OUTCOME BASED EDUCATION
WITH
CHOICE BASED CREDIT SYSTEM

BACHELOR OF TECHNOLOGY
AERONAUTICAL ENGINEERING

ACADEMIC REGULATIONS, COURSE STRUCTURE AND SYLLABI
(Based on AICTE Model Curriculum)

IARE - R18

B.Tech Regular Four Year Degree Program
(for the batches admitted from the academic year 2018-2019)

&

B.Tech (Lateral Entry Scheme)
(for the batches admitted from the academic year 2019-2020)

FAILURE TO READ AND UNDERSTAND THE REGULATIONS
IS NOT AN EXCUSE
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“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.

**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 - R18” 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
For pursuing four year undergraduate Bachelor of Technology degree program of study in Engineering (B.Tech) offered by Institute of Aeronautical Engineering under Autonomous status and herein after referred to as IARE.

Preamble:

All India Council for Technical Education (AICTE) has introduced Model Curriculum for Bachelor of Technology program with 160 credits in the entire program of 4 years, and 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 online courses (MOOCs), perhaps for the first time in the country, to tap the zeal and excitement of learning beyond the classrooms. So, the students will have to complete additional 20 credits through MOOCs within 4 years of time. 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 regular degree program mentioning that the student has cleared Honours / Minor specialization in respective courses in addition to scheduled courses for B.Tech programs.

1. CHOICE BASED CREDIT SYSTEM

The Indian Higher Education Institutions (HEIs) are changing from the conventional course structure to Choice Based Credit System (CBCS) along with introduction to semester system in the first year itself. The semester system helps in accelerating the teaching-learning process and enables vertical and horizontal mobility in learning.

The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice based credit system 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.

Choice Based Credit System (CBCS) is a flexible system of learning and provides choice for students to select from the prescribed elective courses. 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.
The CBCS permits students to:
1. Choose electives from a wide range of elective courses offered by the departments.
2. Undergo additional courses of interest.
3. Adopt an interdisciplinary approach in learning.
4. Make the best use of expertise of the available faculty.

2. MEDIUM OF INSTRUCTION
The medium of instruction shall be English for all courses, examinations, seminar presentations and project work. The 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 the following disciplines:
1. Aeronautical Engineering
2. Computer Science and Engineering
3. Information Technology
4. Electronics and Communication Engineering
5. Electrical and Electronics Engineering
6. Mechanical Engineering
7. Civil Engineering

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. 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.
4.5.1 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.

4.5.2 The academic calendar shown in Table 1 is declared at the beginning of the academic year.

**Table 1: Academic Calendar**

<table>
<thead>
<tr>
<th>FIRST SEMESTER (21 weeks)</th>
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<tbody>
<tr>
<td>I Spell Instruction Period</td>
<td>8 weeks</td>
<td></td>
</tr>
<tr>
<td>I Mid Examinations</td>
<td>1 week</td>
<td></td>
</tr>
<tr>
<td>II Spell Instruction Period</td>
<td>8 weeks</td>
<td></td>
</tr>
<tr>
<td>II Mid Examinations</td>
<td>1 week</td>
<td></td>
</tr>
<tr>
<td>Preparation and Practical Examinations</td>
<td>1 week</td>
<td></td>
</tr>
<tr>
<td>Semester End Examinations</td>
<td>2 weeks</td>
<td></td>
</tr>
<tr>
<td><strong>Semester Break and Supplementary Exams</strong></td>
<td>2 weeks</td>
<td></td>
</tr>
<tr>
<td><strong>SECOND SEMESTER (21 weeks)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I Spell Instruction Period</td>
<td>8 weeks</td>
<td>19 weeks</td>
</tr>
<tr>
<td>I Mid Examinations</td>
<td>1 week</td>
<td></td>
</tr>
<tr>
<td>II Spell Instruction Period</td>
<td>8 weeks</td>
<td></td>
</tr>
<tr>
<td>II Mid Examinations</td>
<td>1 week</td>
<td></td>
</tr>
<tr>
<td>Preparation &amp; Practical Examinations</td>
<td>1 week</td>
<td></td>
</tr>
<tr>
<td>Semester End Examinations</td>
<td>2 weeks</td>
<td></td>
</tr>
<tr>
<td><strong>Summer Vacation, Supplementary Semester and Remedial Exams</strong></td>
<td>8 weeks</td>
<td></td>
</tr>
</tbody>
</table>
4.6 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

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. The student has to normally register for a minimum of 17 credits and may register up to a maximum of 27 credits, in consultation with HOD/faculty mentor. On an average, a student is expected to register for 22 credits.

5.5. 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 Grade Card. 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.

5.6. 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 subjects is not permitted.

5.7. After DROPPING and / or WITHDRAWAL of courses, minimum credits registered shall be 20.

6.0 UNIQUE COURSE IDENTIFICATION CODE

Every course of the B.Tech program will be placed in one of the seven groups of courses as listed in the Table 2. The various courses and their two-letter codes are given below;

**Table 2: Group of Courses**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Branch</th>
<th>Code</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Aeronautical Engineering</td>
<td>AE</td>
</tr>
<tr>
<td>2</td>
<td>Computer Science and Engineering</td>
<td>CS</td>
</tr>
<tr>
<td>3</td>
<td>Information Technology</td>
<td>IT</td>
</tr>
<tr>
<td>4</td>
<td>Electronics and Communication Engineering</td>
<td>EC</td>
</tr>
<tr>
<td>5</td>
<td>Electrical and Electronics Engineering</td>
<td>EE</td>
</tr>
<tr>
<td>6</td>
<td>Mechanical Engineering</td>
<td>ME</td>
</tr>
<tr>
<td>7</td>
<td>Civil Engineering</td>
<td>CE</td>
</tr>
</tbody>
</table>
7.0 CURRICULUM AND COURSE STRUCTURE

The curriculum shall comprise Theory Courses, Elective Courses, Laboratory Courses, Audit Courses, Mandatory Courses, Mini Project, Internship and Project work. The list of elective courses may also include subjects from allied discipline.

Contact Periods: 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 as follows:

- **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.
- **Mini Project:** 1 credit for 2 hours per week

7.1 TYPES OF COURSES

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

7.1.0 **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.

7.1.1 **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.

7.1.2 **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.
7.1.3 Credit distribution for courses offered is given in Table 3.

Table 3: Credit distribution

<table>
<thead>
<tr>
<th>S. No</th>
<th>Course</th>
<th>Hours</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Theory Course</td>
<td>1 / 2 / 3 / 4</td>
<td>1 / 2 / 3 / 4</td>
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<tr>
<td>2</td>
<td>Elective Courses</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>MOOC Courses</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Laboratory Courses</td>
<td>2 / 3 / 4</td>
<td>1 / 1.5 / 2</td>
</tr>
<tr>
<td>5</td>
<td>Audit Course / Mandatory Course</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>Project / Research based learning</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>Full Semester Internship (FSI) / Project Work</td>
<td>-</td>
<td>11</td>
</tr>
</tbody>
</table>

7.2 Course Structure

Every course of the B.Tech program will be placed in one of the eight categories with minimum credits as listed in the Table 4.

Table 4: Category Wise Distribution of Credits

<table>
<thead>
<tr>
<th>S. No</th>
<th>Category</th>
<th>Breakup of Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Humanities and Social Sciences (HSMC), including Management.</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>Basic Science Courses (BSC) including Mathematics, Physics and Chemistry.</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>Engineering Science Courses (ESC), including Workshop, Drawing, Basics of Electrical / Electronics / Mechanical / Computer Engineering.</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>Professional Core Courses (PCC), relevant to the chosen specialization / branch.</td>
<td>48</td>
</tr>
<tr>
<td>5</td>
<td>Professional Electives Courses (PEC), relevant to the chosen specialization / branch.</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>Open Elective Courses (OEC), from other technical and/or emerging subject areas.</td>
<td>18</td>
</tr>
<tr>
<td>7</td>
<td>Project Based Learning, Research Based Learning and Project Work (PROJ) / Full Semester Internship (FSI)</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>Mandatory Courses / Audit Courses.</td>
<td>Non-Credit</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>160</td>
</tr>
</tbody>
</table>

7.3 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

ii. Non Full Semester Internship (NFSI) Model – Project work.

7.4 For Four year regular program (FSI 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 up to IV semester with no current arrears and maintains the CGPA of 7.5 till VI Semester shall be eligible to opt for FSI.

8.0 EVALUATION METHODOLOGY

8.1 Theory Course:
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). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

8.1.1 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 module 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:

<table>
<thead>
<tr>
<th>%</th>
<th>To test the objective of the concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>To test the analytical skill of the concept OR to test the application skill of the concept</td>
</tr>
</tbody>
</table>

8.1.2 Continuous Internal Assessment (CIA):
For each theory course the CIA shall be conducted by the faculty / teacher handling the course as given in Table 5. 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).

Table 5: Assessment pattern for Theory Courses

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>THEORY</th>
<th>TOTAL MARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Assessment</td>
<td>CIE Exam</td>
<td>Quiz</td>
</tr>
<tr>
<td>Max. CIA Marks</td>
<td>20</td>
<td>05</td>
</tr>
</tbody>
</table>

8.1.2.1 Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams. The valuation and verification of answer scripts of CIE exams shall be completed within a week after the conduct of the Examination.

8.1.2.2 Quiz – Online Examination
Two Quiz exams shall be online examination consisting of 50 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.
8.1.2.3 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 tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs 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:

8.2.1 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 lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the Principal from the panel of experts recommended by the Chairman, BOS.

8.2.2 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 lab examination. There shall be ONE internal test of 10 marks in each semester.

8.3 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.

8.4 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.

8.5 Project / Research Based Learning

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.

8.6 Project work

The project work shall be evaluated for 100 marks out of which 30 marks for internal evaluation and 70 marks for semester end evaluation. The project work shall be spread over in VII semester and in VIII semester. The project work shall be somewhat innovative in nature and explore the research bent of the mind of the student. A student shall carry out the project work under the supervision of a member of the faculty or may undertake to execute the project in collaboration with an Industry, R&D organization or another academic institution/University where sufficient facilities exist to carry out the project work.

At the end of VII semester, students should submit synopsis summarizing the work done in VII semester. The project is expected to be completed by the end of VIII semester. In VII semester, a first mid review is conducted by Project Review Committee (PRC) (on the progress) for 10 marks.

In VIII semester, a second mid review is conducted by PRC (on the progress) for 10 marks. On completion of the project, a third evaluation is conducted for award of internal marks of another 10 marks before the report is submitted, making the total internal marks 30.

The end semester examination shall be based on the 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.

8.7 Full Semester Internship (FSI)

FSI is a full semester internship program carrying 11 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) up to IV semester
- Competency Mapping / Allotment

9.0 MAKEUP EXAMINATION

The make-up examination facility shall be available to students who may have missed to attend CIE exams in one or more courses in a semester for valid genuine reasons. The make-up examination shall have comprehensive online objective type questions. The syllabus for the make-up examination shall be the whole syllabus covered till the end of the semester under consideration and will be conducted at the end of the semester.

10.0 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.

11.0 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.

12.0 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 before the same papers are kept for second evaluation by external examiner.

12.4 In case of difference of more than 15% of marks, the answer paper shall be re-evaluated by a third examiner appointed by the Examination Committee and marks awarded by this examiner shall be taken as final.

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

12.6 Examinations Control Committee shall consolidate the marks awarded by internal and external examiners and award grades.

13.0 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
   i. Not less than 35% marks for each theory course in the semester end examination, and
   ii. A minimum of 40% marks for each theory course considering both internal and semester end examination.

13.2 A student shall be deemed to have satisfied the minimum academic requirements and earn the credits for each Lab / Project based learning / Research based learning / Project work / FSI, if s/he secures
   i. Not less than 40% marks for each Lab / Project based learning / Research based learning / Project work / FSI course in the semester end examination,
   ii. A minimum of 40% marks for each Lab / Project based learning / Research based learning / Project work / FSI 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.

14.0 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-6.
### Table-6: Grade Points Scale (Absolute Grading)

<table>
<thead>
<tr>
<th>Range of Marks</th>
<th>Grade Point</th>
<th>Letter Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 – 90</td>
<td>10</td>
<td>S (Superior)</td>
</tr>
<tr>
<td>89 – 80</td>
<td>9</td>
<td>A+ (Excellent)</td>
</tr>
<tr>
<td>79 – 70</td>
<td>8</td>
<td>A (Very Good)</td>
</tr>
<tr>
<td>69 – 60</td>
<td>7</td>
<td>B+ (Good)</td>
</tr>
<tr>
<td>59 – 50</td>
<td>6</td>
<td>B (Average)</td>
</tr>
<tr>
<td>49 – 40</td>
<td>5</td>
<td>C (Pass)</td>
</tr>
<tr>
<td>Below 40</td>
<td>0</td>
<td>F (Fail)</td>
</tr>
<tr>
<td>Absent</td>
<td>0</td>
<td>AB (Absent)</td>
</tr>
</tbody>
</table>

**Authorized Break of Study**

<table>
<thead>
<tr>
<th></th>
<th>Grade Point</th>
<th>Letter Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>ABS</td>
</tr>
</tbody>
</table>

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.

