. Apply fundamentals of AS/RS storage systems and control system for line balancing.

IV.COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO AUTOMATION (09)

Introduction Types and strategies of automation, pneumatic and hydraulic components circuits, Automation in machine tools. Mechanical feeding and tool changing and machine tool control transfer the automaton.

MODULE –II: AUTOMATED FLOW LINE AND ANALYSIS OF AUTOMATED FLOW LINES (09)

Automated flow lines: Methods or work part transport transfer, Mechanical buffer storage control function, design and fabrication consideration. Analysis of Automated flow lines: General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.

MODULE –III: ASSEMBLY SYSTEM AND LINE BALANCING AND AUTOMATED MATERIAL HANDLING (09)

Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

Automated material handling: Types of equipment, functions, analysis and design of material handling systems conveyor systems, automated guided vehicle systems.

MODULE –IV: AUTOMATED STORAGE SYSTEMS AND ADAPTIVE CONTROL SYSTEMS (09)

Automated storage systems, automated storage and retrieval systems, work in process storage, interfacing handling and storage with manufacturing. Adaptive control systems: Introduction, adaptive control with optimization, Adaptive control with constraints, Application of A.C. in machining operations. Use of various parameters such as cutting force, Temperatures, vibration and acoustic emission.

MODULE –V: BUSINESS PROCESS RE-ENGINEERING (09)

Business process Re-engineering: Introduction to BPE logistics, ERP, Software configuration of BPE, concurrent Engineering.

V. TEXT BOOKS:

1. M.P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson, 4th Edition, 2016.
2. Yoram koren, "Computer control of Manufacturing Systems" Mc Graw Hill, 1st Edition, 2017.

VI. REFERENCE BOOKS:

1. Radhakrishnan, “CAD / CAM/ CIM”, New Age, 2nd Edition, 2013.
2. K. Vara Prasada Rao, “Advanced Manufacturing Technology”, Kanna Publications, 1st Edition, 2013.

VII. WEB REFERENCES:

1. https://www3.nd.edu/~manufact/MPEM_pdf_files/Ch14.pdf
2. http://nptel.ac.in/courses/112102011

MECHATRONICS

VI Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC31	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 prerequisite is needed to take this course								

I. COURSE OVERVIEW:

Mechatronics is an interdisciplinary engineering field that combines principles from mechanics, electronics, computer engineering, robotics and automatic control. Mechatronics engineers design, develop and test a broad range of automated machines from industrial systems, artificial intelligence and medical equipment, to consumer products. Since their field involves such broad knowledge of engineering, mechatronics professionals are often general engineers, rather than having a particular specialization.

II.COURSE OBJECTIVES:

The students will try to learn:

I. The basic mechatronics system, design and their structure, mechanism, ergonomic and safety.
II. The theoretical and practical aspects of computer interfacing and real time data acquisition and control.
III. The Identification sensors, transducers and actuators to monitor and control the behaviour of a process or product.
IV. Understand the fundamentals of PLC.

III. COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO MECHATRONICS (09)

Overview of the course, Examination and Evaluation patterns, History of Mechatronics, Mechatronics systems, elements level of mechatronics system, mechatronics design process, system, measurement system, control system, micro processor based controller, advantages and disadvantages of mechatronics systems.

MODULE –II: SENSORS AND ELECTRONIC DEVICES (09)

Classification of sensors basic working principles, Displacement Sensor - Linear and rotary potentiometers, LVDT and RVDT.

Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC, analog signal conditioning, amplifiers, filtering, introduction to mems and typical applications.

MODULE –III: HYDRAULIC AND PNEUMATIC ACTUATORS (09)

Hydraulic & Pneumatic devices – Power supplies, valves, cylinder sequencing.Hydraulic and pneumatic actuating systems, fluid systems.

Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro pneumatic. Piezoelectric actuators, Shape memory alloys.

MODULE –IV: DIGITAL ELECTRONIC AND SYSTEMS (09)

Digital electronics and systems, digital logic control, micro processor and micro controller, programming, process controller, PLC Principles of operation PLC, programmable logic controller, PLC"s versus computer, Ladder Programming, ladder diagrams, application of PLC and Application PLC on real time industrial automation systems.

MODULE –V: SYSTEM INTERFACING AND DATA ACCQUISITION (09)

System interfacing and data acquisition, DAQS, SCADA, A to D, D to A, conversion; Dynamic models and analogies, system response, design of mechatronics system and future trend.

V.TEXT BOOKS:

1. W.Bolton,"Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering", Pearson Education Press, 3rd Edition, 2005.
2. M.D.Singh,J.G.Joshi,"Mechatronics",PrenticeHall,1st Edition,2013..

VI.REFERENCE BOOKS:

1. Devdas Shetty& Richard Kolk, “Mechatronics System Design”, 3rd Edition. PWS Publishing, 2009.
2. Alciatore David G &Histand Michael B, “Introduction to Mechatronics and Measurement systems”, 4th Edition, Tata McGraw Hill, 2006

VII. WEB REFERENCES:

1. https://nptel.ac.in/courses/112/107/112107298/
2. http://mechatronics.me.wisc.edu/

ROBOTICS

VI Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC32	**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: Kinematics of Machinery, Dynamics of Machinery								

I. COURSE OVERVIEW:

Robotics is to familiarize the students with the concepts and techniques in robotic engineering, manipulator kinematics, dynamics and control, chose, and incorporate robotic technology in engineering systems.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental concepts of various configurations of the robot manipulators and their working principles used in the industries.
II. The basics of motion analysis of manipulator and process to find forward kinematics and inverse kinematics of the robot manipulator.
III. The path planning of a robot manipulator for given polynomial equation and how to avoid obstacles in its path.
IV. The performance of various feedback components like sensors and actuators and how they can be used according to the specifications of the manipulator.

III. COURSE SYLLABUS:

MODULE-I: INTRODUCTION AND COMPONENTS OF THE INDUSTRIAL ROBOTICS (09)

Introduction: Automation and Robotics, CAD/CAM and Robotics – An over view of Robotics – present and future applications. Components of the Industrial Robotics: common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, Design of end effectors, Precision of Movement: Resolution, Accuracy and Repeatability, Speed of Response and Load Carrying Capacity.

MODULE –II: MOTION ANALYSIS: (09)

Motion Analysis: Basic Rotation Matrices, Equivalent Axis and Angle, Euler Angles, Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation – problems. Manipulator Kinematics-H notation-H method of Assignment of frames-H Transformation Matrix, joint coordinates and world coordinates, Forward and inverse kinematics – problems on Industrial Robotic Manipulation.

MODULE –III: TRAJECTORY PLANNING (09)

Differential transformation of manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton – Euler formations – Problems.

Trajectory planning and avoidance of obstacles, path planning, Slew motion, joint interpolated motion – straight line motion.

MODULE –IV: ROBOT ACTUATORS AND FEEDBACK COMPONENTS (09)

Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors.

MODULE –V: ROBOT APPLICATION IN MANUFACTURING (09)

Material Transfer - Material handling, loading and unloading- Processing - spot and continuous arc welding & spray painting - Assembly and Inspection.

V.TEXT BOOKS

1. Groover M P, “Industrial Robotics”, Mc Graw Hill.
2. Ramachandran Nagarajan, “Introduction to Industrial Robotics”, Pearson,

VI.REFERENCE BOOKS:

1. Spony, Vidyasagar, “Robot Dynamics and Controls”, John Wiley,
2. Asada, Slotine, “Robot Analysis and control”, Wiley Inter-Science,

VII.WEB REFERENCES:

1. http://nptel.ac.in/courses/112101099
2. http://www.intechopen.com/books/robot-control http://www.som.com

ADVANCED MACHINE DESIGN

VI Semester: ME									
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC33	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: Machine Design								

IV. COURSE OVERVIEW:

Advanced Machine Design is the continues course of machine design and this course deals with the design, analysis and integration of machine elements, such as gears, shafts, bearings, springs and columns, This is primarily based upon extensive application of the principles of mechanical engineering, Through the study of machine elements, students develop their capacity to understand and apply advanced engineering concepts to analyse and integrate the individual elements into a system/product, Students also explore, learn and apply the principles of reliability assessment to predict component failure under various loading conditions,

V. COURSE OBJECTIVES:

The students will try to learn:

I. To understand the different theories of failure and develop an ability to apply its knowledge for design of mechanical component and determine the resisting areas against failure.
II. The variety of mechanical components available and emphasize the need to continue learning.
III. How to apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems.
IV. To determine forces on clutches and brakes and formulate design solution for clutches and brakes.

III.COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO ADVANCED MACHINE DESIGN (09)

Introduction, classifications of machine design, general considerations in machine design, general procedure in machine design, fundamental units, physical properties of metals, mechanical properties of metals, maximum principal or normal stress theory(rankine's theory),maximum shear stress theory (guest's or tresca'stheory),maximum principal strain, theory (saintvenant'stheory), maximum strain energy theory (haigh's theory),maximum distortion energy theory (hencky and vonmises theory)

MODULE –II: CHAIN DRIVES (09)

Introduction, advantages and disadvantages of chain drive over belt or rope drive, terms used in chain drive, relation between pitch and pitch circle diameter, velocity ratio of chain drives, length of chain and centre distance, classification of chains, hoisting and hauling chains, conveyor chains, power transmitting chains, characteristics of roller chains, factor of safety for chain drives, permissible speed of smaller sprocket, power transmitted by chains, number of teeth on the smaller or driving sprocket or pinion, maximum speed for chains, principal dimensions of tooth profile, design procedure for chain drive.

MODULE –III: FLYWHEELS (09)

Coefficient of Fluctuation of Speed, Fluctuation of Energy, Maximum Fluctuation of Energy, Coefficient of Fluctuation of Energy, Energy Stored in a Flywheel.

Stresses in a Flywheel Rim, Stresses in Flywheel Arms, Design of Flywheel Arms, Design of Shaft, Hub and Key, Construction of Flywheel.

MODULE –IV: CLUTCHES (09)

Introduction, Types of clutches, positive clutches friction clutches, Material for friction surfaces, consideration in designing a friction clutch, types of friction clutches, Single disc or plate clutch, Design of a disc or plate clutch, Multiple disc clutch, cone clutch, Design of cone clutch, Centrifugal clutch, Design of Centrifugal clutch

MODULE –V: BRAKES (09)

Introduction, Energy Absorbed by a Brake, Heat to be Dissipated during Braking, Materials for Brake Lining, Types of Brakes, Single Block or Shoe Brake, Pivoted Block or Shoe Brake, Double Block or Shoe Brake, Simple Band Brake, Differential Band Brake, Band and Block Brake, Internal Expanding Brake.

V. TEXT BOOKS

1. L. Norton, "Machine Design an Integrated Approach", Prentice-Hall New Jersey, USA.
2. J.E. Shigley, "Mechanical Engineering Design",McGrawHill, New Delhi.
3. Fundamentals of machine elements by Hamrock, Schmid and Jacobian, 2nd edition, McGraw- Hill.
4. Product design and development by Karl T. Ulrich and Steven D. Eppinger. 3rd edition, Tata McGraw Hill.

VI.REFERENCE BOOKS:

1. Product Design and Manufacturing by A.K.Chitale and R.C. Gupta, Prentice Hall
2. Engineering Design / George E Dieter / McGraw Hill /2008 7. Fundamentals of machine elements/ Hamrock, Schmid and Jacobian/ 2nd edition /McGrawHill International edition.

VII.WEBREFERENCES:

1. https://nptel.ac.in/courses/112/105/112105124/
2. https://youtube/QfhIea6KzZA
3. http://www.rmcet.com/lib/Resources/E-Books/Mech-auto/E-Books%20Machine%20Design-Khurmi%20R.s/

FLIGHT CONTROL THEORY

<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><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">AAEC30</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:

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.