### 15.0 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,

\[
SGPA = \frac{\sum_{i=1}^{n} (C_i G_i)}{\sum_{i=1}^{n} C_i}
\]

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.

\[
CGPA = \frac{\sum_{j=1}^{m} (C_j S_j)}{\sum_{j=1}^{m} C_j}
\]

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.
16.0 ILLUSTRATION OF COMPUTATION OF SGPA AND CGPA

16.1 Illustration for SGPA

<table>
<thead>
<tr>
<th>Course Name</th>
<th>Course Credits</th>
<th>Grade letter</th>
<th>Grade point</th>
<th>Credit Point (Credit x Grade)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course 1</td>
<td>3</td>
<td>A</td>
<td>8</td>
<td>3 x 8 = 24</td>
</tr>
<tr>
<td>Course 2</td>
<td>4</td>
<td>B+</td>
<td>7</td>
<td>4 x 7 = 28</td>
</tr>
<tr>
<td>Course 3</td>
<td>3</td>
<td>B</td>
<td>6</td>
<td>3 x 6 = 18</td>
</tr>
<tr>
<td>Course 4</td>
<td>3</td>
<td>S</td>
<td>10</td>
<td>3 x 10 = 30</td>
</tr>
<tr>
<td>Course 5</td>
<td>3</td>
<td>C</td>
<td>5</td>
<td>3 x 5 = 15</td>
</tr>
<tr>
<td>Course 6</td>
<td>4</td>
<td>B</td>
<td>6</td>
<td>4 x 6 = 24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>139</td>
</tr>
</tbody>
</table>

Thus, SGPA = 139 / 20 = 6.95

16.2 Illustration for CGPA

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Semester 2</th>
<th>Semester 3</th>
<th>Semester 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit: 20</td>
<td>Credit: 22</td>
<td>Credit: 25</td>
<td>Credit: 26</td>
</tr>
<tr>
<td>SGPA: 6.9</td>
<td>SGPA: 7.8</td>
<td>SGPA: 5.6</td>
<td>SGPA: 6.0</td>
</tr>
<tr>
<td>Semester 5</td>
<td>Semester 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credit: 26</td>
<td>Credit: 25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGPA: 6.3</td>
<td>SGPA: 8.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thus, CGPA = \(
\frac{20 \times 6.9 + 22 \times 7.8 + 25 \times 5.6 + 26 \times 6.0 + 26 \times 6.3 + 25 \times 8.0}{144}
\) = 6.73

17.0 PHOTOCOPY / REVALUATION

A student, who seeks the re-valuation of the answer script, is directed to apply for the photocopy of his/her semester examination answer paper(s) in the theory course(s), within 2 working days from the declaration of results in the prescribed format to the Controller of Examinations through the Head of the department. On receiving the photocopy, the student can consult with a competent member of faculty and seek the opinion for revaluation. Based on the recommendations, the student can register for the revaluation with prescribed fee. The Controller of Examinations shall arrange for the revaluation and declare the results. Revaluation is not permitted to the courses other than theory courses.

18.0 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 50% of the total credits (rounded to the next lowest integer) up to III semester or 50% 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 50% of the total credits (rounded to the next lowest integer) up to V semester or 50% 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 50% 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 50% of the total credits (rounded to the next lowest integer) up to V semester or 50% 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 123 credits and earn all the 123 credits. Marks obtained in all the 123 credits shall be considered for the award of the Grade.

19.0 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 for regular program and 123 credits 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 4.0, shall forfeit his/her degree and his/her admission stands cancelled.

19.3 A student of a lateral entry program who fails to earn 123 credits within six consecutive academic years from the year of his/her admission with a minimum CGPA of 4.0, shall forfeit his/her degree and his/her admission stands cancelled.

20.0 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.

21.0 AWARD OF DEGREE

21.1 Classification of degree will be as follows:

<table>
<thead>
<tr>
<th>CGPA ≥ 7.5</th>
<th>CGPA ≥ 6.5 and &lt; 7.5</th>
<th>CGPA ≥ 5.0 and &lt; 6.5</th>
<th>CGPA ≥ 4.0 and &lt; 5.0</th>
<th>CGPA &lt; 4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Class with Distinction</td>
<td>First Class</td>
<td>Second Class</td>
<td>Pass Class</td>
<td>Fail</td>
</tr>
</tbody>
</table>
21.2 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).

21.3 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.

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

21.5 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 grade sheet by the institute. Apart from the semester wise grade sheet, the institute will issue the provisional certificate and consolidated grade sheet 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:

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<thead>
<tr>
<th>S. No</th>
<th>Department</th>
<th>Honours scheme</th>
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<tbody>
<tr>
<td>1</td>
<td>Aeronautical Engineering</td>
<td>Aerospace Engineering / Space Science etc.</td>
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<tr>
<td>2</td>
<td>Computer Science and Engineering / Information Technology</td>
<td>Big data and Analytics / Cyber Physical Systems, Information Security / Cognitive Science / Internet of Things (IoT) etc.</td>
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<td>4</td>
<td>Electrical and Electronics Engineering</td>
<td>Renewable Energy systems / Energy and Sustainability / IoT Applications in Green Energy Systems etc.</td>
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<tr>
<td>5</td>
<td>Mechanical Engineering</td>
<td>Industrial Automation and Robotics / Manufacturing Sciences and Computation Techniques etc.</td>
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<td>6</td>
<td>Civil Engineering</td>
<td>Structural Engineering / Environmental Engineering etc.</td>
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### 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.

**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.

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

1. Space Science
2. Information Security
3. Data Analytics
4. Cyber Physical Systems
5. Electronic System Design
6. Renewable Energy Sources
7. Energy and Sustainability
8. Industrial Automation and Robotics
9. Aerospace Engineering
10. Manufacturing Sciences and Computation Techniques
11. Structural Engineering
12. Environmental Engineering
13. Internet of Things
14. Computer Science and Engineering
15. Technological Entrepreneurship
16. Materials Engineering
17. Physics (Materials / Nuclear / Optical / Medical)
18. 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’.

24.0 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.

25.0 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.

26.0 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.
27.0 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.

28.0 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.

29.0 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 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 to IARE-R18 regulations

A student took admission in IARE-R16 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 - R16). However, in case of having backlog courses, they shall be cleared by appearing for supplementary examinations conducted under IARE - R16 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-R16 regulations.

30.0 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.

FAILURE TO READ AND UNDERSTAND THE REGULATIONS IS NOT AN EXCUSE
## I SEMESTER

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<th>Course Code</th>
<th>Course Name</th>
<th>Subject Area</th>
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<th>Credits</th>
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TOTAL 12 03 12 21 240 560 800
### III SEMESTER

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<tr>
<td>AHSB02</td>
<td>Foundation</td>
<td>L T P C CIA SEE Total</td>
<td>3 1 - 4 30 70 100</td>
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</tbody>
</table>

Contact Classes: 45  Tutorial Classes: 15  Practical Classes: Nil  Total Classes: 60

## OBJECTIVES:
The course should enable the students to:

I. Determine rank of a matrix and solve linear differential equations of second order.
II. Determine the characteristic roots and apply double integrals to evaluate area.
III. Apply mean value theorems and apply triple integrals to evaluate volume.
IV. Determine the functional dependence and extremum value of a function.
V. Analyze gradient, divergence, curl and evaluate line, surface, volume integrals over a vector field.

### Module-I  THEORY OF MATRICES AND HIGHER ORDER LINEAR DIFFERENTIAL EQUATIONS  Classes: 09

**THEORY OF MATRICES:** Real matrices: Symmetric, skew-symmetric and orthogonal matrices; Complex matrices: Hermitian, Skew-Hermitian and unitary matrices; Elementary row and column transformations; Rank of a matrix: Echelon form and normal form; Inverse by Gauss-Jordan method.

**HIGHER ORDER LINEAR DIFFERENTIAL EQUATIONS:** 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 $f(x) = x^n, e^{ax}v(x), x^m(x)$; Method of variation of parameters.

### Module-II  LINEAR TRANSFORMATIONS AND DOUBLE INTEGRALS  Classes: 09

**LINEAR TRANSFORMATIONS:** Cayley-Hamilton theorem: Statement, verification, finding inverse and powers of a matrix; Linear dependence and independence of vectors; Eigen values and Eigen vectors of a matrix and Properties (without proof); Diagonalization of matrix by linear transformation.

**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.

### Module-III  FUNCTIONS OF SINGLE VARIABLES AND TRIPLE INTEGRALS  Classes: 09

**FUNCTIONS OF SINGLE VARIABLES:** Mean value theorems: Rolle’s theorem, Lagrange’s theorem, Cauchy’s theorem-without proof and geometrical interpretation.

**TRIPLE INTEGRALS:** Evaluation of triple integrals in Cartesian coordinates; volume of a region using triple integration.

### Module-IV  FUNCTIONS OF SEVERAL VARIABLES AND EXTREMA OF A FUNCTION  Classes: 09

**FUNCTIONS OF SEVERAL VARIABLES:** Partial differentiation, functional dependence, Jacobian.

**EXTREMA OF A FUNCTION:** Maxima and minima of functions of two variables without constraints and with constraints; Method of Lagrange multipliers.
### Module-V: VECTOR DIFFERENTIAL AND INTEGRAL CALCULUS

<table>
<thead>
<tr>
<th>Classes: 09</th>
</tr>
</thead>
</table>

**VECTOR DIFFERENTIAL CALCULUS:** Scalar and vector point functions; Definitions of Gradient, divergent and curl with examples; Solenoidal and irrotational vector point functions; Scalar potential function.

**VECTOR INTEGRAL THEOREMS:** Line integral, surface integral and volume integral, Green’s theorem in a plane, Stoke’s theorem and Gauss divergence theorem without proofs.

#### Text Books:


#### Reference Books:


#### Web References:


#### E-Text Books:

# WAVES AND OPTICS

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
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<td>Tutorial Classes: 15</td>
<td>Practical Classes: Nil</td>
<td>Total Classes: 60</td>
<td></td>
</tr>
</tbody>
</table>

**OBJECTIVES:**
The course should enable the students to:
I. Enrich knowledge in principals of quantum mechanics and semiconductors.
II. Correlate principles and applications of lasers and fiber optics.
III. Acquire skills allowing the student to identify and apply formulas of optics and wave physics using course literature.
IV. Develop strong fundamentals of transverse, longitudinal waves and harmonic waves.

**MODULE - I QUANTUM MECHANICS**
Classes: 08

Introduction to quantum physics, Black body radiation, Planck’s law, Photoelectric effect, Compton effect, De-Broglie’s hypothesis, Wave-particle duality, Davison and Germer experiment, Time-independent Schrödinger equation for wave function, Born interpretation of the wave function, Schrödinger equation for one dimensional problem—particle in a box.

**MODULE - II INTRODUCTION TO SOLIDS AND SEMICONDUCTORS**
Classes: 10

Bloch’s theorem for particles in a periodic potential, Kronig-Penney model (Qualitative treatment), Origin of energy bands. Types of electronic materials: metals, semiconductors, and insulators; Intrinsic and extrinsic semiconductors, Carrier concentration, Dependence of Fermi level on carrier-concentration and temperature, Carrier generation and recombination, Hall effect.

**MODULE - III LASERS AND FIBER OPTICS**
Classes: 10

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), Attenuation in optical fibers, Optical fiber communication system with block diagram.

**MODULE - IV LIGHT AND OPTICS**
Classes: 07

Huygens’ principle, Superposition of waves and interference of light by wavefront splitting and amplitude splitting; Young’s double slit experiment, Newton’s rings, Michelson interferometer; Fraunhofer diffraction from a single slit, circular aperture and diffraction grating.

**MODULE - V HARMONIC OSCILLATIONS AND WAVES IN ONE DIMENSION**
Classes: 10

Mechanical and electrical simple harmonic oscillators, Damped harmonic oscillator, Forced mechanical and electrical oscillators, Impedance, Steady state motion of forced damped harmonic oscillator; Transverse wave on a string, the wave equation on a string, Harmonic waves, Reflection and transmission of waves at a boundary, Longitudinal waves and the wave equation for them, acoustics waves.
Text Books:

Reference Books:

Web References:
2. http://www.thphys.physics.ox.ac.uk

E-Text Books:
1. http://www.peaceone.net/basic/Feynman/
PROGRAMMING FOR PROBLEM SOLVING

I Semester: AE / ME | II Semester: CSE / IT / ECE / EEE / CE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
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<th>Maximum Marks</th>
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<td>3  -  -  3  30  70  100</td>
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</table>

Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Learn adequate knowledge by problem solving techniques.
II. Understand programming skills using the fundamentals and basics of C Language.
III. Improve problem solving skills using arrays, strings, and functions.
IV. Understand the dynamics of memory by pointers.
V. Study files creation process with access permissions.

MODULE - I  INTRODUCTION  Classes: 10

Introduction to Programming: Computer system, components of a computer system, computing environments, computer languages, creating and running programs, algorithms, flowcharts; Introduction to C language: Computer languages, History of C, basic structure of C programs, process of compiling and running a C program, C tokens, keywords, identifiers, constants, strings, special symbols, variables, data types; Operators and expressions.

MODULE - II  CONTROL STRUCTURES  Classes: 08

Conditional Control structures: Decision statements; Simple if, if-else, else if ladder, Nested if and Case Statement-switch statement; Loop control statements: while, for and do while loops, jump statements, break, continue, goto statements.

MODULE - III  ARRAYS AND FUNCTIONS  Classes: 10

Arrays: Concepts, one dimensional arrays, declaration and initialization of one dimensional arrays, two dimensional arrays, initialization and accessing, multi-dimensional arrays; Strings: Arrays of characters, variable length character strings, inputting character strings, character library functions, string handling functions.

Functions: Need for user defined functions, function declaration, function prototype, category of functions, inter function communication, function calls, parameter passing mechanisms, recursion, passing arrays to functions, passing strings to functions, storage classes, preprocessor directive.

MODULE - IV  STRUCTURES, UNIONS AND POINTERS  Classes: 09

Structures and unions: Structure definition, initialization, accessing structures, nested structures, arrays of structures, structures and functions, passing structures through pointers, self-referential structures, unions, bit fields, typedef, enumerations; Pointers: Pointer basics, pointer arithmetic, pointers to pointers, generic pointers, array of pointers, pointers and arrays, pointers as functions arguments, functions returning pointers. Dynamic memory allocation: Basic concepts, library functions.
MODULE - V  FILE HANDLING AND BASICALGORITHMS

Files: Streams, basic file operations, file types, file opening modes, input and output operations with files, special functions for working with files, file positioning functions, command line arguments. Searching, basic sorting algorithms (bubble, insertion, selection), algorithm complexity through example programs (no formal definitions required).