EXT 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.

EFERENCE 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.

EB REFERENCES:

1. https://www.e-booksdirectory.com/
2. https://www.aerospaceengineering.es/book/

-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**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AAEC31	**Elective**	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="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>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.
2. K. P. Roy, S. K. Hajra Choudary, Nirjhar Roy, "Element of Mechanical Engineering", Media Promoters & Publishers, 7th Edition, 2012.
3. 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

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**		
ACEC31	**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:

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

EXPERIENTIAL ENGINEERING EDUCATION (ExEEd) – RESEARCH BASED LEARNING

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

HEAT TRANSFER LABORATORY

VI Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC36	**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: Thermodynamics								

I. COURSE OVERVIEW:

Heat transfer laboratory is intended to enhance the learning experience of the student about the flow ofthermal energy due to temperature difference and the subsequent temperature distribution changes. Thislaboratory focuses on heat transfer modes, boundary conditions, one dimensional steady and unsteadystate condition and heat exchangers applied to modern electric and electronic plants require efficientdissipation of thermal losses. Students are expected to gain experience in hands on training as well asknowledge to model heat exchangers, heat treatment of fins and complex mechanical systems.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The information for validating heat transfer parameters during internal and externalflows based on non-dimensional numbers and convective mode heat transfer.
II. Enhance the performance and analysis of heat exchangers for real-time applicationsusing logarithmic mean temperature difference and number of transfer unit methods.
III. Compare experimental results with theoretical to improve the design for improvingthe efficiency of heat transfer rate.

III. COURSE SYLLABUS:

Week-1: COMPOSITE SLAB APPARATUS-OVERALL HEAT TRANSFER COEFFICIENT
Calculating the overall heat transfer coefficient for a composite slab.

Week-2: HEAT TRANSFER THROUGH LAGGED PIPE
Determination of thermal conductivity

Week-3: HEAT TRANSFER THROUGH CONCENTRIC SPHERE
Determination of thermal conductivity

Week-4: THERMAL CONDUCTIVITY OF GIVEN METAL ROD
Determination of thermal conductivity

Week-5: HEAT TRANSFER IN PIN FIN APPARATUS
Calculate the effectiveness and efficiency of pin fin.

Week-6: EXPERIMENT ON TRANSIENT HEAT CONDUCTION
Determination of thermal conductivity in transient mode.

Week-7: HEAT TRANSFER IN FORCED CONVECTION APPARATUS
Calculating convective heat transfer coefficient.

Week-8: HEAT TRANSFER IN NATURAL CONVECTION APPARATUS
Calculating convective heat transfer coefficient

Week-9: PARALLEL AND COUNTER FLOW HEAT EXCHANGERS
Calculate the effectiveness of heat exchangers both experimental and theoretical method.

Week-10: EMISSIVITY APPARATUS
Determination of emissivity of grey and black body.

Week-11: STEFAN BOTLZMAN APPARATUS
Determination of Stefan Botlzman constant and compare its value.

Week-12: CRITICAL HEAT FLUX APPARATUS
Evaluate the critical heat flux value by studying different zones of boiling.

Week-13: STUDY OF HEAT PIPE
Demonstration of heat pipe.

Week-14 FILM AND DROP WISE CONDENSATION APPARATUS
Understanding different methods of condensation.

V.TEXT BOOKS:

1. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw hill Education (P) Ltd, New Delhi, India. 4th Edition, 2012.
2. R. C. Sachdeva, "Fundamentals of Engineering, Heat and Mass Transfer", New Age, New Delhi, India, 3rd Edition, 2012.

VI.REFERENCE BOOKS:

1. Holman, "Heat Transfer", Tata McGraw-Hill education, 10th Edition, 2011.
2. P. S. Ghoshdastidar, "Heat Transfer", Oxford University Press, 2nd Edition, 2012.
3. D. S. Kumar, "Heat and Mass Transfer", S.K. Kataria & Sons, 9th Edition, 2015.

VII.WEB REFERENCES:

1. https: //nptel.ac.in/courses/112108149/
2. https://www.wisc-online.com/learn/natural-science/earth-science/sce304/heat-transfer-conduction-convection-radiation

VIII.E-TEXT BOOKS:

1. https://www.e-booksdirectory.com/details.php?ebook=8139
2. https:// bookboon.com/en/engineering-ebooks

THERMO-FLUID MODELING AND SIMULATION LABORATORY

VI Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC37	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: Heat transfer and Fluid mechanics laboratory.								

I.COURSE OVERVIEW:

The Fluid thermal modeling and simulation laboratory sessions are focusing on creation of geometry, meshing (Discretization) and the physics applied to fluid thermal systems in order to visualize fluid flow and temperature distribution, solving, and reviewing results. FTMS laboratory also covers the usage of finite element methods and necessary coding techniques in the interpretation of results. The Workbench environment is an intuitive up-front numerical methods analysis tool that is used in conjunction with CAD systems and/or Design Modeler. These simulations are used in performing structural, thermal, and electromagnetic systems in the emerging technologies of interdisciplinary applications such as mechanical, aerospace, refrigeration systems.

II.COURSE OBJECTIVES:

The students will try to learn:

I. The formulation of the problem, discretization and suitable boundary conditions by using numerical methods.
II. The basic computational coding techniques that provide the data and contours in the prediction the performance of thermo fluid systems.
III. The environment and usage of commercial Computational Fluid Dynamics packages to carry out research in interdisciplinary applications.

III.LIST OF EXPERIMENTS:

Week-1: INTERNAL PIPE FLUID FLOW – FEM

Batch 1 & Batch2: Determine fluid flow velocity at different nodes of the system by using FEM.

Week-2: INTERNAL PIPE FLUID FLOW - ANSYS

Batch 1 & Batch2: Visualization of fluid flow at different grid points using ANSYS workbench .

Week-3: HEAT TRANSFER ANALYSIS BY USING MATLAB

Batch 1 & Batch2: Determine the temperature distribution in a pipe (MAT LAB).

Week-4: EXTERNAL FLUID FLOW

Batch 1 & Batch2: Determination of the heat transfer when the fluid is flowing over a flat plate.

Week-5: HEAT CONDUCTION

Batch 1 & Batch2: Generating heat transfer by representing temperature distribution in conduction mode.

Week-6: HEAT TRANSFER THROUGH FORCED CONVECTION

Batch 1 & Batch2: Generating heat transfer in forced convection mode using ANSYS.

Week-7: HEAT TRANSFER THROUGH NATURAL CONVECTION

Batch 1 & Batch2: Generating heat transfer in free convection mode using ANSYS.

Week-8: 3D HEAT CONDUCTION

Batch 1 & Batch2: Generation of Conduction mode of heat transfer within a Solid (3D model) using ANSYS.

Week-9: ANALYSIS OF SHELL AND TUBE HEAT EXCHANGER

Batch 1 & Batch2:Distribution of temperature and fluid flow in a shell and tube heat exchanger using ANSYS.

Week-10: CONJUGATE HEAT TRANSFER
Batch 1 & Batch2:Analysis of a pipe which exhibits Conjugate heat transfer using ANSYS Flow Simulation.

Week-11: THERMAL ANALYSIS OF PIN FIN
Batch 1 & Batch2:Thermal Analysis of Finned Pipe using ANSYS workbench.

Week-12: STRUCTURAL ANALYSIS
Batch 1 & Batch2:Structural analysis of beams using ANSYS(Mechanical APDL).

V.TEXT BOOKS:

1. J. D. Anderson, (Jr), "Computational Fluid Dynamics", McGraw-Hill Book Company, 1st Edition, 1995.
2. K.A.Hoffman, and S. T. Chiang, "Computational Fluid Dynamics", Vol. I, II and III, Engineering Education System, Kansas, USA, 2000.
3. D. A. Anderson, J. C. Tannehill, and R. H. Pletcher, "Computational Fluid Mechanics and Heat Transfer", McGraw Hill Book Company, 2002.

VI. REFERENCE BOOKS:

1. J Chung, T.J., "Computational Fluid Dynamics", Cambridge University Press, 2003
2. Muralidhar K and Sundararajan. Computational Fluid Flow & Heat Transfer", 2009.

VII. WEB REFERENCES:

1. ANSYS 18 Fluent tutorial guide

DESIGN OF ALGORITHMS

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
ACSC29	Skill	-	-	-	-	-	-	-
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. COURSE 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, 2^{nd} Edition, 2015.
2. Alfred V. Aho, John E. Hopcroft, Jeffrey D, “The Design And Analysis Of Computer Algorithms”, Pearson India, 1^{st} 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:

1. https://kailash392.files.wordpress.com/2019/02/fundamentalsof-computer-algorithms-by-ellis-horowitz.pdf.

CAD / CAM

<table>
<tr><td colspan="9">VII Semester: ME</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">AMEC38</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: Design and Manufacturing</td></tr>
</table>

I. COURSE OVERVIEW:

Computer aided Design/ Computer aided Manufacturing (CAD/CAM) is a course primary important to mechanical engineering students. The aim is to impart the overview of computer applications or design and manufacturing the discrete engine components, assemblies and final product to meet the global competition. The course covers the life cycle of a product describes the product model generation, analysis structural, thermal, dynamic behaviors. This course also deals with creation of synthetic curves and surfaces. It imposes the knowledge o latest manufacturing techniques using CNC/DNC Machines centers with different CNC programming methods, Manufacturing processes, Group Technologies. It makes the student to understand the modern inspection methods and concepts of CIM.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The product designs, manufacturing processes, and production plant as critical base for the interface and integration of CAD/CAM.

II. The assimilation of all product life cycle systems using computer controlled networks, integrated systems software and secondary information technologies.

III. Implementation of computer aided design techniques, digital in seamless way in the manufacturing automation for product life management systems.

IV. Identify the quality parameters by adopting the contact and non-contact type of inspection techniques.

III. COURSE SYLLABUS:

MODULE-I: Introduction to CAD and Computer Graphics (10)

Computers in Industrial Manufacturing, Product cycle, CAD / CAM Hardware, Basic structure, CPU, Memory types, input devices, display devices, hard copy devices, storage devices, Computer Graphics: raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, 3D transformations, mathematics of projections, clipping, hidden surface removal.

MODULE –II: Geometrical Modelling and Drafting Systems (08)

Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods, solid modeling, modeling facilities desired, Basic geometric commands, layers, display control commands, editing, dimensioning.

MODULE –III: Introduction to Computer Aided Manufacturing (10)

Introduction: Need of NC technology, Fundamental concepts in numeric control: structure and functions of NC System, advantages of NC technology over conventional manufacturing. NC Machine Tools: Types, Definition and designation of control axes,Special constructional and design characteristics of NC machine tools, Standard tooling used for NC turning and milling centres.

Computer Numerical Control of Machine Tools: Types and functions of computer numeric control (CNC), Types and functions of direct numeric control (DNC), Need of adaptive control types, functions and types of adaptive control, its uses & benefits, Advantages of combined CNC/DNC systems

MODULE –IV: NC Part Programming (08)

Work holding and tool setting procedure for NC turning and milling centres, Tool zero presetting, Block formats and introduction to ISO based G & M codes for NC part programming, Concepts of tool length and radius compensation, Standard canned cycles used in CNC turning and milling centres, Introduction to automatic NC part program generation from CAD models using standard CAD/CAM software for machining of surfaces, moulds and dies etc.

MODULE –V: Computer Aided Engineering (09)

Group technology: Part family, coding and classification, production flow analysis, advantages and limitations, computer Aided Processes Planning, Retrieval type and generative type, terminology in quality control, the computer in QC, contact inspection methods, non-contact inspection methods, optical, computer aided testing, integration of CAQC with CAD/CAM.Types of manufacturing systems, machine tools and related equipment, material handling systems, computer control systems, human labor in the manufacturing systems, CIMS benefits.