Text Books:


Reference Books:


Web References:

1. https://www.bfoit.org/itp/Programming.html
2. https://www.khanacademy.org/computing/computer-programming

E-Text Books:


MOOC Course

ENGINEERING PHYSICS LABORATORY

I Semester: AE / ECE / ME | II Semester: CSE / IT / CE / EEE

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Maximum Marks</th>
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<td>CIA 30</td>
<td>SEE 70 100</td>
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</table>

Contact Classes: Nil  Tutorial Classes: Nil  Practical Classes: 39  Total Classes: 39

OBJECTIVES:
The course should enable the students to:
I. Upgrade practical knowledge in optics.
II. Analyze the behavior and characteristics of various materials for its optimum utilization.
III. Enrich the knowledge of electric and magnetic properties.

LIST OF EXPERIMENTS

Week-1  INTRODUCTION TO PHYSICS LABORATORY
Do's and Don'ts in physics laboratory. Precautions to be taken in laboratory.

Week-2  HALL EFFECT (LORENTZ FORCE)
Determination of charge carrier density.

Week-3  MELDE'E EXPERIMENT
Determination of frequency of a given tuning fork.

Week-4  STEWART GEE’S APPARATUS
Magnetic field along the axis of current carrying coil-Stewart and Gee’s method.

Week-5  B-H CURVE WITH CRO
To determine the value of retentivity and coercivity of a given magnetic material.

Week-6  ENERGY GAP OF A SEMICONDUCTOR DIODE
Determination of energy gap of a semiconductor diode.

Week-7  PIN AND AVALANCHE DIODE
Studying V-I characteristics of PIN and Avalanche diode.

Week-8  OPTICAL FIBER
Evaluation of numerical aperture of a given optical fiber.

Week-9  WAVE LENGTH OF LASER LIGHT
Determination of wavelength of a given laser light using diffraction grating.
<table>
<thead>
<tr>
<th>Week-10</th>
<th>PLANK’S CONSTANT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Determination of Plank’s constant using LED.</td>
</tr>
<tr>
<td>Week-11</td>
<td>LIGHT EMITTING DIODE</td>
</tr>
<tr>
<td></td>
<td>Studying V-I characteristics of LED</td>
</tr>
<tr>
<td>Week-12</td>
<td>NEWTONS RINGS</td>
</tr>
<tr>
<td></td>
<td>Determination of radius of curvature of a given plano-convex lens.</td>
</tr>
<tr>
<td>Week-13</td>
<td>SINGLE SLIT DIFFRACTION</td>
</tr>
<tr>
<td></td>
<td>Determination of width of a given single slit.</td>
</tr>
</tbody>
</table>

**Manuals:**


**Web Reference:**

http://www.iare.ac.in
PROGRAMMING FOR PROBLEM SOLVING LABORATORY

I Semester: AE / ME | II Semester: CSE / IT / ECE / EEE / CE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
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<th>Maximum Marks</th>
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</thead>
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<tr>
<td></td>
<td></td>
<td>- - 4 2</td>
<td>30 70 100</td>
<td></td>
</tr>
</tbody>
</table>

Contact Classes: Nil  Tutorial Classes: Nil  Practical Classes: 48  Total Classes: 48

OBJECTIVES:
The course should enable the students to:
I. Formulate problems and implement algorithms using C programming language.
II. Develop programs using decision structures, loops and functions.
III. Learn memory allocation techniques using pointers.
IV. Use structured programming approach for solving of computing problems in real world.

LIST OF EXPERIMENTS

Week-1 OPERATORS AND EVALUATION OF EXPRESSIONS
a. Write a C program to check whether a number is even or odd using ternary operator.
b. Write a C program to perform the addition of two numbers without using +operator.
c. Write a C program to evaluate the arithmetic expression \((a + b / c * d - e) * (f - g)\). Read the values a, b, c, d, e, f, g from the standard input device.
d. Write a C program to find the sum of individual digits of a 3 digit number.
e. Write a C program to read the values of x and y and print the results of the following expressions in one line:
   i. \((x + y) / (x - y)\)
   ii. \((x + y)(x - y)\)

Week-2 CONTROL STRUCTURES
a. Write a C program to find the sum of individual digits of a positive integer.
b. A Fibonacci sequence is defined as follows: The first and second terms in the sequence are 0 and 1. Subsequent terms are found by adding the preceding two terms in the sequence. Write a C program to generate the first n terms of these sequences.
c. Write a C program to generate all the prime numbers between 1 and n, where n is a value supplied by the user.
d. A character is entered through keyboard. Write a C program to determine whether the character entered is a capital letter, a small case letter, a digit or a special symbol using if-else and switch case. The following table shows the range of ASCII values for various characters.

<table>
<thead>
<tr>
<th>Characters</th>
<th>ASCII values</th>
</tr>
</thead>
<tbody>
<tr>
<td>A–Z</td>
<td>65 –90</td>
</tr>
<tr>
<td>a – z</td>
<td>97 –122</td>
</tr>
<tr>
<td>0 – 9</td>
<td>48 –57</td>
</tr>
<tr>
<td>Special symbols</td>
<td>0 – 47, 58 – 64, 91 – 96, 123 –127</td>
</tr>
</tbody>
</table>

e. If cost price and selling price of an item is input through the keyboard, write a program to determine whether the seller has made profit or incurred loss. Write a C program to determine how much profit or loss incurred in percentage.
### Week-3  CONTROL STRUCTURES

a. Write a C program, which takes two integer operands and one operator from the user, performs the operation and then prints the result. (Consider the operators +, -, *, /, % and use switch statement).
b. Write a C program to calculate the following sum:
   \[ \text{sum} = 1 - x^2 / 2! + x^4 / 4! - x^6 / 6! + x^8 / 8! - x^{10} / 10! \]
c. Write a C program to find the roots of a quadratic equation.
d. Write a C program to check whether a given 3 digit number is Armstrong number or not.
e. Write a C program to print the numbers in triangular form
   
   \[
   \begin{align*}
   &1 \\
   &1 \ 2 \\
   &1 \ 2 \ 3 \\
   &1 \ 2 \ 3 \ 4
   \end{align*}
   \]

### Week-4  ARRAYS

a. Write a C program to find the second largest integer in a list of integers.
b. Write a C program to perform the following:
   i. Addition of two matrices
   ii. Multiplication of two matrices
c. Write a C program to count and display positive, negative, odd and even numbers in an array.
d. Write a C program to merge two sorted arrays into another array in a sorted order.
e. Write a C program to find the frequency of a particular number in a list of integers.

### Week-5  STRINGS

a. Write a C program that uses functions to perform the following operations:
   i. To insert a sub string into a given main string from a given position.
   ii. To delete n characters from a given position in a given string.
b. Write a C program to determine if the given string is a palindrome or not.
c. Write a C program to find a string within a sentence and replace it with another string.
d. Write a C program that reads a line of text and counts all occurrence of a particular word.
e. Write a C program that displays the position or index in the string S where the string T begins, or 1 if S doesn’t contain T.

### Week-6  FUNCTIONS

a. Write C programs that use both recursive and non-recursive functions
   i. To find the factorial of a given integer.
   ii. To find the greatest common divisor of two given integers.
b. Write C programs that use both recursive and non-recursive functions
   i. To print Fibonacci series.
   ii. To solve towers of Hanoi problem.
c. Write a C program to print the transpose of a given matrix using function.
d. Write a C program that uses a function to reverse a given string.

### Week-7  POINTERS

a. Write a C program to concatenate two strings using pointers.
b. Write a C program to find the length of string using pointers.
c. Write a C program to compare two strings using pointers.
d. Write a C program to copy a string from source to destination using pointers.
e. Write a C program to reverse a string using pointers.
### Week-8  STRUCTURES AND UNIONS

a. Write a C program that uses functions to perform the following operations:
   i. Reading a complex number
   ii. Writing a complex number
   iii. Addition and subtraction of two complex numbers
   iv. Multiplication of two complex numbers. Note: represent complex number using a structure.

b. Write a C program to compute the monthly pay of 100 employees using each employee's name, basic pay. The DA is computed as 52% of the basic pay. Gross-salary (basic pay + DA). Print the employees name and gross salary.

c. Create a Book structure containing book_id, title, author name and price. Write a C program to pass a structure as a function argument and print the book details.

d. Create a union containing 6 strings: name, home_address, hostel_address, city, state and zip. Write a C program to display your present address.

e. Write a C program to define a structure named DOB, which contains name, day, month and year. Using the concept of nested structures display your name and date of birth.

### Week-9  ADDITIONAL PROGRAMS

a. Write a C program to read in two numbers, x and n, and then compute the sum of this geometric progression: \( 1 + x + x^2 + x^3 + \ldots + x^n \). For example: if \( n = 3 \) and \( x = 5 \), then the program computes \( 1 + 5 + 25 + 125 \). Print x, n, the sum. Perform error checking. For example, the formula does not make sense for negative exponents – if \( n < 0 \), have your program print an error message if \( n < 0 \), then go back and read in the next pair of numbers of without computing the sum. Are any values of x also illegal? If so, test for them too.

b. 2's complement of a number is obtained by scanning it from right to left and complementing all the bits after the first appearance of a 1. Thus 2's complement of 11100 is 00100. Write a C program to find the 2's complement of a binary number.

c. Write a C program to convert a Roman numeral to its decimal equivalent. E.g. Roman number CD is equivalent to 400.

### Week-10  PREPROCESSOR DIRECTIVES

a. Define a macro with one parameter to compute the volume of a sphere. Write a C program using this macro to compute the volume for spheres of radius 5, 10 and 15 meters.

b. Define a macro that receives an array and the number of elements in the array as arguments. Write a C program for using this macro to print the elements of the array.

c. Write symbolic constants for the binary arithmetic operators +, -, *, and /. Write a C program to illustrate the use of these symbolic constants.

### Week-11  FILES

a. Write a C program to display the contents of a file.

b. Write a C program to copy the contents of one file to another.

c. Write a C program to reverse the first n characters in a file, where n is given by the user.

d. Two files DATA1 and DATA2 contain sorted lists of integers. Write a C program to merge the contents of two files into a third file DATA i.e., the contents of the first file followed by those of the second are put in the third file.

e. Write a C program to count the no. of characters present in the file.
### COMMAND LINE ARGUMENTS AND NUMERICAL METHODS

<table>
<thead>
<tr>
<th>Week-12</th>
<th>Reference Books:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Write a C program to read two numbers at the command line and perform arithmetic operations on it.</td>
</tr>
<tr>
<td></td>
<td>b. Write a C program to read a file name at the command line and display its contents.</td>
</tr>
<tr>
<td></td>
<td>c. Write a C program to solve numerical methods problems (root finding, numerical differentiation and numerical integration)</td>
</tr>
</tbody>
</table>

**Reference Books:**


**Web References:**

2. [http://www.geeksforgeeks.org/c](http://www.geeksforgeeks.org/c)
# WORKSHOP / MANUFACTURING PRACTICES LABORATORY

**I Semester:** AERO / CSE / IT / MECH  |  **II Semester:** ECE / EEE / CE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
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<td>- - 3</td>
<td>1.5 30 70 100</td>
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**Contact Classes:** Nil  
**Tutorial Classes:** Nil  
**Practical Classes:** 42  
**Total Classes:** 42

**OBJECTIVES:**  
The course should enable the students to:  
I. Identify and use of tools, types of joints in carpentry, fitting, tin smithy and plumbing operations.  
II. Understand of electrical wiring and components.  
III. Observation of the function of lathe, shaper, drilling, boring, milling, grinding machines.

**LIST OF EXPERIMENTS**

**Week-1**  
**MACHINE SHOP-Turning and other machines**
Batch I: Working on central lathe and shaping machine.  
Batch II: Working on drilling, grinding machines.

**Week-2**  
**MACHINE SHOP-Milling and other machines**
Batch I: Working on milling machine.  
Batch II: Working on milling and shaping machine.

**Week-3**  
**ADVANCED MACHINE SHOP**
Batch I: Working on CNC Turning machines.  
Batch II: Working on CNC Vertical Drill Tap Center.

**Week-4**  
**FITTING**
Batch I: Make a straight fit and straight fit for given dimensions.  
Batch II: Make a square fit for straight fit for given sizes.

**Week-5**  
**CARPENTRY-I**
Batch I: Preparation of lap joint as per given dimensions.  
Batch II: Preparation of dovetail joint as per given taper angle.

**Week-6**  
**CARPENTRY-II**
Batch I: Preparation of dovetail joint as per given taper angle.  
Batch II: Preparation of lap joint as per given dimensions.

**Week-7**  
**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.

<table>
<thead>
<tr>
<th>Week-8</th>
<th>WELDING</th>
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**Week-9**

<table>
<thead>
<tr>
<th>MOULD PREPARATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batch I: Prepare a wheel flange mould using a given wooden pattern. Batch II: Prepare a bearing housing using an aluminum pattern.</td>
</tr>
</tbody>
</table>

**Week-10**

<table>
<thead>
<tr>
<th>MOULD PREPARATION</th>
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</thead>
<tbody>
<tr>
<td>Batch I: Prepare a bearing housing using an aluminum pattern. Batch II: Prepare a wheel flange mould using a given wooden pattern.</td>
</tr>
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<table>
<thead>
<tr>
<th>Week-11</th>
<th>BLACKSMITHY-I, TINSMITHY-I,</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batch I: Prepare S-bend &amp; 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.</td>
<td></td>
</tr>
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</table>

**Week-12**

<table>
<thead>
<tr>
<th>TINSMITHY-I, BLACKSMITHY-I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batch I: Prepare the development of a surface and make a rectangular tray and a round tin. Batch II: Prepare S-bend &amp; J-bend of given MS rod using open hearth furnace.</td>
</tr>
</tbody>
</table>

**Week-13**

<table>
<thead>
<tr>
<th>PLASTIC MOULDING, INJECTION MOULDING, GLASS CUTTING</th>
</tr>
</thead>
</table>

**Week-14**

<table>
<thead>
<tr>
<th>BLOW MOULDING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batch I&amp; II: Blow Moulding.</td>
</tr>
</tbody>
</table>

**Reference Books:**


**Web References:**

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

I Semester: ECE / EEE / CE | II Semester: AE / CSE / IT / ME

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<th>Credits</th>
<th>Maximum Marks</th>
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Contact Classes: 30  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 30

OBJECTIVES:
The course should enable the students to:
I. Communicate in an intelligible English accent and pronunciation.
II. Use the four language skills i.e., Listening, Speaking, Reading and Writing effectively.
III. Develop the art of writing accurate English with correct spelling, grammar and punctuation.

MODULE - I  GENERAL INTRODUCTION AND LISTENING SKILLS  Classes: 06
Introduction to communication skills; Communication process; Elements of communication; Soft skills vs hard skills; Importance of soft skills for engineering students; Listening skills; Significance; Stages of listening; Barriers to listening and effectiveness of listening; Listening comprehension.

MODULE - II  SPEAKING SKILLS  Classes: 06
Significance; Essentials; Barriers and effectiveness of speaking; Verbal and non-verbal communication; Generating talks based on visual prompts; Public speaking; Addressing a small group or a large formal gathering; Oral presentation; Power point presentation.

MODULE - III  VOCABULARY & GRAMMAR  Classes: 06
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; Synonyms; Antonyms; Standard abbreviations; 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  Classes: 06
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  Classes: 06
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.
## Text Books:

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

## Reference Books:


## Web References:

1. www.edufind.com
2. www.myenglishpages.com
3. http://grammar.ccc.comment.edu

## E-Text Books:

MATHEMATICAL TRANSFORM TECHNIQUES

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
<th>Credits</th>
<th>Maximum Marks</th>
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<td></td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

Contact Classes: 45  Tutorial Classes: 15  Practical Classes: Nil  Total Classes: 60

OBJECTIVES:
The course should enable the students to:

I. Enrich the knowledge solving algebra and transcendental equations and understanding Laplace transforms.
II. Determine the unknown values of a function by interpolation and applying inverse Laplace transforms.
III. Fitting of a curve and determining the Fourier transform of a function.
IV. Solving the ordinary differential equations by numerical techniques.
V. Formulate to solve partial differential equation.

Module-I  ROOT FINDING TECHNIQUES AND LAPLACE TRANSFORMS  Classes: 09

ROOT FINDING TECHNIQUES: Root finding techniques: Solving algebraic and transcendental equations by bisection method, method of false position, Newton-Raphson method.

LAPLACE TRANSFORMS: 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.

Module-II  INTERPOLATION AND INVERSE LAPLACE TRANSFORMS  Classes: 09

INTERPOLATION: Interpolation: Finite differences, forward differences, backward differences and central differences; Symbolic relations; Newton’s forward interpolation, Newton’s backward interpolation; Gauss forward central difference formula, Gauss backward central difference formula; Interpolation of unequal intervals: Lagrange’s interpolation.

INVERSE LAPLACE TRANSFORMS: 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.

Module-III  CURVE FITTING AND FOURIER TRANSFORMS  Classes: 09

CURVE FITTING: Fitting a straight line; Second degree curves; Exponential curve, power curve by method of least squares.

FOURIER TRANSFORMS: Fourier integral theorem, Fourier sine and cosine integrals; Fourier transforms; Fourier sine and cosine transform, properties, inverse transforms, finite Fourier transforms.
### Module-IV  
**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**  
Classes: 09

**STEP BY STEP METHOD:** Taylor’s series method; Euler’s method, modified Euler’s method for first order differential equations.

**MULTI STEP METHOD:** Runge-Kutta method for first order differential equations.

### Module-V  
**PARTIAL DIFFERENTIAL EQUATIONS AND APPLICATIONS**  
Classes: 09

**PARTIAL DIFFERENTIAL EQUATIONS:** Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equation by Lagrange method.

**APPLICATIONS:** Method of separation of variables; One dimensional heat and wave equations under initial and boundary conditions.

### Text Books:

### Reference Books:

### Web References:

### E-Text Books:
## OBJECTIVES:
The course should enable the students to:

I. Apply the electrochemical principles in batteries, understand the fundamentals of corrosion.

II. Analysis of water for its various parameters and its significance in industrial and domestic applications.

III. Analyze microscopic chemistry in terms of atomic, molecular orbitals and Intermolecular forces.

IV. Analysis of major chemical reactions that are used in the synthesis of molecules.

V. Understand the chemistry of various fuels and their combustion.

### MODULE-I  ELECTROCHEMISTRY AND CORROSION  Classes: 09

Electrochemical cells: Electrode potential, standard electrode potential, types of electrodes; Calomel, Quinhydrone and glass electrode; Nernst equation; Electrochemical series and its applications; Numerical problems; Batteries: Primary (Dry cell) and secondary batteries (Lead-acid storage battery and Lithium ion battery).

Causes and effects of corrosion: Theories of chemical and electrochemical corrosion, mechanism of electrochemical corrosion; Types of corrosion: Galvanic, water-line and pitting corrosion; Factors affecting rate of corrosion; Corrosion control methods: Cathodic protection, sacrificial anode and impressed current; Surface coatings: Metallic coatings- Methods of coating- Hot dipping, cementation, electroplating and Electroless plating of copper.

### MODULE-II  WATER AND ITS TREATMENT  Classes: 08

Introduction: Hardness of water, Causes of hardness; Types of hardness: temporary and permanent, expression and units of hardness; Estimation of hardness of water by complexometric method; Potable water and its specifications, Steps involved in treatment of water, Disinfection of water by chlorination and ozonation; Boiler feed water and its treatment, Calgon conditioning, Phosphate conditioning and Colloidal conditioning; External treatment of water; Ion-exchange process; Desalination of water: Reverse osmosis, numerical problems.

### MODULE-III  MOLECULAR STRUCTURE AND THEORIES OF BONDING  Classes: 08

Shapes of Atomic orbitals, Linear Combination of Atomic orbitals (LCAO), molecular orbitals of diatomic molecules; Molecular orbital energy level diagrams of \( \text{N}_2, \text{O}_2, \text{F}_2, \text{CO} \) and \( \text{NO} \) molecules.

Crystal Field Theory (CFT): Salient Features of CFT-Crystal Fields; Splitting of transition metal ion \( d \)-orbitals in Tetrahedral, Octahedral and square planar geometries; Band structure of solids and effect of doping on conductance.
### MODULE - IV
**STEREOCHEMISTRY, REACTION MECHANISM AND SYNTHESIS OF DRUG MOLECULES**  
Classes: 12

Introduction to representation of 3-dimensional structures: Structural and stereoisomers, configurations, symmetry and chirality; Enantiomers, diastereomers, optical activity and Absolute configuration; Confirmation analysis of n- butane. Substitution reactions: Nucleophilic substitution reactions, Mechanism of $\text{SN}_1$, $\text{SN}_2$ reactions; Electrophilic and nucleophilic addition reactions; Addition of HBr to propene; Markownikoff and anti Markownikoff’s additions; Grignard additions on carbonyl compounds; Elimination reactions: Dehydro halogenation of alkylhalides; Saytzeff rule; Oxidation reactions: Oxidation of alcohols using $\text{KMnO}_4$ and chromicacid; Reduction reactions: Reduction of carbonyl compounds using $\text{LiAlH}_4$ & $\text{NaBH}_4$; Hydroboration of olefins; Structure, synthesis and pharmaceutical applications of Paracetamol and Aspirin.

### MODULE – V
**FUELS AND COMBUSTION**  
Classes: 08

Fuels: Definition, classification of fuels and characteristics of a good fuels; Solid fuels: Coal; Analysis of coal: Proximate and ultimate analysis; Liquid fuels: Petroleum and its refining; Cracking: Fixed bed catalytic cracking; Knocking: Octane and cetane numbers; Gaseous fuels: Composition, characteristics and applications of natural gas, LPG and CNG; Combustion: Calorific value: Gross Calorific Value(GCV) and Net Calorific Value(NCV), calculation of air quantity required for complete combustion of fuel, numerical problems.

**Text Books:**


**Reference Books:**


**Web References:**

ENGINEERING MECHANICS

II Semester: AE | III Semester: ME / CE

<table>
<thead>
<tr>
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<th>Credits</th>
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Contact Classes: 45  Tutorial Classes: 15  Practical Classes: Nil  Total Classes: 60

OBJECTIVES:
The course should enable the students to:
I. Ability to work comfortably with basic engineering mechanics concepts required for analyzing static structures.
II. Identify an appropriate structural system to studying a given problem and isolate it from its environment, model the problem using good free-body diagrams and accurate equilibrium equations.
III. Identify and model various types of loading and support conditions that act on structural systems, apply pertinent mathematical, physical and engineering mechanical principles to the system to solve and analyze the problem.
IV. Understand the meaning of center of gravity (mass)/centroid and moment of Inertia using integration methods and method of moments.

MODULE-I  INTRODUCTION TO ENGINEERING MECHANICS  Classes: 10
Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy

MODULE -II  FRICTION AND BASICS STRUCTURAL ANALYSIS  Classes: 09
Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack; Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines;

MODULE -III  CENTROID AND CENTRE OF GRAVITY AND VIRTUAL WORK AND ENERGY METHOD  Classes: 10
Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.
Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.

MODULE -IV  PARTICLE DYNAMICS AND INTRODUCTION TO KINETICS  Classes: 08
Particle dynamics- Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates).
3-D curvilinear motion; Relative and constrained motion; Newton’s 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique). Introduction to Kinetics of Rigid Bodies covering, Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D’Alembert’s principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation;

**MODULE -V MECHANICAL VIBRATIONS**

Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums;

**Text Books:**


**Reference Books:**


**Web References:**

2. https://www.youtube.com/playlist?list=PLUl4u3cNGP62esZEwffjMAEMW_YArxYC

**E-Text Books:**

ENGLISH LANGUAGE AND COMMUNICATION SKILLS LABORATORY

I Semester: ECE / EEE / CE | II Semester: AE / CSE / IT / ME

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
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</table>

Contact Classes: Nil  Tutorial Classes: Nil  Practical Classes: 24  Total Classes: 24

OBJECTIVES:
The course enables the students 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.

LIST OF ACTIVITIES

Week-1  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 compere and newsreader; Greetings for different occasions with feedback preferably through video recording.
<table>
<thead>
<tr>
<th>Week</th>
<th>READING SKILL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week-6</td>
<td>a. Intonation.</td>
</tr>
<tr>
<td></td>
<td>b. Reading newspaper and magazine articles; Reading selective autobiographies for critical commentary.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Week-7</th>
<th>READING SKILL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a. Improving pronunciation through tongue twisters.</td>
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<tr>
<td></td>
<td>b. Reading advertisements, pamphlets; Reading comprehension exercises with critical and analytical questions based on context.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week-8</th>
<th>WRITING SKILL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a. Listening to inspirational short stories.</td>
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<tr>
<td></td>
<td>b. Writing messages, leaflets, Notice; Writing tasks; Flashcards – Exercises.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week-9</th>
<th>WRITING SKILL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a. Write the review on a video clipping of short duration (5 to 10minutes).</td>
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<tr>
<td></td>
<td>b. Write a slogan related to the image; Write a short story of 6-10 lines based on the hints given.</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Week-10</th>
<th>WRITING SKILL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a. Minimizing Mother Tongue Influence to improve fluency through watching educational videos.</td>
</tr>
<tr>
<td></td>
<td>b. Writing practices – précis writing; Essay writing.</td>
</tr>
</tbody>
</table>

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<tr>
<th>Week-11</th>
<th>THINKING SKILL</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>a. Correcting common errors in day to day conversations.</td>
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<tr>
<td></td>
<td>b. Practice in preparing thinking blocks to decode diagrammatical representations into English words, expressions, idioms, proverbs.</td>
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</table>

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<thead>
<tr>
<th>Week-12</th>
<th>THINKING SKILL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a. Correcting common errors in day to day conversations.</td>
</tr>
<tr>
<td></td>
<td>b. Making pictures and improvising diagrams to form English words, phrases and proverbs.</td>
</tr>
</tbody>
</table>

**Reference Books:**


**Web References:**

1. http://learnenglish.britishcouncil.org
EQUIPMENT REQUIRED FOR A BATCH OF 60 STUDENTS (ORAL AND MULTIMEDIA)

1. Career laboratory: 1 Room
2. Server computer for the laboratory with high configuration: 1 no
3. Computers: 30 nos
4. Software: K Van Solution
5. LCD Projector: 1 no
6. Speakers with amplifiers, one wireless mic and one collar mic
7. Podium: 1
8. Chairs: 30
9. Discussion Tables: 2
10. White board: 1
OBJECTIVES:
The course should enable the students to:
I. Analyze, interpret, and draw conclusions from experimental data.
II. Describe the fluid property of surface tension and viscosity.
III. Perform a complexometric titration to determine the hardness of water from various sources.
IV. Comprehend the experimental results.

LIST OF EXPERIMENTS

Week-1 INTRODUCTION TO CHEMISTRY LABORATORY
Introduction to chemistry laboratory. Do's and Don'ts in chemistry laboratory.

Week-2 PREPARATION OF ORGANIC COMPOUNDS
Synthesis of Aspirin.

Week-3 VOLUMETRIC ANALYSIS
Estimation of Total hardness of water by complexometric method using EDTA.

Week-5 INSTRUMENTATION
Estimation of an HCl by conductometric titrations.

Week-6 INSTRUMENTATION
Estimation of HCl by potentiometric titrations.

Week-7 INSTRUMENTATION
Estimation of Acetic acid by Conductometric titrations.