V. TEXT BOOKS

1. IbrahimZeid, "Mastering CAD/CAM", McGraw-Hill, 1st Edition, 2007.
2. William M Neumann and Robert F.Sproull, "Principles of Computer Graphics", McGraw-Hill Book Co. Singapore, 1st Edition, 1989.
3. Groover M. P, Zimmers. E. W., "CAD/CAM: Computer Aided Design Manufacturing", Pearson Education India, 1st Edition, 2006.

VI. REFERENCE BOOKS:

1. YoramKoren, "ComputerControlof ManufacturingSystems", McGraw-Hill, 1st Edition,1983.
2. K. Lalit Narayan, K. Mallikarjuna Rao and M.M.M. Sarcar, "Computer Aided Design Manufacturing", PHI, 1st Edition, 2008.

VII. WEB REFERENCES:

1. https://nptel.ac.in/courses/112/102/112102101/
2. https://nptel.ac.in/courses/112/102/112102103/

INSTRUCTIONS AND CONTROL SYSTEMS

VII Semester: ME								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC39	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: Machnie Tools and Metrology								

I. COURSE OVERVIEW:

The Present course concentrates on developing basic understanding about various instruments that are involved in measuring. This course enables the student to understand the working of various measuring instruments. The course focuses on all principles, working, advantages, disadvantages and applications of various measuring instruments. In this course; students also will gain a broad understanding of the control systems. Student can learn in detail about how to measure displacement, temperature, pressure, level, flow, acceleration, vibration, strain, humidity, force, torque and power and their appropriate application.

II COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental knowledge of measuring principles, configuration and functional description of instruments with static, dynamic inputs and error control.

II. The concepts and working of instrumentation devices for displacement, flow, dynamic and other mechanical measurement applications.

III. Instrumentation practices and automatic control system for monitoring industrial real time processes within limits of parameter specifications.

III.COURSE SYLLABUS:

MODULE-I: PRINCIPLES OF MEASUREMENT (09)

Definition – Basic principles of measurement – Measurement systems, generalized configuration and functional descriptions of measuring instruments – examples. Dynamic performance characteristics – sources of error, Classification and elimination of error.

MODULE –II: MEASUREMENT OF DISPLACEMENT, TEMPERATURE, PRESSURE (09)

Measurement of Displacement: Theory and construction of various transducers to measuredisplacement – Piezo electric, Inductive, capacitance, resistance, ionization and Photo electric transducers, Calibration procedures.
Measurement of Temperature: Classification – Ranges – Various Principles of measurement – Expansion, Electrical Resistance – Thermistor – Thermocouple – Pyrometers – Temperature Indicators.
Measurement of Pressure: Units – classification – different principles used. Manometers, Piston, Bourdon pressure gauges, Bellows – Diaphragm gauges. Low pressure measurement – Thermal conductivity gauges – ionization pressure gauges, Mcleod pressure gauge.

MODULE –III: MEASUREMENT OF LEVEL, FLOW, SPEED, ACCELERATION AND VIBRATION (09)

Measurement of Level: Direct method – Indirect methods capacitive, ultrasonic, magnetic, cryogenic fuel level indicators – Bubbler level indicators. Flow Measurement: Rotameter, magnetic, Ultrasonic, Turbine flow meter, Hot – wire anemometer, Laser Doppler Anemometer (LDA).

Measurement of Speed: Mechanical Tachometers – Electrical tachometers – Stroboscope, Noncontact type of tachometer. Measurement of Acceleration and Vibration: Different simple instruments –Principles of Seismic instruments – Vibrometer and accelerometer using this principle.

MODULE –IV: MEASUREMENT OF STRESS–STRAIN, HUMIDITY, FORCE, TORQUE AND POWER (09)

Stress Strain Measurements: Various types of stress and strain measurements – electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains usage for measuring torque, Strain gauge Rosettes. Measurement of Humidity: Moisture content of gases, sling psychrometer, Absorption psychrometer, Dew point meter. Measurement of Force, Torque and Power: Elastic force meters, load cells, Torsion meters, Dynamometers.

MODULE –V: ELEMENTS OF CONTROL SYSTEMS (09)
Elements of Control Systems: Introduction, Importance – Classification – Open and closed systems
Servomechanisms – Examples with block diagrams–Temperature, speed & position control systems

V.TEXT BOOKS:

1. K.Padma Raju, Y J Reddy, "Instrumentation and Control Systems", McGraw Hill Education, 1st Edition, 2016.
2. S.W.Bolton,"InstrumentationandControlSystems", Newness Publisher,1stEdition, 2004
3. K.Singh, "Industrial Instrumentation and Control", McGraw Hill Education, 3rd Edition, 2015.

VI. REFERENCE BOOKS:

1. D.S Kumar, " Measurement Systems, Applications & Design ", Anuradha agencies , 4th Edition, 2016
2. B.C Nakra, K.K Choudary, "Instrumentation , measurement & analysis , McGraw Hill Education 3rd Edition, 2010

VII. WEB REFERENCES:

1. https://nptel.ac.in/courses/112/103/112103261/
2. https://nptel.ac.in/courses/108/105/108105064/

UNCONVENTIONAL MACHINING PROCESS

VII Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC40	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: Manufacturing Processes

I. COURSE OVERVIEW:

Unconventional Machining Process is advanced topics in the machining processes. The concept of machining components of complex shapes made hard, difficult - to - machine materials with exacting tolerances and surface finish has resulted in the development of a number of new machining processes.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Understand the basic techniques of machining processes modeling.
II. Estimate the material removal rate and cutting force, in an industrially useful manner, for practical machining processes.
III. Gain the knowledge to remove material by thermal evaporation, mechanical energy process.
IV. Apply the knowledge to remove material by chemical and electro chemical methods.

III.COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO UNCONVENTIONAL MACHINING PROCESS (09)

Introduction – Need for non-traditional machining methods-Classification of modern machining processes – considerations in process selection. Materials. Applications. material removal phenomena

MODULE –II: MECHANICAL ENERGY BASED PROCESSES (09)

Abrasive Jet Machining, Water Jet Machining And Abrasive Water Jet Machine: Basic principles, equipments, process variables, and mechanics of metal removal, MRR, application and limitations. Ultrasonic machining – Elements of the process, mechanics of metal removal process parameters, economic considerations, applications and limitations, recent development.

MODULE –III: ELECTRICAL ENERGY BASED PROCESSES (09)

General Principle and applications of Electric Discharge Machining, Electric Discharge Grinding and electric discharge wire cutting processes – Power circuits for EDM, flushing – applications;

Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy, characteristics of spark eroded surface and machine tool selection. Wire EDM, principle, applications.

MODULE –IV: THERMAL ENERGY BASED PROCESSES (09)

Generation and control of electron beam for machining, theory of electron beam machining, comparison of thermal and non-thermal processes –General Principle and application of laser beam machining – thermal features, cutting speed and accuracy of cut. Application of plasma for machining, metal removing mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries. Chemical machining – principle - maskants - applications.

MODULE –V: ELECTRO – CHEMICAL PROCESSES (09)

Chemical machining – principle - maskants - applications. Magnetic abrasive finishing, Abrasive flow finishing, Electro stream drilling, shaped tube electrolyte machining. Electro – Chemical Processes: Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and deburring process, metal removal rate in ECM, Tool design, Surface finish and accuracy economic aspects of ECM – Simple problems for estimation of metal removal rate. Fundamentals of chemical, machining, advantages and applications.

V. TEXT BOOKS

1. V.K. Jain, "Advanced Machining Processes", Allied publishers, 1st Edition, 2013.
2. P. C. Pandey, H. S. Shan, "Modern Machining Processes", 1st Edition, 2013.

VI. REFERENCE BOOKS:

1. Serope Kalpakjain, "Manufacturing Engineering and Technology", Pearson Publications 4th Edition, 2000.
2. M.K.Singh, "Unconventional Manufacturing Processes", 1st Edition, 2013.

VII. WEB REFERENCES:

1. http://Non-Traditional-Machining-Rev (iitb.ac.in)
2. http://nptel.ac.in/courses/112105127/pdf/LM-40.pdf

ADDITIVE MANUFACTURING PROCESSES

VII Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC41	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: **Manufacturing Processes**								

I. COURSE OVERVIEW:

The primary objective of this course is to build bridges between the gap of an idea and production. Rapid prototyping is a group of methods used to rapidly manufacture a scale model of a physical part or assembly using three-dimensional computer aided design (CAD), Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) data. Construction of the part or assembly is usually done using 3D printing technology. Rapid prototyping techniques are often referred to solid free; computer automated manufacturing, form fabrication. This course covers the knowledge of rapid prototyping systems.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The Importance of Additive manufacturing Technology in the day-to-day life, and study the basic 3D Printing processes and techniques used.

II. The knowledge in various materials and machines used for the development of prototypes.

III. The Design features that make each of these Additive manufacturing process both harder, easier, assess design and manufacturing features on real products.

III.COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO RAPID PROTOTYPING (09)

Introduction: Prototype Fundamentals, Types and Roles of Prototype, Fundamentals of Rapid Prototyping, Phases of Development Leading to Rapid Prototyping, Advantages of Rapid Prototyping and Classifications of Rapid Prototyping System, Generic RP process. Rapid Product Development: An Overview virtual prototyping and testing technology.

MODULE-II: LIQUID-BASED RAPID PROTOTYPING SYSTEMS (09)

Liquid-Based Rapid Prototyping Systems: Principle, Process parameter, Process details, Advantages, Disadvantages and Applications of Stereolithography Apparatus (SLA), Solid Ground Curing (SGC), Solid Object Ultraviolet-Laser Printer (SOUP), Rapid Freeze Prototyping and Micro fabrication

MODULE-III: SOLID-BASED RAPID PROTOTYPING SYSTEMS (09)

Solid-Based Rapid Prototyping Systems: Principle, Process parameter, Process details, Advantages, Disadvantages and Applications of Laminated Object Manufacturing (LOM);

Fused Deposition Modeling (FDM), Paper Lamination Technology (PLT), Multi-Jet Modeling System (MJM) and CAM-LEM.

MODULE-IV: POWDER-BASED RAPID PROTOTYPING SYSTEMS (09)

Powder-Based Rapid Prototyping Systems: Principle, Process parameter, Process details, Advantages, Disadvantages and Applications of Selective Laser Sintering (SLS). Laser Engineered Net Shaping (LENS), Multiphase Jet Solidification (MJS) – Hands on Session.

MODULE-V: RAPID TOOLING (09)

Rapid Tooling: Introduction to rapid tooling (RT), Indirect rapid tooling methods: spray metal deposition, RTV epoxy tools, and 3D Keltool process, Direct rapid tooling methods: DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

V.TEXT BOOKS:

1. Chua C K, Leong K F, Chu S L, "Rapid Prototyping: Principles and Applications in Manufacturing", World Scientific, 3rd Edition, 2008.
2. Liou W L, Liou F W, "Rapid Prototyping and Engineering applications: A Tool Box for Prototype Development", CRC Press, 1st Edition, 2007.

VI.REFERENCE BOOKS:

1. Gibson D W Rosen, Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 1st Edition, 2014.
2. A. K. Kamrani, E.A. Nasr, "Rapid Prototyping: Theory and practice", Springer, 1st Edition, 2006.
3. Rafiq I. Noorani, "Rapid Prototyping: Principles and Applications", John Wiley & Sons, 1st Edition, 2005.