Week-8 INSTRUMENTATION
Estimation of Fe²⁺ by Potentiometry using KMnO₄ titrations.
Week-9 | **VOLUMETRIC ANALYSIS**
---|---
Determination of chloride content of water by Argentometry.

Week-10 | **PHYSICAL PROPERTIES**
---|---
Determination of surface tension of a given liquid using Stalagmometer.

Week-11 | **PHYSICAL PROPERTIES**
---|---
Determination of viscosity of a given liquid using Ostwald’s viscometer.

Week-12 | **PHYSICAL PROPERTIES**
---|---
Verification of freundlich adsorption isotherm-adsorption of acetic and on charcoal.

Week-13 | **ANALYSIS OF ORGANIC COMPOUNDS**
---|---
Thin layer chromatography calculation of $R_f$ values. Eg: ortho and para nitro phenols.

Week-14 | **REVISION**
---|---
Revision.

**Reference Books:**

**Web References:**
http://www.iare.ac.in

**LIST OF EQUIPMENT REQUIRED FOR A BATCH OF 30 STUDENTS:**

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<th>Quantity</th>
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<tr>
<td>2</td>
<td>Beaker</td>
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<td>3</td>
<td>Burette</td>
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<tr>
<td>4</td>
<td>Burette Stand</td>
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<td>Metal</td>
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<tr>
<td>5</td>
<td>Clamps with Boss heads</td>
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<td>Metal</td>
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<td>6</td>
<td>Conical Flask</td>
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<td>7</td>
<td>Conductivity cell</td>
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<td>8</td>
<td>Calomel electrode</td>
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<tr>
<td>9</td>
<td>Digital Potentiometer</td>
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<td>TLC Plates</td>
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ENGINEERING GRAPHICS AND DESIGN LABORATORY

I Semester: ECE / EEE / CE | II Semester: AE / ME / CSE / IT

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<th>Hours / Week</th>
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Contact Classes: 15 | Tutorial Classes: Nil | Practical Classes: 60 | Total Classes: 75

OBJECTIVES:
The course should enable the students to
I. Understand the basic principles of engineering drawing and construction of curves used in engineering field.
II. Apply the knowledge of interpretation of projection in different quadrants.
III. Understand the projections of solids, when it is inclined to both planes simultaneously.
IV. Convert the pictorial views into orthographic view and vice versa.
V. Create intricate details of components through sections and develop its surfaces.

LIST OF EXPERIMENTS

MODULE - I
INTRODUCTION TO ENGINEERING DRAWING
Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales - Plain, Diagonal and Vernier Scales.

MODULE - II
OVERVIEW OF COMPUTER GRAPHICS, CUSTOMIZATION & CAD DRAWING, ANNOTATIONS, LAYERING & OTHER FUNCTIONS, DEMONSTRATION OF A SIMPLE TEAM DESIGN PROJECT
Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids].
Consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles.
Applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling.
MODULE - III  ORTHOGRAPHIC PROJECTIONS

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

Projections of planes inclined Planes-Auxiliary Planes.

MODULE - IV  PROJECTIONS OF REGULAR SOLIDS AND SECTIONS AND SECTIONAL VIEWS OF RIGHT ANGULAR SOLIDS

Those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale.Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Draw the sectional orthographic views of geometrical solids ofPrism, Pyramid, Cylinder and Cone; Objects from industry and dwellings (foundation to slab only).

MODULE - V  DEVELOPMENT OF SURFACES AND ISOMETRIC PROJECTIONS

Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; 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, Conventions.

DEMONSTRATION OF A SIMPLE TEAM DESIGN PROJECT:
Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Text Books


Reference Books:


Web References:

1. http://nptel.ac.in/courses/112103019
2. http://www.autocadtutorials.net/

SOFTWARE AND HARDWARE REQUIREMENTS FOR A BATCH OF 30 STUDENTS:

SOFTWARE:  AUTOCAD 2016
HARDWARE: 30 numbers of Intel Desktop Computers with 2 GB RAM
BASIC SIMULATION WITH MATLAB LABORATORY

II Semester: AE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
<th>Credits</th>
<th>Maximum Marks</th>
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Contact Classes: Nil  Tutorial Classes: Nil  Practical Classes: 36  Total Classes: 36

OBJECTIVES:
The course should enable the students to:
I. Understand the procedures, algorithms, and concepts require to solve specific problems
II. Analyze the concepts of algebra, calculus and numerical solutions using MATLAB software.
III. Enrich the knowledge in MATLAB and can apply for project works.
IV. Interpret and visualize simple mathematical functions and operations thereon using plots/display.

LIST OF EXPERIMENTS

Week-1  BASIC FEATURES
a. Features and uses.
b. Local environment setup.

Week-2  ALGEBRA
a. Solving basic algebraic equations.
b. Solving system of equations.
c. Two dimensional plots.

Week-3  CONTROL STRUCTURES
a. For Loop.
b. While Loop.
c. If- elseif- else control structure.

Week-4  MATRICES
a. Addition, subtraction and multiplication of matrices.
b. Transpose of a matrix.
c. Inverse of a matrix.

Week-5  SYSTEM OF LINEAR EQUATIONS
a. Rank of a matrix.
b. Gauss Jordan method.
c. LU decomposition method.

Week-6  LINEAR TRANSFORMATION
a. Characteristic equation.
b. Eigen values.
c. Eigen vectors.
<table>
<thead>
<tr>
<th>Week-7</th>
<th>DIFFERENTIATION AND INTEGRATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>b.</td>
<td>Double integrals.</td>
</tr>
<tr>
<td>c.</td>
<td>Triple integrals.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Week-8</th>
<th>NUMERICAL DIFFERENTIATION AND INTEGRATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Trapezoidal, Simpson’s method.</td>
</tr>
<tr>
<td>b.</td>
<td>Euler method.</td>
</tr>
<tr>
<td>c.</td>
<td>Runge Kutta method.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week-9</th>
<th>3D PLOTTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Line plotting.</td>
</tr>
<tr>
<td>b.</td>
<td>Surface plotting.</td>
</tr>
<tr>
<td>c.</td>
<td>Volume plotting.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week-10</th>
<th>DEFLECTION OF SIMPLY SUPPORTED BEAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Calculating vertical displacement with point load.</td>
</tr>
<tr>
<td>b.</td>
<td>Calculating vertical displacement with uniformly distributed load.</td>
</tr>
<tr>
<td>c.</td>
<td>Calculating vertical displacement with uniformly varying load.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week-11</th>
<th>DEFLECTION OF CANTILEVER BEAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>b.</td>
<td>Calculating vertical displacement with point load.</td>
</tr>
<tr>
<td>c.</td>
<td>Calculating vertical displacement with uniformly distributed load.</td>
</tr>
<tr>
<td>c.</td>
<td>Calculating vertical displacement with uniformly varying load.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week-12</th>
<th>FORMULATION OF IDEAL AND REAL GAS EQUATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Calculating the pressure, temperature, density for Earth’s atmospheric conditions at different altitudes.</td>
</tr>
<tr>
<td>b.</td>
<td>Calculating the pressure, temperature, density for other planets at different altitudes.</td>
</tr>
</tbody>
</table>

**Reference Books:**


**Web Reference:**

http://www.tutorialspoint.com/matlab/
http://www.iare.ac.in

**SOFTWARE AND HARDWARE REQUIREMENTS FOR A BATCH OF 30 STUDENTS:**

**SOFTWARE:** Microsoft Windows 7 and MATLAB – V 8.5, which is also R2015a

**HARDWARE:** 30 numbers of Intel Desktop Computers with 2 GB RAM
### ENGINEERING THERMODYNAMICS

#### III Semester: AE

<table>
<thead>
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<th>Credits</th>
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<td>3</td>
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</table>

**Contact Classes:** 45  
**Tutorial Classes:** Nil  
**Practical Classes:** Nil  
**Total Classes:** 45

**OBJECTIVES:**

The course should enable the students to:

I. Understand the laws of thermodynamics and determine thermodynamic properties and gas laws.

II. Apply Knowledge of properties of pure substances, mixtures, usage of steam tables and Mollier chart, psychometric charts.

III. Understand the direction law and concept of increase of entropy of the universe.

IV. Understand the working of ideal air standard, vapor cycles and evaluate their performance in open systems like steam power plants, internal combustion engines, gas turbines and refrigeration systems.

#### MODULE - I  
**BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS**  
Classes : 09

Basic concepts: 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, PMMI Joule’s experiments, first law of thermodynamics, corollaries first law applied to a process, applied to a flow system, steady flow energy equation.

#### MODULE - II  
**SECOND LAW OF THERMODYNAMICS**  
Classes : 09


#### MODULE - III  
**PURE SUBSTANCES AND MIXTURES OF PERFECT GASES**  
Classes : 09

Pure substances: 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, psychometric properties, dry bulb temperature, wet bulb temperature, dew point temperature, thermodynamic wet bulb temperature, specific humidity, relative humidity, saturated air, vapour pressure, degree of saturation, adiabatic saturation, Carrier’s equation, Psychometric chart.
### MODULE-IV  POWER CYCLES

Power cycles: 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, introduction to Brayton cycle and Bell Coleman cycle.

### MODULE-V  ELEMENTS OF HEAT TRANSFER AND GAS COMPRESSORS


### Text Books:


### Reference Books:


### Web References:


### E-Text Book:

OBJECTIVES:
The course should enable the students to:
I. Understand Kirchhoff laws and their application in series and parallel electric circuits.
II. Discuss principle and operation of measuring instruments.
III. Analyze the characteristics of alternating quantities, DC and AC machines.
IV. Illustrate the V-I characteristics of various diodes and bi-polar junction transistor.

MODULE - I
ELECTRIC CIRCUITS, ELECTROMAGNETISM AND INSTRUMENTS
Classes: 09


MODULE - II
DC MACHINES
Classes: 08

DC Machines: Principle of operation of DC generator, EMF equation, principle of operation of DC motors, torque equation, types of DC machines, applications, three point starter.

MODULE - III
ALTERNATING QUANTITIES AND AC MACHINES
Classes: 10

Alternating quantities: Sinusoidal AC voltage, average and RMS values, form and peak factor, concept of three phase alternating quantity; Transformer: Principle of operation, EMF equation, losses, efficiency and regulation.


MODULE - IV
SEMICONDUCTOR DIODE AND APPLICATIONS
Classes: 09

Semiconductor diode: P-N Junction diode, symbol, V-I characteristics, half wave rectifier, full wave rectifier, bridge rectifier and filters, diode as a switch, Zener diode as a voltage regulator.

MODULE - V
BIPOLAR JUNCTION TRANSISTOR AND APPLICATIONS
Classes: 09

Bipolar junction transistor: Working principle of transistors, DC characteristics, CE, CB, CC configurations, biasing, load line, applications.
**Text Books:**


**Reference Books:**


**Web References:**


**E-Text Books:**

5. https://www.ktustudents.in

**Course Home Page:**
## OBJECTIVES:
**The course should enable the students to:**

I. Enrich the knowledge of probability on single random variables and probability distributions.

II. Apply the concept of correlation and regression to find covariance.

III. Analyze the given data for appropriate test of hypothesis.

### MODULE I: PROBABILITY AND RANDOM VARIABLES

- Probability, Conditional Probability, Baye’s Theorem; Random variables: Basic definitions, discrete and continuous random variables; Probability distribution: Probability mass function and probability density functions; Mathematical expectation.

### MODULE II: PROBABILITY DISTRIBUTION

- Binomial distribution; Mean and variances of Binomial distribution, Recurrence formula for the Binomial distribution; Poisson distribution: Poisson distribution as a limiting case of Binomial distribution, mean and variance of Poisson distribution, Recurrence formula for the Poisson distribution; Normal distribution; Mean, Variance, Mode, Median, Characteristics of normal distribution.

### MODULE III: CORRELATIONS AND REGRESSION

- Correlation: Karl Pearson’s Coefficient of correlation, Computation of correlation coefficient, Rank correlation, Repeated Ranks; Properties of correlation.

- Regression: Lines of regression, Regression coefficient, Properties of Regression coefficient, Angle between two lines of regression; Multiple correlation and Regression.

### MODULE IV: TEST OF HYPOTHESIS - I

- Sampling: Definitions of population, Sampling, Parameter of statistics, standard error; Test of significance: Null hypothesis, alternate hypothesis, type I and type II errors, critical region, confidence interval, level of significance. One sided test, two sided test. Large sample test: Test of significance for single mean, Test of significance for difference between two sample means, Tests of significance single proportion and Test of difference between proportions.

### MODULE V: TEST OF HYPOTHESIS - II

- Small sample tests: Student t-distribution, its properties: Test of significance difference between sample mean and population mean; difference between means of two small samples. Snedecor’s F-distribution and its properties; Test of equality of two population variances Chi-square distribution and it’s properties; Test of equality of two population variances Chi-square distribution, it’s properties, Chi-square test of goodness of fit.

### Text Books:

**Reference Books:**


**Web References:**


**E-Text Books:**

OBJECTIVES:
The course should enable the students to:
I. Illustrate about the basic properties of a fluid, hydrostatic forces on submerged bodies and different manometers.
II. Derive the basic principles of a fluid-continuity, momentum, Euler and Bernoulli’s equations.
III. Explain the concept of boundary layer theory and importance of Prandtl’s boundary layer theory.
IV. Understand the flow through pipes and their losses for different geometries.

MODULE -I FLUID PROPERTIES AND FLUID STATIC
Density, specific weight, specific gravity, surface tension and capillarity, Newton’s law of viscosity, incompressible and compressible fluid, numerical problems; Hydrostatic forces on submerged bodies - Pressure at a point, Pascal's law, pressure variation with temperature and height, center of pressure plane, vertical and inclined surfaces; Manometers - simple and differential Manometers, inverted manometers, micro manometers, pressure gauges and numerical problems. Buoyancy - Archimedes principle, metacenter, Meta centric height calculations; Stability.