VII.WEB REFERENCES:

1.https://nptel.ac.in/courses/112102103/16
2.https://nptel.ac.in/courses/112107078/37

VIII.E-TEXT BOOKS:

https://www.cet.edu.in/noticefiles/258_Lecture%20Notes%20on%20RP-ilovepdf-compressed.pdf

DESIGN FOR MANUFACTURING

<table>
<tr><td colspan="11">VII Semester: ME</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">AMEC42</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: Manufacturing Processes</td></tr>
</table>

I. COURSE OVERVIEW:

Design for manufacturing is an engineering methodology that focuses on reducing time-to-market and total production costs by prioritizing both the ease of manufacture for the product's parts and the simplified assembly of those parts into the final product. The main objective of this course is to design a product for Part Minimization, Quantitative analysis of a design's efficiency, Critique product designs for ease of assembly and the importance of involving production engineers in DFMA analysis.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The techniques of Design for Manufacturing and Assembly applied for minimizing product cost through design and process improvements.
II. The selection of material and process used in the prototype design in the early stages of product development for cost effectiveness.
III. The Identification of the manufacturing constraints that influence the design of parts and part systems
IV. The pattern movement in assembly process, assembly errors and minimization steps by considering logical sub-assemblies and re-orientation of parts during machining.

III. COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO DFM (09)

Introduction: Design philosophy, steps in design process, general design rules for manufacture ability, basic principles of designing for economical production, creativity in design; materials: Selection of materials for design, developments in material technology, criteria for material selection, and material selection interrelationship with process selection, process selection charts.

MODULE –II: DESIGN FOR MACHINING & MOULDING (09)

Machining Process: Overview of various machining processes, general design rules for machining, dimensional tolerance and surface roughness, design for machining ease, redesigning of components for machining ease with suitable examples, general design recommendations for machined parts. Plastics: Viscoelastic and Creep behavior in plastics – Design guidelines for Plastic components – Design considerations for Injection Moulding

MODULE –III: DESIGN FOR METAL CASTING &METAL JOINING (09)

Metal Casting: Appraisal of various casting processes, selection of casting process, - general design considerations for casting - casting tolerances - use of solidification simulation in casting design - product design rules for sand casting

Metal Joining: Appraisal of various welding processes, Factors in design of weldments - general design guidelines - pre and post treatment of welds - effects of thermal stresses in weld joints - design of brazed joints. Forging - Design factors for Forging - Closed dies forging design - parting lines of dies drop forging die design - general design recommendations. Extrusion & Sheet Metal Work: Design guidelines for extruded sections - design principles for Punching, Blanking, Bending, Deep Drawing - Keeler Goodman Forming Line Diagram - Component Design for Blanking. .

MODULE –IV: DEVELOPMENT OF THE ASSEMBLE PROCESS (09)

Development of the assemble process, choice of assemble method assemble advantages social effects of automation. Automatic Assembly Transfer Systems: Continuous transfer, intermittent transfer, indexing mechanisms, and operator - paced free – transfer machine

MODULE –V: DESIGN OF MANUAL ASSEMBLY (09)

Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.

IV. TEXT BOOKS:

1. Geoffrey Boothroyd, "Assembly Automation and Product Design", Marcel and Dekken, Inc., NY, 1992.
2. George E. Deiter, "Engineering Design - Material & Processing Approach", McGraw Hill Intl. 2nd Edition, 2000.
3. Geoffrey Boothroyd," Hand Book of Product Design", Marcel and Dekken,, N.Y. 1990

V. REFERENCE BOOKS:

1. Geoffrey Boothroyd, "Hand Book of Product Design", Marcel and Dekken, 1st Edition, 2013.
2. Geoffrey Boothroyd, Peter Dewhurst, Winston, "Product Design for Manufacturing and Assembly", CRC Press, 1st Edition, 2010.

VI. WEB REFERENCES:

1. http://www.nptel.ac.in/courses/107103012/
2. http://nptel.ac.in/courses/112101005/

NANO-MATERIALS

VII Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC43	**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**		
Prerequisite: Engineering Materials								

I. COURSE OVERVIEW:

Without nanomaterials, there is no nanotechnology. As such, this course covers the basic principles associated with nanoscience and nanotechnology including the fabrication and synthesis, size dependent properties, characterization, and applications of materials at nanometer length scales with an emphasis on recent technological breakthroughs in the field.

II.COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental principles of nanotechnology to identify the essential concepts used in nanotechnology.
II. The properties, production and characterization of nanomaterials by fabrication and characterization techniques.
III. The applications of nanotechnology in various engineering and technology fields.

III.COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO NANO TECHNOLOGY (09)

History and scope, can small things make a big difference, classifications of nano-structured materials, fascinating nanostructures, applications of nano materials, nature: The best nanotechnologist, challenges and future prospects.

MODULE –II: UNIQUE PROPERTIES OF NANO MATERIALS (09)

Microstructure and defects in nanocrystalline materials: dislocations ,twins stacklling faults and voids, grain boundaries, triple and disclinations; Effects of nano-dimension on material behavior: Elastic properties, melting point, diffusivity, grain growth characteristics, enhanced solid solubility; Magnetic properties: Soft magnetic nano crystalline alloy, permanent magnetic nanocrystalline material, giant magnetic resonance, electrical properties, optical properties, thermal properties and mechanical properties.

MODULE –III: SYNTHESIS ROUTES (09)

Bottom up approaches: Physical vapor deposition, inert gas condensation, laser ablation, chemical vapor deposition, molecular beam epitaxy, sol-gel method, self-assembly.

Top down approaches: Mechanical alloying, nano-lithography; Condensation of nano powders: Shockwave consolidation, hot isostatic pressing and cold isostatic, spark plasma sintering.

MODULE –IV: CHARACTERIZATION TECHNIQUES (09)

X-Ray diffraction and Scherrer method, scanning electron microscopy, transmission electron microscopy, scanning probe microscopy, atomic force microscopy, X-ray photoelectron spectroscopy, UV-Visible and Infrared spectroscopy, Raman spectroscopy, Thermogravimetric analysis, Differential thermal analysis, Differential Scanning Calorimetry.

MODULE –V: APPLICATION OF NANO MATERIALS (09)

Applications in material engineering, biology and medicine, surface science, energy and environment. Applications of nano structured thin films, applications of quantum dots.

V. TEXT BOOKS:

1.B.S. Murthy P. Shankar, Baladev Raj, James Munday, "Text Book of Nano Science and Nano Technology", University Press-IIM, 1st Edition, 2013.
2. Charles P. Poole, Frank .J. Owens, "Introduction to Nanotechnology", Wiley, 1st Edition, 2012.

VI. REFERENCE BOOKS:

1. T. Pradeep, “Nano: The Essential “, Tata McGraw Hill, 1st Edition, 2008.
2. Miachel F. Ashby, Paulo J. Ferreira, “Nano materials, Nanotechnologies and design”, wiley, 1st Edition, 2013.

VII. WEB REFERENCES:

1. https://nptel.ac.in/courses/118/107/118107015/
2. https://nptel.ac.in/courses/118/104/118104008/

AUTOMOBILE ENGINEERING

VII Semester: ME									
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC44	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		
Prerequisite: Kinematics of Machinery								

I. COURSE OVERVIEW:

This is a first course in automobile engineering introducing the anatomy and the functioning of all major components of the modern automobile. With an introduction to the engine and its accessories, the course deals in detail with the description of automobile components like clutch, transmission, final drive, axles, wheels, suspension, steering, Cooling systems among others. Concepts of emissions from automobile are also included.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The need and scope of automobile engineering in the field of automotive industry.
II. The basic concepts and working principles of various automobile systems.
III. The problems associated with the power transmission from engine to rear axles by using theconcepts of kinematics of machines.
IV. The causes of automobile emissions and preventive measures according to the national andinternational standards.

III.COURSE SYLLABUS:

MODULE-I: INTRODUCTION (09)

Introduction to automobile engineering, chassis and body components, types of automobile engines, engine lubrication, engine servicing; Fuel system; spark ignition engine fuel supply systems, mechanical and electrical fuel pump, filters, carburetor types, air filters, petrol injection, multipoint fuel injection(MPFI) and gasoline direct injection systems; Compression ignition engines fuel supply systems, requirement of diesel injection systems, types of injection systems, direct injection systems, indirect injection (IDI) systems, fuel pump, nozzle, spray formation, injection timing, testing of fuel pumps, CRDI and turbocharged direct injection (TDI) systems.

MODULE-II: COOLING SYSTEM (09)

Cooling requirements, air cooling, water cooling, thermo, water and forced circulation system, radiators types cooling fan, water pump, thermostat, pressure sealed cooling, antifreeze solutions, intelligent cooling; Ignition system**:** Function of an ignition system, battery ignition system constructional features of storage, battery, contact breaker points, condenser and spark plug, magneto coil ignition system, electronic ignition system using contact breaker, electronic ignition using contact triggers, spark advance and retard mechanism; Electrical system**:** Charging circuit, generator, current-voltage regulator, starting system,bendix drive mechanism solenoid switch, lighting systems, automatic high beam control, horn, wiper, fuel gauge, oil pressure gauge, engine temperature indicator.

MODULE-III: TRANSMISSION AND SUSPENSIONS SYSTEM (09)

Transmission system: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid flywheel, gear box, types, sliding mesh, constant mesh, synchro mesh gear boxes, epicyclic gear box, auto transmission, continuous variable transmission over drive, torque converter, propeller shaft, Hotch-Kiss drive, torque tube drive, universal joint, differential, rear axles, types, wheels and tyres.
Suspension system: Objects of suspension systems, rigid axle suspension system, torsion bar, shock absorber, independent suspension system, air suspension system, Daimler-benz vehicle suspension.

MODULE-IV: BRAKING AND STEERING SYSTEMS (09)

Braking system: Mechanical brake system, Hydraulic brakes system, Master cylinder, wheel cylinder tandem master cylinder; Requirement of brake fluid, Pneumatic and vacuum brake, anti-skidbraking (ABS), regenerative braking; Steering system: Steering geometry, camber, castor, king pin, rake, combined angle, toe-in, toe-out, center point steering, types of steering mechanism, power steering, Hydraulic, electronics, Ackerman steering mechanism, Davis steering mechanism, steering gears types, steering linkages, special steering colomuns.

MODULE-V: EMISSIONS FROM AUTOMOBILES (09)

Emissions from Automobiles, Pollution standards national and international, various pollution control techniques: Multipoint fuel injection for spark ignition engines, common rail diesel injection, variable valve timing, closed crank cake ventilation, pc valves, EGR value, catalytic converters, catalyst window, lambda probe, energy alternatives, solar, photo-voltaic, hydrogen, biomass, alcohols, LPG, CNG, liquid Fuels and gaseous fuels, hydrogen as a fuel for internal combustion engines, their merits and demerits, standard vehicle maintenance practice.

V. TEXT BOOKS:

1. Willam H Crouse, Donald L. Anglin, "Automobile Engineering", McGraw-Hill, 10th Edition,2006.
2. Manzoor, Nawazish Mehdi, YosufAli, "A Text Book Automobile Engineering", Frontline Publications, 1st Edition, 2008.
3. Dr.KirpalSingh,"Automobile Engineering", Standard Publishers, 2nd Edition, 2013.

VI. REFERENCE BOOKS:

1. R.K. Rajput,"A Text Book of Automobile Engineering", Laxmi Publications, 1st Edition, 2010.
2. S. Srinivasan, "Automotive Engines", McGraw-Hill, 2nd Edition, 2003.
3. Khalil U Siddiqui, "A Text Book of Automobile Engineering", New Age International, 1st Edition, 2009.

VII.WEB REFERENCES:

http://nptel.kmeacollege.ac.in/syllabus/125106002/

VIII. E-TEXT BOOKS:

1. http://www.engineeringstudymaterial.net/tag/automotive-engineering-books/
2. www.engineering108.com/.../Automobile_Engineering/Automobile-engineering-ebook

TURBO MACHINES

VII Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC45	**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: Thermodynamics, Thermal Engineering								

I. COURSE OVERVIEW:

The purpose of this course is meant to throw more light on Thermodynamics, in an area where the basic course in Thermodynamics would not have reached or the applied course in Thermodynamics would have crossed over. This area is precisely the area where the turbomachines operate. And also covers the energy exchange in turbomachines and general analysis turbomachines. The main applications are almost every type of renewable energy cycle requires a piece of turbomachinery. Compressors, fans, blowers, pumps, turbines all are critical components in a wide range of renewable energy applications, from wind energy to ocean energy to bottoming cycles to hydrogen pumping.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The energy transfer and losses in centrifugal compressors, axial fans and steam turbines.
II. The Classifications of turbo machines based on impulsive and reaction forces.
III. The Estimation of energy transfer through a turbo machines equipment.

III. COURSE SYLLABUS:

MODULE-I: BASICS OF TURBO MACHINES (09)

Introduction , Classification of Fluid Machines, Turbomachines , Turbomachines and Positive Displacement Machines , Classification of Turbomachines ,Units and Dimensions , Energy of Fluids : Pressure Energy ,Kinetic Energy ,Potential Energy , Thermal Energy or Enthalpy ,Head Energy , Application of the First Law of Thermodynamics ,Application of the Second Law of Thermodynamics : Efficiencies of Turbomachines, Power-Flow Diagrams in Head Units.

MODULE –II: THERMODYNAMICS OF FLUID FLOW (09)

Introduction , Static and Stagnation States, Thermodynamics of Turbomachine Processes,Isentropic Compression Process,Isothermal Compression Process,Isentropic Expansion Process, Overall Isentropic Efficiency versus Stage Efficiency: Pre-heat Effect in Multi-stage Compressor,Re-heat Effect in Multi-stage Turbines , Infinitesimal-Stage or Small-Stage Efficiency or Polytropic Efficiency ,Reheat Factor for Expansion Processes,Overall Isentropic Efficiency versus Finite-Stage Efficiency:Compression and Expansion Processes.

MODULE –III: ENERGY EXCHANGE IN TURBOMACHINES (09)

Introduction, Velocity Triangles, Basic Equations: Linear Momentum Equation, Impulse Momentum, Equation, Moment of Momentum Equation, and Euler Turbine Equation, Alternate Form of the Euler Turbine Equation.

Components of Energy Transfer, Energy Equation of Relative Velocities, Impulse and Reaction, Utilization Factor of Turbines, Speed Ratio.

MODULE –IV: GENERAL ANALYSIS OF TURBOMACHINES (09)

Introduction, General Analysis of Radial Flow Machines , Radial Flow Machines (Centrifugal Pumps, Centrifugal Blowers, and Centrifugal,Compressors): Velocity Triangles , Effect of Blade Outlet Angle on Energy Transfer , Effect of the Blade Outlet Angle on Reaction , Effect of the Blade Exit Angle on the Performance , Flow Analysis in Impeller Blades: Slip and Slip Factor or the Coefficient of Slip ,Losses in Impeller Blade Passages , Characteristic Curves: Head–Capacity Relationship , Effect of Prewhirl , Axial Flow Machines , Compressors .

MODULE –V: STEAM TURBINES (09)

Introduction, Classification of Steam Turbines , Compounding of Steam Turbines , Analysis , Rateau Stages, Parsons Stages , Curtis Stage , Mass Flow Rate and Blade Heights , Efficiencies : Nozzle Efficiency ,Carryover Efficiency , Stator Efficiency or Blade Passage Efficiency ,Rotor Efficiency or Vane Efficiency, Stage Efficiency.

V. TEXT BOOKS

1. BU Pai, "Turbomachines", Wiley, 1st Edition, 2013.
2. G. Gopalakrishnan, and D. Prithvi Raj, "A treatise on Turbomachines", Scitech Publications, Chennai, 1st Edition, 2008.

VI. REFERENCE BOOKS:

1. Sheppard, "Principles of Turbomachinery", Collier Macmillan, 1st Edition, 2013.
2. R. K. Turton, "Principles of Turbomachinery", Springer Publishers, India, 2nd Edition, 2013.

VII. WEB REFERENCES:

https://onlinecourses.nptel.ac.in/noc11_mg14

GAS DYNAMICS

VII Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AMEC46	Elective	3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			

Prerequisite: Thermodynamics, Fluid Mechanics

I. COURSE OVERVIEW:

Gas Dynamics imparts the fundamentals of compressible fluid flow, with an emphasis on a wide variety of steady, one-dimensional flow problems and a general understanding of the principles of multi-dimensional flow. These mainly includes in fundamental research and Industrial R&D. Industries like Aerospace, automotive, chemical, power and bio-medical rely heavily on CFD for design, analysis and even for service & maintenance of Mechatronic systems.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The knowledge of basic concepts and isentropic flows of energy in gas dynamicscompressible flow through constant and variable area duct and propulsive system by applying principles of Fluid mechanics.

II. The operational concepts, principles, features, procedures and detailed thermodynamic analyses related to gas dynamic systems.

III. The real-world engineering problems and examples towards gaining the experience for designing and developing systems in engineering practice.

III.COURSE SYLLABUS:

MODULE-I: COMPRESSIBLE FLOW (09)

Concept of compressible flow, speed of sound, temperature rise, Mach angle, thermodynamics of fluid flow, energy equation, entropy equation, thermal properties, the perfect gas, wave propagation, subsonic and supersonic flows.

MODULE –II: SHOCKWAVE PROPAGATION (09)

Fundamental equations, stream tube area-velocity relations, De Laval nozzle, supersonic flow generation, diffusers, equation of motion for a normal shockwave, Hugoniot equation, reflected shockwave, shock tube, oblique shock relations, shock polar, Prandtl-Meyer expansions, reflection and intersection of shockwaves, Mach reflection, shock expansion theory.

MODULE –III: 1D, 2D COMPRESSIBLE FLOWS (09)

Croccos theorem, linearization of potential equation, boundary conditions, pressure coefficient, Prandtl-Glauert rule for subsonic, supersonic flows, Von Karman rule for transonic flows.

Hypersonic similarity, critical Mach number, general linear solutions for supersonic flows, flow along a wave shaped wall, two dimensional compressible flows

MODULE –IV: FRICTION FLOW WITH HEAT TRANSFER (09)

Prandtl-Meyer expansion fan, thermodynamics considerations, reflections, flow in a constant area duct with friction, flow with heating and cooling in ducts, the concepts of characteristics, compatibility relations, theorems for two dimensional flow, design of supersonic nozzle.

MODULE –V: HIGH TEMPERATURE GAS DYNAMICS (09)

Pressure, temperature, velocity and density measurement, compressible flow visualization, high speed wind tunnels, Knudsen number, slip flow, importance of high temperature flows, nature of high temperature flows.

V.TEXT BOOKS:

1. E. Radhakrishnan, “Gas Dynamics”, PHI Learning Pvt Ltd, 6th Edition, 2017.
2. S.M. Yahya, “Fundamental of Compressible Flow”, New Age Publication, 3rd Edition, 2006.

VI. REFERENCE BOOKS:

1. Frank H Shu, "Physics of Astrophysics II: Gas Dynamics", 1st Edition, 1992.
2. J. D. Anderson, "Hypersonic and High Temperature Gas Dynamics", AIAA Edu Series, 2nd Edition, 1988.

VII. WEB REFERENCES:

1. https://b-ok.cc/book/449653/7ec8b0
2. https://b-ok.cc/book/449803/d9554e

GAS TURBINES AND JET PROPULSION SYSTEMS

VII Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC47	**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: Thermodyanmics, Thermal Engineering								

I. COURSE OVERVIEW:

The primary objective of this course is to introduce the concept of Jet engines, like rocket engines, use the reaction principle in that they accelerate a mass in one direction and, from Newton's third law of motion, experience thrust in the opposite direction. Air-breathing provides higher performance in terms of thrust per unit of propellant and allows the highest endurance.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamentals of gas turbine theory and applications.
II. The Ability to calculate the thermal efficiency thrust power and overall efficiency.
III. Visualize the geometry of inlets, combustors and nozzles in industrial applications.
IV. Analyze the axial flow compressor and turbines, velocity diagram and application in industrial field.

III. COURSE SYLLABUS:

MODULE-I: FUNDAMENTALS OF GAS TURBINE THEORY (09)

Thermodynamic Cycles, open closed and semi-closed, parameters of performances, cycle modifications forimprovement of performance; Jet Propulsion: Historical sketch-reaction principle, essential features of propulsion devices, thermal engines, classification of energy flow thrust, thrust power and propulsion efficiency, need for thermal jet engines and applications.

MODULE –II: TURBOPROPULSION AND TURBOJET (09)

Thermo dynamic cycles, plant layout, essential components, principles of operation, performance evaluation, thrust augmentation and thrust reversal, contrasting with piston engine propeller plant, power and efficiency calculations, turbojet, turbofan, and turboprop engines, ramjet engine, pulse-jet engine, turbo-jet engine ,turboprop engine, thrust equation, ram efficiency, thermal efficiency of turbo-jet engine, propulsion efficiency, overall efficiency of a propulsive system.

MODULE –III: INLETS, COMBUSTORS, AND NOZZLES (09)

Introduction, subsonic inlets, supersonic inlets, gas turbine combustors, afterburners and ramjet.

Combustors, supersonic combustion, exhaust nozzle, numerical problems.

MODULE –IV: AXIAL FLOW COMPRESSOR (09)

Euler's turbo-machinery equations, axial flow compressor analysis, cascade action, flow field, velocity diagrams, flow annulus area stage parameters, degree of reaction, cascade airfoil nomenclature and loss coefficient, diffusion factor, stage loading and flow coefficient, stage pressure ratio, Blade Mach no., repeating-stage, repeating-row, mean line design, flow path dimensions, number of blades per stage, radial variation, design process, performance.

MODULE –V: AXIAL FLOW TURBINE (09)

Axial flow turbine : Introduction to turbine analysis, mean-radius stage calculations, stage parameters, stage loading and flow coefficients, degree of reaction, stage temperature ratio and pressure ratio, blade spacing, radial variation, velocity ratio, axial flow turbine stage flow path dimension, stage analysis, multistage design steps of design, single stage and two-stage, turbine performance, blade cooling.

V.TEXT BOOKS:

1. J.J.Bertin, “Aerodynamics for Engineers”, Pearson Education, 4^{th} Edition, 2012.
2. Jr.Anderson, “Fundamentals of Aerodynamics”, J.D., McGraw-Hill, 3^{rd} Edition, 2013.
3. A.M.Kuethe, C.Chow, “Foundations of Aerodynamics”, Wiley, 5^{th} Edition, 2013.
4. Karamcheti, Krishnamurthy, “Ideal fluid Aerodynamics”, Kreiger Publications, 2^{nd} Edition, 2013.