MODULE -II FLUID KINEMATICS AND BASIC EQUATIONS OF FLUID FLOW ANALYSIS
Statement of Buckingham’s π-theorem, similarity parameters - Reynolds number, Froude number, concepts of geometric, kinematic and dynamic similarity, Reynolds number as a very approximate measure of ratio of inertia force and viscous force.
Types of fluid flows, differential equations of mass and momentum for incompressible flows, inviscid-eulers equation and viscous flows- navier stokes equations, concept of fluid rotation, vorticity and stream function, exact solutions of navier stokes equations for coquette flow and poiseuille flow, numericals.

MODULE -III FLUID DYNAMICS
Fluid forces and Motion of a fluid particle; Fluid deformation; Euler's and Bernoulli's equation, phenomenological basis of Naviers- stokes equation, flow measurements : pressure, velocity and mass flow rate, viscosity, pitot-static tube, venturi meter, orifice meter and V-Notch, numericals.

MODULE -IV BOUNDARY LAYER THEORY
Concept and assumptions, qualitative idea of boundary layer and separation, streamlined and bluff bodies, drag and lift forces. Displacement, momentum and energy thickness, numericals.

MODULE -V TURBO MACHINERY
Introduction and classification of fluid machines: Turbo machinery analysis; The angular momentum principle; Euler turbo machine equation; Application to fluid systems, working principle overview of turbines, fans, pumps and compressors.

Text Books:

**Reference Books:**


**Web References:**

1. https://nptel.ac.in/courses/112105171/1

**E-Text Books:**

3. https://eprints.staffs.ac.uk/222/1/engineering-fluid-mechanics%5B1%5D.pdf
## MECHANICS OF SOLIDS

### III Semester: AE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
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<th>Credits</th>
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<td>3 - - 3 30 70 100</td>
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Contact Classes: 45  
Tutorial Classes: Nil  
Practical Classes: Nil  
Total Classes: 45

### OBJECTIVES:
The course should enable the students to:

I. Understand various aspects of mechanics of materials as applied to engineering problems in a systematic manner stressing the fundamentals.

II. Analyze problems on thermal stresses, shear force, bending moment and deflection of beams.

III. Discuss the equilibrium and compatibility conditions for two-dimensional and three-dimensional elastic bodies.

### MODULE - I  INTRODUCTION

Properties of Engineering materials, Stresses and strains, Hooke’s law, elastic constant, relation between module, working stress, factor of safety, poisons ratio, bars of varying cross section; Thermal stresses. Torsion of solid and hollow circular shafts and shear stress variations, Power transmission in shafts. Shear force and bending moment diagrams for different types of beams with various loads.

### MODULE - II  STRESSES IN BEAMS

Bending stresses and Shear stress variation in beams of symmetric and un-symmetric sections, Beams of uniform strength, Flexural stresses: Bending equations, calculation of bending stresses for different sections of beams like I, L, T, C, angle section.

### MODULE - III  BEAMS AND COLUMNS

Deflection of beams by Double integration method, Macaulay’s method, moment area method, conjugate beam method; Principle of superposition.

Columns, types of columns, Euler’s formula instability of columns, Rakine’s and Jonson’s formula, Eigen values and Eigen modes, concept of beam-column.

### MODULE - IV  REDUNDANT STRUCTURES

Trusses, perfect frames, analysis of trusses. Determinate and indeterminate structures, order of redundancy; Redundant analysis, analysis of determinate structures, Clayperons method, slope deflection method.

### MODULE - V  THEORY OF ELASTISITY

Equilibrium and compatibility conditions and constitute relations for elastic solid and plane: generalized plane strain cases Airy’s stress function

Stress on inclined planes, stress transformations determination of principal stresses and strains by analytical method and graphical method - Mohr’s circles and its constructions.

### Text Books:

**Reference Books:**


**Web References:**

1. www.nptel.ac.in/courses/112107147/
2. www.vssut.ac.in/lecture_notes/lecture1423904647.pdf

**E-Text Books:**

2. www.esag.harvard.edu/rice/e0_Solid_Mechanics_94_10.pdf
3. www.itiomar.it/pubblica/dispense/MECHANICAL%20ENGINEERING%20HANDBOOK/
FLUID DYNAMICS LABORATORY

III Semester: AE

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Contact Classes: Nil  Tutorial Classes: Nil  Practical Classes: 24  Total Classes: 24

OBJECTIVES:
The course should enable the students to:
I. Gain knowledge on working of centrifugal pumps, positive displacement pumps, hydraulic turbines, centrifugal blowers and steam turbines.
II. Compare performance of various machines at different operating points.
III. Knowledge of various flow meters and the concept of fluid mechanics.

LIST OF EXPERIMENTS

<table>
<thead>
<tr>
<th>Week</th>
<th>Experiment</th>
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<tbody>
<tr>
<td>1</td>
<td>CALIBRATION</td>
</tr>
<tr>
<td></td>
<td>Calibration of Venturimeter and Orifice meter.</td>
</tr>
<tr>
<td>2</td>
<td>PIPE FLOW LOSSES</td>
</tr>
<tr>
<td></td>
<td>Determination of pipe flow losses in rectangular and circular pipes</td>
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<tr>
<td>3</td>
<td>BERNOULLI'S THEOREM</td>
</tr>
<tr>
<td></td>
<td>Verification of Bernoulli’s theorem.</td>
</tr>
<tr>
<td>4</td>
<td>REYNOLDS EXPERIMENT</td>
</tr>
<tr>
<td></td>
<td>Determination of Reynolds Number of fluid flow</td>
</tr>
<tr>
<td>5</td>
<td>IMPACT OF JET ON VANES</td>
</tr>
<tr>
<td></td>
<td>Study Impact of jet on Vanes.</td>
</tr>
<tr>
<td>6</td>
<td>CENTRIFUGAL PUMPS</td>
</tr>
<tr>
<td></td>
<td>Performance test on centrifugal pumps.</td>
</tr>
<tr>
<td>7</td>
<td>RECIPROCATING PUMPS</td>
</tr>
<tr>
<td></td>
<td>Performance test on reciprocating pumps.</td>
</tr>
<tr>
<td>8</td>
<td>PELTON WHEEL TURBINE</td>
</tr>
<tr>
<td></td>
<td>Performance test on piston wheel turbine.</td>
</tr>
<tr>
<td>9</td>
<td>FRANCIS TURBINE</td>
</tr>
<tr>
<td></td>
<td>Performance test on Francis turbine.</td>
</tr>
<tr>
<td>Week-10</td>
<td><strong>FLOW THROUGH WEIRS</strong></td>
</tr>
<tr>
<td>---------</td>
<td>------------------------</td>
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<tr>
<td></td>
<td>Rate of discharge Flow through Weirs</td>
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<tr>
<th>Week-11</th>
<th><strong>FLOW THROUGH NOTCH</strong></th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Flow through rectangular and V-Notch</td>
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<tr>
<th>Week-12</th>
<th><strong>FLOW THOUGH ORIFICE MOUTH PIECE</strong></th>
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<tbody>
<tr>
<td></td>
<td>Flow analysis of different shapes of mouth pieces</td>
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</table>

**Reference Books:**


**Web References:**

1. https://nptel.ac.in/courses/112105171/1
MECHANICS OF SOLIDS LABORATORY

III Semester: AE

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</table>

Contact Classes: Nil  Tutorial Classes: Nil Practical Classes: 24 Total Classes: 24

OBJECTIVES:
The course should enable the students to:
I. Understand basic knowledge on the mechanical behavior of materials like aluminum, mild steel, and cast iron.
II. Adopt with the experimental methods to determine the mechanical properties of materials.

LIST OF EXPERIMENTS

Week-1  BRINELL HARDNESS TEST
Determination of Brinell number of a given test specimen.

Week-2  ROCKWELL HARDNESS TEST
Determination of hardness number of different specimens such as steel, brass, copper and aluminum.

Week-3  TENSION TEST
Study the behavior of mild steel and various materials under different loads.
To determine
a) Tensile
b) Yield strength
c) Elongation
d) Young’s modulus

Week-4  TORSION TEST
Determine of Modulus of rigidity of various specimens.

Week-5  IZOD IMPACT TEST
Determination the toughness of the materials like steel, copper, brass and other alloys using Izod test

Week-6  CHARPY IMPACT TEST
Determine the toughness of the materials like steel, copper, brass and other alloys using Charpy test.

Week-7  COMPRESSION TEST ON SHORT COLUMN
Determine the compressive stress on material.

Week-8  COMPRESSION TEST ON LONG COLUMN
Determine Young’s modulus of the given long column.
<table>
<thead>
<tr>
<th>Week-9</th>
<th>TESTING OF SPRINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine the stiffness of the spring and the Modulus of rigidity of wire material.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Week-10</th>
<th>DEFLECTION TEST FOR SSB AND CANTILEVER BEAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine the Young’s modulus of the given material with the help of deflection of SSB and cantilever beam.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Week-11</th>
<th>REVIEW - I</th>
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<tbody>
<tr>
<td>Spare session for additional repetitions and review.</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Week-12</th>
<th>REVIEW - II</th>
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</thead>
<tbody>
<tr>
<td>Spare session for additional repetitions and review.</td>
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</table>

**Reference Books:**


**Web References:**

1. https://nptel.ac.in/courses/112107147/
OBJECT ORIENTED PROGRAMMING THROUGH PYTHON LABORATORY

III Semester: AE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
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Contact Classes: 12  Tutorial Classes: Nil  Practical Classes: 24  Total Classes: 36

COURSE OBJECTIVES:
The course should enable the students to:
I. To be able to introduce core programming basics and program design with functions using Python programming language.
II. To understand a range of Object-Oriented Programming, as well as in-depth data and information processing techniques.
III. To understand the high-performance programs designed to strengthen the practical expertise.

LIST OF EXPERIMENTS

WEEK-1  BASICS OF PYTHON
Write Python programs for the following:
a. Purposefully raise Indentation Error and Correct it
b. Compute distance between two points taking input from the user (Pythagorean Theorem)
c. To takes numbers as command line arguments and print its sum.

WEEK-2  CONTROL FLOW
Write Python programs for implementing the following:
a. Checking whether the given number is even number or not.
b. Finding the factorial of a number
c. Print the prime numbers below 100

WEEK-3  STRINGS
Write Python programs for implementing the following:
a. Count the numbers of characters in the string and store them in a dictionary data structure
b. Using split and joins methods in the string and trace a birthday with a dictionary data structure.

WEEK-4  LIST
Write Python programs to for the following:
a. Finding mean, median, mode for the given set of numbers in a list.
b. Function dups to find all duplicates in the list.

WEEK-5  MULTI DIMENSIONAL LIST
Write Python programs for the following:
a. Addition of two square matrices.
b. Multiplication of two matrices.

WEEK-6  CLASS
Write Python programs to implement the following
i. Find the validity of a string of parentheses, '(', ')', '{', '}', '[' and '']. These brackets must be close in the
<table>
<thead>
<tr>
<th>WEEK-7</th>
<th>METHODS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write Python programs to do the following</td>
<td></td>
</tr>
<tr>
<td>i. Create a Python class named Circle constructed by a radius and two methods which will compute the area and the perimeter of a circle.</td>
<td></td>
</tr>
<tr>
<td>ii. Create a Python class named Rectangle constructed by a length and width and a method which will compute the area of a rectangle.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WEEK-8</th>
<th>CONSTRUCTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write Python program to implement constructors.</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>WEEK-9</th>
<th>INHERITANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write Python program to implement inheritance.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>WEEK-10</th>
<th>POLYMORPHISM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write Python program to implement Polymorphism.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WEEK-11</th>
<th>OVERRIDING MAGIC METHODS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write Python program to override Magic Methods</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>WEEK-12</th>
<th>EVENT-DRIVEN PROGRAMMING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write Python program to create a simple calculator, where the user will enter a number in a text field, and either add it to or subtract it from a running total, which we will display. We will also allow the user to reset the total.</td>
<td></td>
</tr>
</tbody>
</table>

**LIST OF REFERENCE BOOKS:**


**WEB REFERENCES:**

1. [https://www.w3resource.com/python-exercises/class-exercises/](https://www.w3resource.com/python-exercises/class-exercises/)
AEROSPACE STRUCTURES

IV Semester: AE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
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<th>Maximum Marks</th>
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<td>3</td>
<td>30</td>
</tr>
</tbody>
</table>

Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Understand the aircraft structural components and its behavior under different loading conditions.
II. Obtain knowledge in plate buckling and structural instability of stiffened panels for airframe structural analysis.
III. Explain the thin walled section and structural idealization of panels and differentiate from the type of loads carried.
IV. Solve for stresses and deflection in aircraft structures like fuselage, wing and landing gear.

MODULE -I  INTRODUCTION TO AIRCRAFT STRUCTURAL COMPONENTS AND ENERGY METHODS  Classes: 10
Aircraft Structural components and loads, functions of structural components, airframe loads; Types of structural joints, type of loads on structural joints; Aircraft inertia loads; Symmetric manoeuvre loads, gust loads. Monocoque and semi monocoque structures, stress in thinshells; Introductions to energy principles, castiglianos theorems, maxiwells reciprocal theorem, unit load method, Rayleigh Ritz method, total potential energy method, flexibility method.

MODULE -II  THIN PLATE THEORY, STRUCTURAL INSTABILITY  Classes: 09
Analysis of thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading: Thin plates having small initial curvature, energy methods of analysis.
Buckling of thin plates: Elastic, inelastic, experimental determination of critical load for a flat plate, local instability, instability of stiffened panels, failure stresses in plates and stiffened panels. Tension field beams- complete diagonal tension, incomplete diagonal tension, post buckling behavior.