VI.REFERENCE BOOKS:

1. D.Kuchemann, D., “The Aerodynamic Design of Aircraft”, Pergamon Press, 1^{st} Edition, 2013.
2. R.S.Shevell, “Fundamentals of Flight”, Pearson Education”, 2^{nd} Edition, 2013.
3. B.W.McCormick, “Aerodynamics, Aeronautics & Flight Mechanics”, John Wiley, 2^{nd} Edition, 2013

VII.WEB REFERENCES:

1. http://www.industrial-electronics.com/engineering-industrial/fund-tool_1.html
2. https://www.engineeringclicks.com/tooling-design-basics/

VIII. E-TEXT BOOKS:

1. https://www.e-booksdirectory.com/details.php?ebook=8139
2. https:// bookboon.com/en/engineering-ebooks

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 rowspan="3">Course Code</td><td rowspan="3">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>3</td><td>-</td><td>-</td><td>3</td><td>30</td><td>70</td><td>100</td></tr>
<tr><td>ACSC25</td><td>Elective</td><td colspan="7"></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. AI 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

OE – I: VI Semester: ECE / EEE
OE –II: VII Semester: AERO / MECH / CIVIL

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AITC19	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 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

OE – I: VI Semester: ECE / EEE OE –II: VII Semester: AERO / MECH / CIVIL								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AITC20	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 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

COMPUTER AIDED DESIGN/ COMPUTER AIDED MANUFACTURING (CAD/CAM) LABORATORY

VII Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC48	Core	L	T	P	C	CIA	SEE	Total
		0	0	3	1.5	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 24			Total Classes: 24			

Prerequisite: Design and Manufacturing

I. COURSE OVERVIEW:

Computer aided Design/ Computer aided Manufacturing (CAD/CAM) laboratory is a course primary important to mechanical engineering students. The aim is to impart the overview of computer applications or design and manufacturing the discrete engine components, assemblies and final product to meet the global competition. The course covers the life cycle of a product describes the product model generation, analysis structural, thermal, dynamic behaviors. This course also deals with creation of synthetic curves and surfaces. It imposes the knowledge of latest manufacturing techniques using CNC/DNC Machines centers with different CNC programming methods, Manufacturing processes, Group Technologies.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The 2D drawings of machine components and modify commands for simple geometric assemblies
II. The 2D Sectinal views for part drawing and assemblies, and generation of 2D, 3D models through different features
III. The Simulation software used for anlyse stresses in various beams and truss
IV. The fundamentals of CNC turning and milling, Part programming and interpolation techniques using CAM software.

III. COURSE SYLLABUS:

Week-1: INTRODUCTION TO CAD SOFTWARE

Batch 1 & Batch2:Familiarization and practicing of drawing and modifying commands, template creation, lettering, object snapping and sectioning.

Week-2: DRAFTING OF SIMPLE 2D DRAWINGS

Batch 1 & Batch2:Prepare the 2D drawings using draw and modify commands for simple geometric assemblies, sectional views for part drawing and assemblies.

Week-3: SOLID MODELING

Batch 1 & Batch2: Preparing the 2D and 3D models (wire frame, surface and solid models) by using B-REP, CSG. Introduction of Boolean operations. Generation of 2D, 3D models through protrusion, revolve, sweep.

Week-4: CREATING ORTHOGRAPHIC VIEWS FROM SOLID MODELS

Batch 1 & Batch2: Development of orthographic views for assembly drawings and preparation of bill of materials (IC engine components, Machine tool accessories, Jigs and Fixtures).

Week-5: INTRODUCTION TO SIMULATION SOFTWARE

Batch 1 & Batch2: Basic commands used in Simulation Software (Eg. Ansys, Hyperworks, etc.) and related simulation methodologies.

Week-6: SIMPLE BEAM

Batch 1 & Batch2: Determination of deflection and stresses in bar.

Week-7: TRUSSES

Batch 1 & Batch2: Simulation and analysis of a truss.

Week-8: CANTILEVER BEAM-1

Batch 1 & Batch2: Simulation and analysis of a cantilever beam with load.

Week-9: CANTILEVER BEAM-2

Batch 1 & Batch2: Simulation and analysis of a cantilever beam with UDL.

Week-10: INTRODUCTION TO CAM

Batch 1 & Batch2: Basic fundamentals of CNC milling, familiarization of machine control panel, Part programming and interpolation techniques using CAM software.

Week-11: CNC MILLING

Batch 1 & Batch2: Machining practice on CNC milling.

Week-12: CNC TURNING

Batch 1 & Batch2:Machining practice on CNC Turning

V. TEXT BOOKS:

1. IbrahimZeid, "MasteringCAD/CAM", McGraw-Hill,1st Edition,2007.
2. William M Neumann and Robert F.Sproull, "Principles of Computer Graphics", McGraw-Hill Book Co. Singapore, 1st Edition, 1989.
3. Groover M. P, Zimmers. E. W., "CAD/CAM: Computer Aided Design Manufacturing", Pearson Education India, 1st Edition, 2006.

VI. REFERENCE BOOKS:

1. YoramKoren, "ComputerControlof ManufacturingSystems", McGraw-Hill,1st Edition,1983.
2. K. Lalit Narayan, K. Mallikarjuna Rao and M.M.M. Sarcar, "Computer Aided Design Manufacturing", PHI, 1st Edition, 2008.

VII. WEB REFERENCES:

1. https://nptel.ac.in/courses/112/102/112102101/
2. https://nptel.ac.in/courses/112/102/112102103/

INSTRUMENTATION, CONTROL SYSTEMS & PRODUCTION DRAWING PRACTICE LABORATORY

VII Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC49	**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: Machine Tools and Metrology Laboraory								

I. COURSE OVERVIEW:

Instrumentation is the division of engineering science which deals with measuring techniques, devices and their associated problems. The primary objective of this laboratory course is to measure parameters related to linear and angular displacement, temperature, pressure, vacuum, speed, strain, and vibration using appropriate transducer. The transducer converts input signal to digital output which will be compared with appropriate mechanical type measuring instruments such as dial gauges, micrometers and pressure gauges, tachometer etc. At end of the this course the students can calibrate measuring instrument so as to maintain the devices in working condition.

II COURSE OBJECTIVES:

The students will try to learn:

I. The measurement of physical quantities and converting them into digital signals.
II. Calibration of instruments related for measurement of displacement, temperature, pressure, vacuum, flow, speed, strain and vibration.
III. Conventional representation of various parts, estimation of limits and surface roughness representation.
IV. Part drawing, production drawing practices.

III. COURSE SYLLABUS:

A) INSTRUMENTATION & CONTROL SYSTEMS LAB

1. Calibration of capacitive transducer for angular measurement.
2. Study and calibration of LVDT transducer for displacement measurement.
3. Study of resistance temperature detector for temperature measurement.
4. Calibration of thermister for measurement.
5. Calibration of thermocouple for temperature measurement.
6. Calibration of Pressure gauges.
7. Calibration of strain gauge for temperature measurement.
8. Study and calibration of photo speed pickups for the measurement of speed.
9. Study and use of a Seismic pickup for the measurement of vibration amplitude of an engine bed at various Loads.
10. Calibration of Mcleod gauge for low pressure.
11. Study and calibration of magnetic speed pickups for the measurement of speed.

B) PRODUCTION DRAWING PRACTICE LAB

1. **COVENTIONAL REPRESENTATION OF MATERIALS:**
   Conventional representation of parts-scew joints, welded joints, springs, gears, electrical , hydraulic and pneumatic circuits- methods of indicating notes on drawing.
   Limits, Fits and Tolerances: Types of fits, excerises involving selection / interpretation of fits and estimation of limits from tables.

2. **FORM AND POSITIONAL TOLERANCES:**
   Introduction an indication of form and position tolerances on drawings, types of run out and their indication.

3. **SURFACE ROUGHNESS AND ITS INDICATION:**
   Definition, types of surface roughness indication- Surface roughness obtainable from various manufacturing processes, recommended surface roughness on mechanical components. Heat treatment and surface treatment symbols used on drawings.

4. **DETAILED AND PART DRWAINGS:**
   Drawing of parts from assembly drawings with indication of size, tolerances, roughness, form and position errors etc.

5. **PRODUCTION DRAWING PRACTICE:**
   Part drawings using computer aided drafting by CAD software.

V. TEXT BOOKS

1. D.S. Kumar, "Measurement Systems: Applications & Design", Anuradha Agencies, 1st Edition, 2013.
2. Nakra K.K. Choudary, "Instrumentation, Measurement & Analysis", Tata McGrawHill, 1st Edition, 2013.

VI. REFERENCE BOOKS:

1. K Padma Raju, Y J Reddy, "Instrumentation and Control Systems", McGraw Hill Education 1st Edition, 2016.
2. S W. Bolton, "Instrumentation and Control Systems", Newnes Publisher, 1st Edition, 2004.
3. K Singh, "Industrial Instrumentation and Control", McGraw Hill Education, 3rd Edition, 2015.

VII. WEB REFERENCES:

1. https://nptel.ac.in/courses/112/103/112103261/
2. https://nptel.ac.in/courses/108/105/108105064/

PROJECT WORK - I

<table>
<tr><td colspan="10">VII 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">AMEC50</td><td rowspan="2">Project</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>0</td><td>0</td><td>4</td><td>2</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>
</table>

The object of Project Work I is to enable the student to take up investigative study in the broad field of Mechanical 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.

COMPUTATIONAL FLUID DYNAMICS

VIII Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AMEC51	Elective	3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			

Prerequisite: Heat transfer, Fluid Mechanics

I. COURSE OVERVIEW:

Computational Fluid Dynamics mainly focusses on complex engineering fluid dynamics and heat transfer analysis using numerical methods which are provided with advanced engineering mathematics (Fourier series, partial differential equations). This course also describes the computational simulation tools required for the analysis of thermal engineering problems in the emerging technologies of interdisciplinary applications like aerospace and medical fields of research.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The evolution of the major theories, approaches, methodologies and programming techniques in Computational fluid dynamics

II. The development of various fluid flow governing equations from the conservation laws of motion and Fluid mechanics.

III. The rigorous and comprehensive treatment of numerical methods in fluid flow and heat transfer problems in engineering applications.

IV. The environment and usage of commercial Computational Fluid Dynamics packages and carry out research in interdisciplinary applications

III. COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS (09)

Introduction: History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Numerical Methods Programming fundamentals, Models of the flow, The substantial derivative, Physical meaning of the divergence of velocity.

MODULE –II: GOVERNING EQUATIONS OF FLUID FLOW AND HEAT TRANSFER (09)

Governing Equations of Fluid Dynamics- The continuity equation, The momentum equation, The energy equation, NavierStokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions.

MODULE –III: PARTIAL DIFFERENTIAL EQUATIONS AND ITS NUMERICAL BEHAVIOUR (09)

The Forms of the governing equations suited for CFD, Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching problems.

Mathematical Behavior of Partial Differential Equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behavior of Hyperbolic, Parabolic and Elliptic equations

MODULE –IV: DISCRETIZATION AND NUMERICAL METHODS OF PDEs (09)

Basic aspects of Discretization: Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, uniform and unequally spaced grid points. Grids With Appropriate Transformation: General transformation of the equations, Metrics and Jacobians. Stability Analysis: Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations. Types of Grids.

MODULE –V: SOLUTION METHODS AND APPLICATIONS OF NUMERICS TO SIMPLE PROBLEMS (09)

Parabolic Partial Differential Equations: Finite difference formulations, Explicit methods – FTCS, Richardson. Implicit methods – Lasonen and Crank-Nicolson; Finite Volume Method For Structured and Unstructured Grids: Advantages, Cell Centered and Nodal point Approaches, Numerical Solution of Quasi 1D Flow equation and 2D heat conduction equation.

V.TEXT BOOKS:

1. Anderson, J.D. (Jr), "Computational Fluid Dynamics", McGraw-Hill Book Company, 1st Edition, 1995.
2. Hoffman, K.A., and Chiang, S.T., "Computational Fluid Dynamics", Vol. I, II and III, Engineering Education System, Kansas, USA, 2000.
3. Anderson, D.A., Tannehill, J.C., and Pletcher, R.H., "Computational Fluid Mechanics and Heat Transfer", McGraw Hill Book Company, 2002.

VI.REFERENCE BOOKS:

1. Chung, T.J., "Computational Fluid Dynamics", Cambridge University Press, 2003
2. Muralidhar K and Sundararajan., "Computational Fluid Flow & Heat Transfer", 2009.

VII.WEB REFERENCES:

https://nptel.ac.in/courses/112105045/

REFRIGERATION AND AIR CONDITIONING

VIII Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC52	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: 60**			

Prerequisite: Thermodynamics

I. COURSE OVERVIEW:

Refrigeration and air conditioning means cooling a space, substance or system to lower and/or maintain its temperature below the ambient one. In other words, refrigeration is artificial cooling. course covers various conventional refrigeration systems like aircraft refrigeration, vapor compression, vapor absorption and steam jet refrigeration systems, also describes some unconventional refrigeration systems; thermoelectric refrigeration, Hilsch tube, etc.. The course introduces the psychrometry, cooling load calculations, thermodynamics of human body, industrial and comfort air conditioning, equipment required for air conditioning systems and heat pump circuits.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The familiarize with terminology associated with refrigeration systems and air conditioning.
II. The functions of basic refrigeration components and their thermodynamic processes.
III. The basics of psychrometry and practice of applied psychrometrics.
IV. The skills required to model, analyze and design different refrigeration as well as air conditioning processes and components.

III. COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO REFRIGERATION (09)

Basic concepts of refrigeration and COP, refrigerators, heat pump, Carnot refrigerator applications of refrigerators, ideal cycle, deviations of practical (actual cycle) from ideal cycle, constructionand use of P-H chart and problems. Classification of refrigeration systems.

MODULE –II: VAPOURCOMPRESSION AND VAPOUR ABSORPTIONREFRIGERATION SYSTEMS (09)

Advanced vapor compression cycles, Refrigerants and their mixtures: properties and characteristics –Ozonedepletion and global warming issues. Advanced absorption refrigeration systems and their components.

MODULE –III: REFRIGERATION EQUIPMENT (09)

System components: functions, working principles of Compressors and Condensers.

Expansion devices and Evaporators; Performance matching of Compressors, Condensers, expansion devices and Evaporators of refrigerationsystems.

MODULE –IV: INTRODUCTION TO AIR CONDITIONING (09)

Review Psychometric Properties and Processes, sensible and latent heat loads, characterization, need forventilation, consideration of Infiltration, load concepts of RSHF, ASHF, ESHF and ADP; concept of humancomfort and effective temperature, comfort air conditioning, industrial air conditioning and requirements.

MODULE –V: AIRCONDITIONINGEQUIPMENT (09)

Classification of equipment, Filters, Grills and Registers, Air Washers, Evaporativecondensers, Cooling and dehumidifying coils.

V.TEXT BOOKS:

1. R.Subramaniam, The strength of Materials, Oxford publishers, 4th Edition, 2018.
2. Gosney, W.B, “Principles of Refrigeration”, Cambridge University Press, 1982.
3. Stoecker, W.F. and Jones, J.W., “Refrigeration and Air conditioning”, Tata McGraw Hill, 1986.
4. Arora, C.P., “Refrigeration and Air conditioning”, Tata McGraw Hill, 2nd Edition, 2000.

VI.REFERENCE BOOKS:

1. R.K.Rajput "A text of Refrigeration and Air Conditioning" S. K. Kataria& Sons, 3rd Edition, 2009
2. P. L. Ballaney, "Refrigeration and Air Conditioning" Khanna Publishers, 16th Edition, 2015.

VII. WEB REFERENCES:

1. http://engineeringstudymaterial.net/tag/air-conditioning-and-refrigeration-books/
2. http://books.mcgraw-hill.com/engineering/PDFs/Miller.pdf
3. http://royalmechanicalbuzz.blogspot.in/2015/12/refrigeration-and-air-conditioning-by-cp-arora-pdfdownload.html
4. https://en.wikipedia.org/wiki/Air_conditioning.

POWER PLANT ENGINEERING

<table>
<tr><td colspan="9">VIII Semester: ME</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">AMEC53</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: Thermodynamics</td></tr>
</table>

I. COURSEOVERVIEW:

Providing an overview of Power Plants and detailing the role of Mechanical Engineers in their operation and maintenance and to address the underlying concepts, methods and application of different thermal Power Plants.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The various sources of energy, working of thermal power plants and combustion process.
II. The familiarize of working various power plants based on different fuels.
III. The principles of economics and environmental issues.

III. COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO THE SOURCES OF ENERGY (09)

Introduction to the Sources of Energy: Resources and development of power in india; Steam power plant: Plant layout, Working of different circuits; Fuel and handling equipment, types of coals, coal handling, choice of handling equipment, coal storage, ash handling systems; Combustion process: Properties of coal overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and drought system, cyclone furnace, design and construction, dust collectors, cooling towers and heat rejection, corrosion and feed water treatment.

MODULE –II: INTERNAL COMBUSTION ENGINE PLANT, GAS TURBINE PLANT (09)

Internal combustion engine plant: Diesel power plant, introduction, internal combustion engines, types, construction, plant layout with auxiliaries, fuel supply system, air starting equipment, lubrication and cooling system, super charging; Gas turbine plant: Introduction, classification, construction, layout with auxiliaries, principles of working of closed and open cycle gas turbines, combined cycle power plants and comparison; Direct energy conversion: solar energy, fuel cells, thermo electric and thermo ionic, MHD generation.

MODULE –III: HYDRO ELECTRIC POWER PLANT, HYDRO PROJECT AND PLANT (09)

Hydro electric power plant: Water power, hydro logical cycle, flow measurement, drainage area characteristics, hydro graphs, storage and Poundage, classification of dams and spill ways;

Hydro Projects and Plant: Classification typical layouts, plant auxiliaries, plant operation pumped storage plants; Power from Non-Conventional Sources: Utilization of Solar-collectors; Principle of working, wind Energy, types, HAWT, VAWT tidal energy.

MODULE –IV: NUCLEAR POWER STATION (09)

Nuclear Power Station: Nuclear fuel, breeding and fertile materials, nuclear reactor, reactor operation, types of reactors, pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor, homogeneous reactor, gas cooled reactor, radiation hazards and shielding radioactive waste disposal.

MODULE –V: POWER PLANT ECONOMICS AND ENVIRONMENT CONSIDERATION (09)

Power plant economics and environmental considerations: Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, load curves, load duration curve, definitions of connected load, maximum demand, demand factor, average load, load factor, diversity factor, related exercises, effluents from power plants and Impact on environment, pollutants and pollution standards, methods of Pollution control.

V.TEXT BOOKS:

1. Dr. P.C. Sharma, “A Text Book of Power Plant Engineering”, S.K.Kataria, 1st Edition, 2016.
2. I Arora, .S. Domkundwar, “A Course in Power Plant Engineering:”, Dhanapat Rai, 1st Edition, 2014.

VI.REFERENCE BOOKS:

1. I Rajput, “A Text Book of Power Plant Engineering”, Laxmi Publications, 5th Edition, 2014.
2. P. K. Nag, “Power Plant Engineering”, Tata McGraw-Hill, 4th Edition, 2014.
3. G. D. Rai, “An Introduction to Power Plant Technology”, Khanna Publishers, 1st Edition, 2013.
4. C. Elanchezhian, L. Sravan Kumar, B. Vijay Ramnath,”Power plant Engineering”, I. K. International Publishers, 1st Edition, 2013.

VII. WEB REFERENCES:

1.http://www.slideshare.net/mo7amedaboubakr/solar-collector-45031961
2.https://alison.com/courses/Renewable-Energy-Sources

VIII. E-Text Books:

1.http://www.cs.kumamoto-u.ac.jp/epslab/APSF/Lecture%20Notes/lecture-1.pdf
2. http://www.vssut.ac.in/lecture_notes/lecture1428910296.pdf

QUALITY AND PRECISION ENGINEERING

VIII Semester: ME								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC54	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: Machine Tools and Metrology								

I. COURSE OVERVIEW:

Vibration is a common phenomenon occurring in a mechanical system. For example, vibration of a rotordue to unbalanced mass, vibration of a vehicle engine at varying speed The study of a dedicated course is required to understand the fundamental and advance concepts of mechanical vibrations for engineers and designers. This course is of basic level. It introduces fundamentals of vibration, vibration of single Degree of Freedom (DoF) system, 2-DoF and multi-DoF systems, continuous systems such as bars and beams, and whirling of shafts.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The BIS code fits and tolerances for geometrical dimensioning and tolerance (GD & T).
II. The principal application of different measuring instruments.
III. Summarize the application of latest manufacturing techniques (nano).

III. COURSE SYLLABUS:

MODULE-I: ACCURACY AND ALIGNMENT TESTS (09)

Accuracy and alignment tests: General concept of accuracy, Spindle rotation accuracy, test methods, displacement accuracy, dimensional wear of cutting tools, accuracy of NC systems, clamping errors, setting errors, location of rectangular prism, cylinder, basic type of tests, measuring instruments used for testing machine tools, alignment tests, straightness, flatness, parallelism, squareness, Circularity, cylindricity.

MODULE –II: INFLUENCE OF STATIC STIFFNESS,THERMAL EFFECTS (09)

Influence of static stiffness, thermal effects: Static stiffness, nature of deformation in a machine tool, overall stiffness of a lathe, compliance of work piece, errors due to the variation of the cutting force and total compliance, accuracies due to thermal effects, methods of decreasing thermal effects-Influence of vibration on accuracy.

MODULE –III: PRECISION MACHINING (09)

Top down and bottom up approach, development of Nanotechnology, precision and micro-machining, diamond turning of parts to nanometer accuracy.

Stereo microlithography, machining of micro-sized components, mirror grinding of ceramics, ultra precision block gauges.

MODULE –IV: NANO MEASURING SYSTEMS (09)

In-process measurement of position of processing point, post process and online measurement of dimensional features, mechanical measuring systems, optical measuring systems, electron beam measuring systems, pattern recognition and inspection systems.

MODULE –V: LITHOGRAPHY (09)

Nano Lithography: Photolithography, nano lithography, photolithography, electron beam lithography, ion Beam lithography, optical lithography, LIGA process, dip pen lithography, deep UV.

V. TEXT BOOKS:

1. Murthy.R.L, "Precision Engineering in Manufacturing", New Age International, New Delhi, 1st Edition, 2005.
2. Norio Taniguchi, "Nanotechnology", Oxford university press, Cambridge, 1st Edition, 1996.

VI. REFERENCE BOOKS:

1. Lee Tong Hong, "Precision Motion control, Design and Implementation", Springer Verlag, U.K., 1st Edition, 2001.

2. Liangchi Zhang, “Precision Machining of Advanced Materials”, Trans Tech Publications Ltd., Switzerland, 1st Edition, 2001.
3. HiromuNakazawa, “Principles of Precision Engineering”, Oxford university press, 1st Edition, 1994.

VII. WEB REFERENCES:

1. http://nptel.ac.in/courses/112106138/

VIII. E-TEXT BOOKS:

1. https://www.accessengineeringlibrary.com/content/book/9780070620902

PLANT LAYOUT AND MATERIAL HANDLING

VIII Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEC55	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:								

I. COURSE OVERVIEW:

Plant layout & Material Handling is basically focused on application of process layout & product layout for Material handling systems to real world applications. More specifically this course is focused on application of material handling methods, paths, methods to minimize cost of material handling energy. The main purpose of implementing this course in curriculum is to learn about material handling layout plants.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The design to improve manufacturing and service facilities.
II. The techniques to evaluate and design material handling and storage systems.
III. The Visualizing plant layout and material handling in industry.

III. COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO PLANT LAYOUT (09)

Introduction, classification of layout, advantages and limitations of different layouts, layout design procedures, overview of the plant layout, process layout and product layout: Selection, specification, implementation and follow up, comparison of product and process layout.

MODULE –II: HEURISTICS FOR PLANT LAYOUT (09)

Heuristics for plant layout ALDEP, CORELAP, CRAFT, group layout, fixed position layout, Quadratic assignment model, branch and bound method.

MODULE –III: MATERIAL HANDLING SYSTEMS (09)

Introduction, material handling systems, material handling principles.