MODULE -III  BENDING, SHEAR AND TORSION OF THIN WALLED BEAMS  Classes: 09
Unsymmetrical bending: Resolution of bending moments, direct stress distribution, position of neutral axis; Deflections due to bending: Approximations for thin walled sections, temperature effects; Shear loaded thin walled beams: General stress, strain and displacement relationships, direct stress and shear flow system, shear centre, twist and warping.
Torsion of beams of closed section: Displacements associated with Bredt-Batho shear flow; Torsion of open section beams; Warping of cross section, conditions for zero warping; Bending, shear, torsion of combined open and closed section beams.

MODULE -IV  STRUCTURAL IDEALIZATION  Classes: 08
Structural idealization: Principal assumptions, idealization of panel, effect on the analysis of thin walled beams under bending, shear, torsion loading- application to determining deflection of open and closed section beams. Fuselage frames - bending, shear and torsion.
<table>
<thead>
<tr>
<th>MODULE - V</th>
<th>ANALYSIS OF FUSELAGE, WING AND LANDING GEAR</th>
<th>Classes: 09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wing spar and box beams, tapered wing spar, open and closed sections beams, beams having variable stringer areas; wings – three boom shell in bending, torsion and shear, tapered wings, deflections, cutouts in wings; Cutouts in fuselages; Fuselage frame and wing rib; principle of stiffener, web constructions. Landing gear and types; Analysis of landing gear.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Text Books:**


**Reference Books:**


**Web References:**

1. https://nptel.ac.in/courses/112101095/

**E-Text Books:**

2. https://docs.google.com/file/d/0Bw8MfqmgWLS4RINqaE1oUzdOajQ/view?pref=2&pli=1

**Course Home Page:**
### DATA STRUCTURES

**III Semester: ME / CSE / IT / ECE / CE | IV Semester: AE / EEE**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
<th>Credits</th>
<th>Maximum Marks</th>
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<td>3 - - 3 30 70 100</td>
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</table>

**Contact Classes: 45**  
**Tutorial Classes: Nil**  
**Practical Classes: Nil**  
**Total Classes: 45**

### OBJECTIVES:

**The course should enable the students to:**

1. Learn the basic techniques of algorithm analysis.
2. Demonstrate searching and sorting algorithms and analyze their time complexities.
3. Implement linear data structures viz. stack, queue and linked list.
4. Demonstrate non-linear data structures viz. tree and graph traversal algorithms.
5. Study and choose appropriate data structure to solve problems in real world.

### MODULE – I  
**INTRODUCTION TO DATA STRUCTURES, SEARCHING AND SORTING**  
**Classes: 09**

Basic concepts: Introduction to data structures, classification of data structures, operations on data structures, abstract data type, algorithms, different approaches to design an algorithm, recursive algorithms; Searching techniques: Linear search, binary search and Fibonacci search; Sorting techniques: Bubble sort, selection sort, insertion sort, quick sort, merge sort, and comparison of sorting algorithms

### MODULE - II  
**LINEAR DATA STRUCTURES**  
**Classes: 09**

Stacks: Primitive operations, implementation of stacks using Arrays, 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**  
**Classes: 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**  
**Classes: 09**

Trees: Basic concept, binary tree, binary tree representation, array and linked representations, binary tree traversal, binary tree variants, application of trees; Graphs: Basic concept, graph terminology, graph implementation, graph traversals, Application of graphs, Priority Queue.

### MODULE - V  
**BINARY TREES AND HASHING**  
**Classes: 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.
### Text Books:


### Reference Books:


### Web References:

OBJECTIVES:
The course should enable the students to:
I. Analyze parametric cyclic analysis, performance parameters, efficiency and specific impulse of all air breathing engines.
II. Know the design and performance of subsonic and supersonic inlets, types of combustion chambers and factors affecting the combustors.
III. Discuss the types of nozzles, flow conditions in nozzles, interaction of nozzle flow with adjacent surfaces and thrust reversal
IV. Explain different types of compressors and turbines, work done, velocity diagrams and stage efficiency calculations.

MODULE - I  AIR-BREATHING ENGINES  Classes: 10
Classification, operational envelopes; Description and function of gas generator, turbojet, turbofan, turboprop, turbo shaft, ramjet, scramjet, turbojet/ramjet combined cycle engine, thrust equation; Engine performance parameters, specific thrust, specific fuel consumption and specific impulse, thermal efficiency, propulsive efficiency, engine overall efficiency and its impact on aircraft range and endurance; Parametric cycle analysis a, turbojet, turbojet with afterburner, turbofan engine, turboprop engine.

MODULE - II  INLETS AND COMBUSTION CHAMBERS  Classes: 10
Internal flow and stall in subsonic inlets, relation between minimum area ratio and eternal deceleration ratio, diffuser performance, supersonic inlets, operating conditions of supersonic inlet, starting problem on supersonic inlets, shock swallowing by area variation; Classification of combustion chambers, Combustion mechanism and important combustion parameters. Pressure losses; combustion efficiency; combustion intensity. Factors affecting combustion chamber design, and operation, flame stabilization.

MODULE - III  NOZZLES  Classes: 08
Theory of flow in isentropic nozzles, nozzles and choking, nozzle throat conditions, nozzle efficiency, losses in nozzles.
Over expanded and under expanded nozzles, Nozzle design considerations: fixed and variable geometry nozzles, thrust vectoring, thrust reversal.

MODULE - IV  COMPRESSORS  Classes: 09
Principle of operation of centrifugal compressor and axial flow compressor, work done and pressure rise, velocity triangles, degree of reaction, free vortex and constant reaction designs of axial flow compressor, performance characteristics of centrifugal and axial flow compressors, stage efficiency calculations, cascade testing.
### MODULE -V  TURBINES

<table>
<thead>
<tr>
<th>Classes: 08</th>
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<tbody>
<tr>
<td>Principle of operation of axial flow turbines, limitations of radial flow turbines, work done and pressure rise, velocity triangles, degree of reaction, free vortex and constant angle designs, performance characteristics, sample ramjet design calculations, flame stability problems in ramjet combustors, integral ram rockets.</td>
</tr>
</tbody>
</table>

#### Text Books:


#### Reference Books:


#### Web References:

1. https://nptel.ac.in/courses/101101002/
2. https://nptel.ac.in/courses/112106073/

#### E-Text Books:


#### Course Home Page:
**FLIGHT MECHANICS**

<table>
<thead>
<tr>
<th>IV Semester: AE</th>
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<th>Course Code</th>
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<tr>
<td>Contact Classes: 45</td>
<td>Tutorial Classes: 15</td>
<td>Practical Classes: Nil</td>
<td>Total Classes: 60</td>
<td></td>
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</tbody>
</table>

**OBJECTIVES:**

The course should enable the students to:

I. Learn the different Regimes of aircraft and performance requirements at different atmospheric conditions.

II. Understand the different type of velocities and gives differences between stall velocity and maximum and minimum velocities.

III. Estimate the time to climb and descent and gives the relation between rate of climb and descent and time to climb and descent at different altitudes.

IV. Illustrate the velocity and radius required for different type of maneuvers like pull-up, pull down and steady turn.

**MODULE -I**

**INTRODUCTION TO AIRCRAFT PERFORMANCE**

Classes: 10

The role and design mission of an aircraft; Performance requirements and mission profile; Aircraft design performance, the standard atmosphere; Off-standard and design atmosphere; Measurement of air data; Air data computers; Equations of motion for performance - the aircraft force system; Total airplane drag- estimation, drag reduction methods; The propulsive forces, the thrust production engines, power producing engines, variation of thrust, propulsive power and specific fuel consumption with altitude and flight speed; The minimum drag speed, minimum power speed; Aerodynamic relationships for a parabolic drag polar.

**MODULE -II**

**CRUISE PERFORMANCE**

Classes: 08

Maximum and minimum speeds in level flight; Range and endurance with thrust production, and power producing engines; Cruise techniques: constant angle of attack, constant mach number; constant altitude, methods- comparison of performance. The effect of weight, altitude and temperature on cruise performance; Cruise performance with mixed power-Plants.

**MODULE -III**

**CLIMB AND DECENT PERFORMANCE**

Classes: 10

Importance of Climb and descent performance. Climb and descent technique generalized performance analysis for thrust producing, power producing and mixed power plants, maximum climb gradient, and climb rate.


**MODULE -IV**

**AIRCRAFT MANOEUVRE PERFORMANCE**

Classes: 09

Lateral maneuvers- turn performance- turn rates, turn radius- limiting factors for turning performance. Instantaneous turn and sustained turns, specific excess power, energy turns. Longitudinal aircraft maneuvers, the pull-up, maneuvers. The maneuver envelope (V-n diagram), Significance. Maneuver boundaries and limitations, Maneuver performance of military Aircraft, transport Aircraft.

**MODULE -V**

**SAFETY REQUIREMENTS -TAKEOFF AND LANDING PERFORMANCE AND FLIGHT PLANNING**

Classes: 08

Estimation of takeoff distances. The effect on the takeoff distance of weight wind, runway conditions, ground effect. Takeoff performance safety factors. Estimation of landing distances. The discontinued landing, Baulk landing, air safety procedures and requirements on performance. Fuel planning fuel requirement, trip fuel,
Environment effects, reserve, and tinkering.

**Text Books:**


**Reference Books:**


**Web References:**

5. www.nptel.ac.in/courses/101106041/

**E-Text Books:**


**Course Home Page:**
**AERODYNAMICS**

**IV Semester: AE**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
<th>Credits</th>
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</table>

Contact Classes: 45  Tutorial Classes: 15  Practical Classes: Nil  Total Classes: 60

**OBJECTIVES:**
The course should enable the students to:
I. Understand the basics of aerodynamics, aerofoil and wing characteristics
II. Calculate forces and moments acting on aerofoils and wings under ideal flow conditions.
III. Design a propeller and determine aerodynamic interaction effects between different components of aircraft.

**MODULE -I**  **INTRODUCTORY TOPICS FOR AERODYNAMICS**  Classes: 09

**MODULE -II**  **THIN AEROFOIL THEORY**  Classes: 09
Aerofoil nomenclature, aerodynamic characteristics, centre of pressure and aerodynamic centre; Wing of infinite aspect ratio, $C_L-\alpha$- diagram for a wing of infinite aspect ratio, generation of lift, starting Vortex, Kutta’s trailing edge condition; Thin aerofoil theory; Elements of panel method; High lift airfoils, High lift devices.

**MODULE -III**  **FINITE WING THEORY**  Classes: 12
Vortex motions, vortex line, vortex tube, vortex sheet; Circulation; Kelvin and Helmholtz theorem; Biot-Savart’s law, applications, Rankine’s vortex; Flow past finite wings, vortex model of the wing and bound vortices; Induced drag; Prandtl’s lifting line theory; Elliptic wing.
Influence of taper and twist applied to wings, effect of sweep back wings; Delta wings, primary and secondary vortex; Elements of lifting surface theory. Source Panel Vortex panel and Vortex lattice methods.

**MODULE -IV**  **FLOW PAST NON-LIFTING BODIES AND INTERFERENCE EFFECTS**  Classes: 08
Flow past non lifting bodies, method of singularities; Wing-body interference; Effect of propeller on wings and bodies and tail unit; Flow over airplane as a whole.

**MODULE -V**  **BOUNDARY LAYER THEORY**  Classes: 07
Introduction to boundary layer, laminar and turbulent boundary layer, transition, boundary layer on flat plate, displacement thickness, momentum thickness, energy thickness, effect of curvature, temperature boundary layer.

**Text Books:**

**Reference Books:**
### Web References:


### E-Text Books:

AEROSPACE STRUCTURES LABORATORY

IV Semester: AE

<table>
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<tr>
<th>Course Code</th>
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<td>30 70 100</td>
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</table>

Contact Classes: Nil  Tutorial Classes: Nil  Practical Classes: 36  Total Classes: 36

OBJECTIVES:
The course should enable the students to:
I. Provide basic knowledge on the mechanical behavior of materials like aluminum, mild steel, and cast iron.
II. Visualize the crack detection using various NDT methods and also discuss the changing strength due to these defects.
III. Understand the concept of locating the shear centre for open and closed section of beams.
IV. Obtain buckling strength of both long and short columns using different elastic supports.

LIST OF EXPERIMENTS

Week-1  DIRECT TENSION TEST
Tensile testing using UTM, mechanical and optical extensometers, stress strain curves and strength test or various engineering materials.

Week-2  DEFLECTION TEST
Stress and deflections of beams for various end conditions, verification of Maxwell’s theorem

Week-3  BUCKLING TEST
Compression tests on long columns, Critical buckling loads.

Week-4  BUCKLING TEST
Compression tests on short columns, Critical buckling loads, south well plot.

Week-5  BENDING TEST
Unsymmetrical Bending of a Beam.

Week-6  SHEAR CENTRE FOR OPEN SECTION
Shear Centre of an open Section beam.

Week-7  SHEAR CENTRE FOR CLOSED SECTION
Shear Centre of a closed Section beam.

Week-8  WAGNER’S THEOREM
Wagner beam – Tension field beam.

Week-9  SANDWICH PANEL TENSION TEST
Fabrication and determine the young’s modulus of a sandwich structures.

Week-10  NON-DESTRUCTIVE TESTING
Study of non-destructive testing procedures using dye penetration,
<table>
<thead>
<tr>
<th>Week-11</th>
<th>NON-DESTRUCTIVE TESTING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Magnetic particle inspection and ultrasonic techniques.</td>
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<table>
<thead>
<tr>
<th>Week-12</th>
<th>VIBRATION TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Determination of natural frequency of beams under free and forced vibration using.</td>
</tr>
</tbody>
</table>

**Reference Books:**


**Web References:**

1. [http://nptel.ac.in/courses/112101095/](http://nptel.ac.in/courses/112101095/)
AERODYNAMICS AND PROPULSIONLABORATORY

IV Semester: AE

<table>
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</table>

Contact Classes: Nil   Tutorial Classes: Nil   Practical Classes: 24   Total Classes: 24

OBJECTIVES:
The course should enable the students to:
I. Understand the behavior of flow properties over different models using subsonic wind tunnel.
II. Demonstrate experimentally the pressure distribution over circular, symmetric and cambered airfoils and evaluate lift and drag.
III. Illustrate flow visualization studies at low speeds over different aerodynamic bodies.
IV. Understand the basics of propulsion, working principles of reciprocating engines, performance estimation based on rotation angles, and components of engine and their functions
V. Knowledge about the operation of valves, ports and their functioning in four stroke and two stroke engines.
VI. Calculation of percentage of carbon residue and flash and fire point temperatures of a Lubricating Oil.