Classification of material handling equipment, relationship of material handling to plant layout.

MODULE –IV: BASIC MATERIAL HANDLING SYSTEMS (09)

Basic material handling systems: Selection, material handling method, path equipment, function orientedSystems.

MODULE –V: METHODS TO MINIMIZE COST OF MATERIAL HANDLING (09)

Methods to minimize cost of material handling, maintenance of material handling equipment, safety in handling ergonomics of material handling equipment, design, miscellaneous equipment.

V.TEXT BOOKS:

1. P. B. Mahapatra, “Operations Management”, PHI, 1st Edition, 2010.
2. Dr. KC Arora, Shinde, “Aspects of Material handling”, Lakshmi Publications, 1st Edition, 2013.

VI.REFERENCE BOOKS:

1. R. L. Francis, LF McLinnisJr, White, “Facility Layout & Location an analytical approach”, PHI, 1st Edition, 2013.
2. R. Paneersevlam, “Production and Operations Management”, PHI, 3rd Edition, 2012.

VII.WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc20_me43

PRODUCTION PLANNING AND CONTROL

<table>
<tr><td colspan="9">VIII Semester: ME</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">AMEC56</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>
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<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: Industrial Engineering and Management</td></tr>
</table>

I. COURSE OVERVIEW:

Production planning and control address a fundamental problem of low productivity, inventory management and resource utilization. Production planning is required for scheduling, dispatch, inspection, quality management, inventory management, supply management and equipment management.

II.COURSE OBJECTIVES:

The students will try to learn:

I. The PPC function in industrial manufacturing scenario.
II. The forecasting techniques for different types of products.
III. The knowledge in optimal inventory control and capacity planning

III. COURSE SYLLABUS:

MODULE-I: OVERVIEW OF PRODUCTION PLANNING CONTROL (09)

Introduction: Definition, Objectives of production planning and control, functions of production planning and control, elements of production control, types of production, organization of production planning and control department, internal organization of department.

MODULE –II: FORECASTING (09)

Forecasting: Importance of forecasting, types of forecasting, their uses, general principles of forecasting, forecasting techniques, qualitative methods and quantitive methods; Inventory management, functions of inventories relevant inventory costs ABC analysis, VED analysis, EOQ model, inventory control systems, PSystems and Q-Systems.

MODULE –III: INTRODUCTION TO MRP (09)

Introduction to MRP and ERP, LOB (Line of Balance), JIT inventory, and Japanese concepts.

Routing, definition, routing procedure Route sheets, bill of material, factors affecting routing procedure, Schedule, definition, difference with loading

MODULE –IV: SCHEDULING (09)

Scheduling Policies, techniques, Standard scheduling methods; Line balancing, aggregate planning, chase planning, expediting, controlling aspects.

MODULE –V: DISPATCHING (09)

Dispatching: Activities of dispatcher, dispatching procedure, follow up, definition, reason for existence of functions, types of follow up, applications of computer in production planning and control.

V.TEXT BOOKS:

1. M. Mahajan, "Production Planning and Control", Dhanpat Rai, 1st Edition, 2010.
2. Jain, "Production planning and control", Khanna Publications, 1st Edition, 2012.

VI.REFERENCE BOOKS:

1. S.K. Mukhopadhyaya, "Production Planning and Control- Text & cases" PHI, 2nd Edition, 2007.
2. U.R.Panneer Selvam, "Production and operations Management", PHI, 3rd Edition, 2012.

VII.WEB REFERENCES:

1. http://nptel.ac.in/courses/112107143/

VIII. E-TEXT BOOK:

http://ggnindia.dronacharya.info/ecedept/Downloads/QuestionBank/IIIsem/PRODUCTION%20PLANNING_CO NTROL.pdf.

OPERATION RESEARCH

<table>
<tr><td colspan="9">VIII Semester: ME</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">AMEC57</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: Linear Algebra and Calculus, Mathematical Transform Techniques</td></tr>
</table>

I.COURSE OVERVIEW:

The Optimization Techniques is also called Operations research for short and it is a scientific approach to decision making which seeks to determine how best to design and operate a system under conditions requiring allocation of scarce resources. Optimization Technique as a research tool, primarily has a set or collection of algorithms which act as tools for problems solving in chosen application areas. This course has extensive applications in engineering, business and public systems and is also used by manufacturing and service industries to solve their day to day problems. This course facilitates to learn various models to optimize the solution of a problem

II.COURSE OBJECTIVES:

The students will try to learn:

I. Operation research models using optimization techniques based upon the fundamentals of engineering mathematics (minimization and Maximization of objective function).
II. The problem formulation by using linear, dynamic programming, game theory and queuing models.
III. The stochastic models for discrete and continuous variables to control inventory and simulation of manufacturing models for the production decision making.
IV. Formulation of mathematical models for quantitative analysis of managerial problems in industry.

III. COURSE SYLLABUS:

MODULE-I: DEVELOPMENT OF O.R AND ALLOCATION (09)

E Development, definition, characteristics and phases, types of operation research models, applications; Allocation: linear programming, problem formulation, graphical solution, simplex method, artificial variables techniques, two–phase method, big-M method. .Degeneracy in Linear programming.

MODULE –II: TRANSPORTATION AND ASSIGNMENT PROBLEM (09)

Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, U.D.L., U.V.L. and combination of these loads – Point of contra flexure – Relation between S.F., B.M, and rate of loading at a section of a beam.

MODULE –III: SEQUENCING AND REPLACEMENT (09)

Sequencing: Introduction, flow, shop sequencing, n jobs through two machines, n jobs through three machines, job shop sequencing, and two jobs through “m” machines.

Replacement: Introduction: Replacement of items that deteriorate with time, when money value is not counted and counted, replacement of items that fail completely, group replacement.

MODULE –IV: THEORY OF GAMES AND INVENTORY (09)

Theory Of Games: Introduction – Terminology, Solution of games with saddle points and without saddle points, 2×2 games, dominance principle, m x 2 & 2 x n games, Graphical method.
Inventory: Introduction, Single item, Deterministic models, Purchase inventory models with one price break and multiple price breaks, Stochastic models, demand may be discrete variable or continuous
variable, Single period model and no setup cost.

MODULE –V: TWAITING LINES, DYNAMIC PROGRAMMIMG AND SIMULATION (09)

Waiting Lines: Introduction, Terminology, Single Channel, Poisson arrivals and exponential service times with infinite population and finite population models, Multichannel, Poisson arrivals and exponential service times with infinite population.Dynamic Programming: Introduction, Terminology, Bellman‟s Principle of optimality, Applications of dynamic programming, shortest path problem, linear programming problem. Simulation: Introduction, Definition, types of simulation models, steps involved in the simulation process - Advantages and Disadvantages, Application of Simulation to queuing and inventory.

V.TEXT BOOKS:

1. J. K. Sharma, "Operations Research", Macmillan, 5th Edition, 2012.
2. R.Pannerselvan,"OperationsResearch",2nd Edition,PHI Publications,2006.

VI.REFERENCE BOOKS:

1. A. M. Natarajan, P. Balasubramani, A. Tamilarasi, "Operations Research", Pearson Education, 2013.
2. Maurice Saseini, Arhur Yaspan, Lawrence Friedman, "Operations Research: Methods & Problems", 1st Edition, 1959.

VII.WEB REFERENCES:

1. https://www.aicte-india.org/flipbook/p&ap/Vol.%20II%20UG/UG_2.html#p=8
2. https://www.britannica.com/topic/operations-research
3. http://www.som.com

MANUFACTURING OF COMPOSITES

VIII Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMEC58	**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: Strength of Materials								

I. COURSE OVERVIEW:

Composite materials can be defined as a material structure consisting of two macroscopically identifiable materials working together to accomplish a superior result. This course covers the introduction, macro and micro mechanical analysis of a lamina and laminates in detail. This course will be useful in the field of mechanical, aeronautical and civil engineering both for doing research and develop a product.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The role of matrix, fiber and filler in the design of polymer/metal matrix composites.
II. The linear elastic properties by rule of mixture, fabrication of composites, mechanical and tribological properties, and fracture behavior of composite materials.
III. The assortment of suitable Fabrication method for different Composite Materials.
IV. The categorize alternatives involved in the design of composites.

III. COURSE SYLLABUS:

MODULE-I: INTRODUCTION TO COMPOSITE MATERIALS (09)

Introduction, Classification: Polymer matrix composites, Metal matrix composites, Ceramic matrix composites, carbon-carbon composites, Recycling fiber reinforced composites, Mechanics Terminology.

MODULE –II: MACRO MECHANICAL ANALYSIS OF A LAMINA (09)

Stress, strain, Elastic moduli, strain energy, Hooke’s law for different types of materials: Anisotropic material, Monoclinic Material, Orthotropic Material, Transversely Isotropic Materials, Isotropic Material, Hook’s law for a two dimensional unidirectional lamina: Plane stress assumption, Reduction of Hooke’s Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina.

MODULE –III: MICROMECHANICAL ANALYSIS OF A LAMINA (09)

Introduction , Volume and Mass Fractions, Density, and Void Content: Volume Fractions, Mass Fractions , Density Void Content. Evaluation of the Four Elastic Moduli: Strength of Materials Approach: Longitudinal Young’s Modulus, Transverse Young’s Modulus, Major Poisson’s Ratio, In-Plane Shear Modulus.

Semi-Empirical Models: Longitudinal Young’s Modulus, Transverse Young’s Modulus, Major Poisson’s Ratio. In-Plane Shear Modulus. Elasticity Approach: Longitudinal Young’s Modulus, Major Poisson’s Ratio, Transverse Young’s Modulus, Axial Shear Modulus. Elastic Moduli of Lamina with Transversely Isotropic Fibers.

MODULE –IV: MACROMECHANICAL ANALYSIS OF LAMINATES (09)

Introduction, Laminate Code, Stress–Strain Relations for a Laminate : One–Dimensional Isotropic Beam Stress–Strain Relation ,Strain-Displacement Equations, Strain and Stress in a Laminate , Force and Moment Resultants Related to Midplane Strains and Curvatures. In-Plane and Flexural Modulus of a Laminate: In-Plane Engineering Constants of a Laminate, Flexural Engineering Constants of a Laminate. Hygrothermal Effects in a Laminate: Hygro thermal Stresses and Strains, Coefficients of Thermal and Moisture Expansion of Laminates, Warpage of Laminates.

MODULE –V: FAILURE, ANALYSIS, AND DESIGN OF LAMINATES (09)

Introduction, Special Cases of Laminates: Symmetric Laminates, Cross-Ply Laminates, Angle Ply Laminates, Antisymmetric Laminates, Balanced Laminate, Quasi-Isotropic Laminates. Failure Criterion for a Laminate, Design of a Laminated Composite, Other Mechanical Design Issues: Sandwich Composites, Long-Term Environmental Effects, Interlaminar Stresses, Impact Resistance, Fracture Resistance, Fatigue Resistance.

V.TEXT BOOKS:

1. Autar K. Kaw, "Mechanics of composite materials", CRC Press, 2nd Edition, 2005.
2. Mein Schwartz, "Composite Materials Handbook", McGraw-Hill, 2nd Edition, 2013.

VI.REFERENCE BOOKS:

1. Rober M. Joness, "Mechanics of Composite Materials", CRC Press, 2nd Edition, 2013.
2. MichaelW, Hye "Stress Analysis of Fiber Reinforced Composite Materials", DESTech Publications, 2013.

VII.WEB REFERENCES:

1. http://manufacturing.stanford.edu/processes/Composites.pdf
2. http://nptel.ac.in/courses/112104168/

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 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">AHSC15</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 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><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">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

<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><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">AHSC17</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 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

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		
AHSC18	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 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

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		
AHSC20	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 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="8">VIII 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">AAEC55</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 ME 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 ME 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