LIST OF EXPERIMENTS

Week-1  CALIBRATION AND PRESSURE DISTRIBUTION-CYLINDER
Calibration of subsonic wind tunnel. Pressure distribution over cylinder.

Week-2  PRESSURE DISTRIBUTION AND FLOW VISUALIZATION -SYMmetric, CAMErBed AIRFOIL
Pressure distribution and flow visualization over symmetric, cambered airfoil

Week-3  FORCE MEASUREMENT
Force measurement using wind tunnel balance.

Week-4  WAKE ANALYSIS
Wake analysis over a cylinder and airfoils

Week-5  FLOW OVER A FLAT PLATE
Flow over a flat plate

Week-6  BLOWER TEST RIG
Efficiency of blower test rig for 3 different vane settings.

Week-7  GAS TURBINE PARAMETERS CALCULATION
Calculation of work, power and Thrust requirement in gas turbine- combustion power input, work heat relationship.

Week-8  GAS TURBINE EFFICIENCY AND PERFORMANCE DIAGRAMS
Elucidate T-S, H-S diagrams for the gas turbine and compare efficiencies of non-ideal engine components.

Week-9  GAS TURBINE EFFICIENCY CALCULATIONS
Calculation of thermal, propulsive and overall efficiency of turbo jet cycle.
<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week-10</td>
<td><strong>NOZZEL PERFORMANCE</strong></td>
<td>Calculation of various nozzle performance with airflow</td>
</tr>
<tr>
<td>Week-11</td>
<td><strong>CALORIFIC VALUE OF DIFFERENT FUELS</strong></td>
<td>Calculation of calorific value of different fuels and materials using digital bomb calorimeter and optimizing astute fuels</td>
</tr>
<tr>
<td>Week-12</td>
<td><strong>PROPELLER TEST RIG</strong></td>
<td>Calculation of propeller efficiency and thrust availability using propeller test rig at various blade pitch angles.</td>
</tr>
</tbody>
</table>

**Reference Books:**

**Web References:**
1. www.loc.gov/rr/scitech/tracer-bullets/aerodynamicstb.html
2. www.myopencourses.com/subject/aerodynamics-2
DATA STRUCTURES LABORATORY

III SEMESTER: ME / CSE / IT / ECE / CE | IV SEMESTER: AE / EEE

<table>
<thead>
<tr>
<th>Course Code</th>
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<td>30 70  100</td>
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Contact Classes: Nil  Tutorial Classes: Nil  Practical Classes: 36  Total Classes: 36

OBJECTIVES:
The course should enable the students to:
I. Understand various data representation techniques in the real world.
II. Implement linear and non-linear data structures.
III. Analyze various algorithms based on their time and space complexity.
IV. Develop real-time applications using suitable data structure.
V. Identify suitable data structure to solve various computing problems.

LIST OF EXPERIMENTS

WEEK-1  SEARCHING TECHNIQUES
Write Python programs for implementing the following searching techniques.
   a. Linear search
   b. Binary search
   c. Fibonacci search

WEEK-2  SORTING TECHNIQUES
Write Python programs for implementing the following sorting techniques to arrange a list of integers in ascending order.
   a. Bubble sort
   b. Insertion sort
   c. Selection sort

WEEK-3  SORTING TECHNIQUES
Write Python programs for implementing the following sorting techniques to arrange a list of integers in ascending order.
   a. Quick sort
   b. Merge sort

WEEK-4  IMPLEMENTATION OF STACK AND QUEUE
Write Python programs to
   a. Design and implement Stack and its operations using list.
   b. Design and implement Queue and its operations using list.

WEEK-5  APPLICATIONS OF STACK
Write Python programs for the following:
   a. Uses Stack operations to convert infix expression into postfix expression.
   b. Uses Stack operations for evaluating the postfix expression.

WEEK6  IMPLEMENTATION OF SINGLE LINKED LIST
a. Write Python programs for the following operations on Single Linked List.
   (i) Creation
   (ii) Insertion
   (iii) Deletion
   (iv) Traversal
b. To store a polynomial expression in memory using single linked list.

<table>
<thead>
<tr>
<th>WEEK-7</th>
<th>IMPLEMENTATION OF CIRCULAR SINGLE LINKED LIST</th>
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<tbody>
<tr>
<td>Write Python programs for the following operations on circular linked list.</td>
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<tr>
<td>(i) Creation</td>
<td></td>
</tr>
<tr>
<td>(ii) Insertion</td>
<td></td>
</tr>
<tr>
<td>(iii) Deletion</td>
<td></td>
</tr>
<tr>
<td>(iv) Traversal</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WEEK-8</th>
<th>IMPLEMENTATION OF DOUBLE LINKED LIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write Python programs for the following:</td>
<td></td>
</tr>
<tr>
<td>Uses functions to perform the following operations on Double Linked List.</td>
<td></td>
</tr>
<tr>
<td>(i) Creation</td>
<td></td>
</tr>
<tr>
<td>(ii) Insertion</td>
<td></td>
</tr>
<tr>
<td>(iii) Deletion</td>
<td></td>
</tr>
<tr>
<td>(iv) Traversal in both ways.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WEEK-9</th>
<th>IMPLEMENTATION OF STACK USING LINKED LIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write a Python program to implement Stack using linked list.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WEEK-10</th>
<th>IMPLEMENTATION OF QUEUE USING LINKED LIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write a Python program to implement Linear Queue using linked list.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WEEK-11</th>
<th>GRAPH TRAVERSAL TECHNIQUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write Python programs to implement the following graph traversal algorithms:</td>
<td></td>
</tr>
<tr>
<td>a. Depth first search.</td>
<td></td>
</tr>
<tr>
<td>b. Breadth first search.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WEEK-12</th>
<th>IMPLEMENTATION OF BINARY SEARCH TREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write a Python program to perform the following:</td>
<td></td>
</tr>
<tr>
<td>a. Create a binary search tree.</td>
<td></td>
</tr>
<tr>
<td>b. Traverse the above binary search tree recursively in pre-order, post-order and in-order.</td>
<td></td>
</tr>
<tr>
<td>c. Count the number of nodes in the binary search tree.</td>
<td></td>
</tr>
</tbody>
</table>

**LIST OF REFERENCE BOOKS:**


**WEB REFERENCES:**
1. https://docs.python.org/3/tutorial/datastructures.html
OBJECTIVES:
The course should enable the students to:
I. Illustrate concept of stability and application to dynamic systems like Aircraft, and the role of primary controls and secondary controls in longitudinal stability.
II. Understand the concept of slide slip angle, roll angle and yaw angle their concepts related to lateral-directional stability.
III. Learn about the mathematical modeling of an aircraft in longitudinal, lateral and directional cases.
IV. Estimate the longitudinal and directional parameters with the help of the linearized equations of aircraft motion.
V. Analyze the different type of modes in longitudinal, lateral and directional motion of aircraft, and recovery from those modes.

MODULE-I  INTRODUCTION AND LONGITUDINAL STABILITY-I
Classes: 10


MODULE-II  LATERAL-DIRECTIONAL STATIC STABILITY
Classes: 09

Introduction to lateral-direction stability- aerodynamic forces and moments, aircraft side force due to side slip, aircraft rolling moment due to side slip, and aircraft yawing moment due to side slip. Aircraft component contribution, directional static stability, Aircraft component contribution for lateral-directional stability, rudder requirements.

MODULE-III  AIRCRAFT EQUATION OF MOTION
Classes: 10


Components of aerodynamic, gravity forces, moments applied on flight vehicle. Equations of motion-longitudinal and lateral-directional (No Derivation).Relation between angular velocity components and Euler angle rates. Determination of velocities of airplane in earth axis system.

MODULE-IV  LINEARIZATION OF EQUATIONS OF MOTION AND AERODYNAMIC FORCES AND MOMENTS DERIVATIVES
Classes: 09

Description of state of motion of vehicle, forces and moments as perturbations over prescribed reference flight condition. Equation of motion in perturbation variables. Assumption of small perturbations, first order approximations-linearization equations of motion. Linearised of force and moment equation, of motion,
Linearised longitudinal and lateral-directional equations of perturbed motion. Significance of aerodynamic derivatives. Derivatives of axial, normal force components and pitching moment with respect to the velocity, angle of attack, angle of attack rate, pitch rate, elevator angle (No derivation only concept).

<table>
<thead>
<tr>
<th>MODULE-V</th>
<th>AIRCRAFT DYNAMIC STABILITY</th>
<th>Classes: 07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principle modes of motion characteristics, mode shapes and significance, time constant, undamped natural frequency and damping ratio- mode shapes- significance. One degree of freedom, two degree of freedom approximations- constant speed (short period), constant angle of attack (long period) approximations- solutions. Determination of longitudinal and lateral stability from coefficients of characteristic equation- stability and lateral stability from coefficients of characteristics equation- stability criteria, Aircraft spin- entry, balance of forces in steady spin, recovery, pilot techniques.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Text Books:**


**Reference Books:**


**Web References:**

2. www.nptel.ac.in/courses/101106043/
3. www.nptel.ac.in/courses/101106042/

**E-Text Books:**

2. www.books.google.co.in/books?isbn=1600860788
ANALYSIS OF AIRCRAFT STRUCTURES

V Semester: AE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
<th>Credits</th>
<th>Maximum Marks</th>
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<td></td>
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<td>2 1 - 3 30</td>
<td>70</td>
<td>100</td>
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</table>

Contact Classes: 30  Tutorial Classes: 15  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Understand the aircraft structural components and its behavior under different loading conditions.
II. Obtain knowledge in plate buckling and structural instability of stiffened panels for airframe structural analysis.
III. Explain the thin walled section and structural idealization of panels and differentiate from the type of loads carried.
IV. Solve for stresses and deflection in aircraft structures like fuselage, wing and landing gear.

MODULE - I  INTRODUCTION TO AIRCRAFT STRUCTURAL COMPONENTS AND ENERGY METHODS  Classes: 10
Aircraft Structural components and loads, functions of structural components, airframe loads; Types of structural joints, type of loads on structural joints; Aircraft inertia loads; Symmetric manoeuvre loads, gust loads. Monocoque and semi monocoque structures, stress in thin and thick shells; Introductions to energy principles, castiglianos theorems, maxiwells reciprocal theorem, unit load method, Rayleigh Ritz method, total potential energy method, flexibility method.

MODULE - II  THIN PLATE THEORY, STRUCTURAL INSTABILITY  Classes: 09
Analysis of thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading: Thin plates having small initial curvature, energy methods of analysis. Buckling of thin plates: Elastic, inelastic, experimental determination of critical load for a flat plate, local instability, instability of stiffened panels, failure stresses in plates and stiffened panels. Tension field beams-complete diagonal tension, incomplete diagonal tension, post buckling behavior.

MODULE - III  BENDING, SHEAR AND TORSION OF THIN WALLED BEAMS  Classes: 10
Unsymmetrical bending: Resolution of bending moments, direct stress distribution, position of neutral axis; Deflections due to bending: Approximations for thin walled sections, temperature effects; Shear loaded thin walled beams: General stress, strain and displacement relationships, direct stress and shear flow system, shear centre, twist and warping.
Torsion of beams of closed section: Displacements associated with Breit-Batho shear flow; Torsion of open section beams; Warping of cross section, conditions for zero warping; Bending, shear, torsion of combined open and closed section beams.

MODULE - IV  STRUCTURAL IDEALIZATION  Classes: 08
Structural idealization: Principal assumptions, idealization of panel, effect on the analysis of thin walled beams under bending, shear, torsion loading- application to determining deflection of open and closed section beams. Fuselage frames - bending, shear and torsion.

MODULE - V  ANALYSIS OF FUSELAGE, WING AND LANDING GEAR  Classes: 08
Wing spar and box beams, tapered wing spar, open and closed sections beams, beams having variable stringer areas; wings – three boom shell in bending, torsion and shear, tapered wings, deflections, cutouts in wings; Cutouts in fuselages; Fuselage frame and wing rib; principle of stiffener, web constructions. Landing gear and
types; Analysis of landing gear.

**Text Books:**


**Reference Books:**


**Web References:**

1. https://nptel.ac.in/courses/112101095/

**E-Text Books:**

2. https://docs.google.com/file/d/0Bw8MfqmgWLS4RIINqaE1oUzdOajQ/view?pref=2&pli=1
# HIGH SPEED AERODYNAMICS

## V Semester: AE

<table>
<thead>
<tr>
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Contact Classes: 30  Tutorial Classes: 15  Practical Classes: Nil  Total Classes: 45

### OBJECTIVES:
The course should enable the students to:

I. Understand the effect of compressibility at high-speeds and the ability to make intelligent design decisions.

II. Explain the dynamics in subsonic, transonic and supersonic flow regimes in both internal and external geometries.

III. Analyze the airfoils at subsonic, transonic and supersonic flight conditions using the perturbed flow theory assumption.

IV. Formulate appropriate aerodynamic models to predict the forces and performance of realistic three-dimensional configurations.

<table>
<thead>
<tr>
<th>MODULE-I</th>
<th>INTRODUCTION TO COMPRESSIBLE FLOWS</th>
<th>Classes: 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic concepts: Introduction to compressible flow, brief review of thermodynamics and fluid mechanics, integral forms of conservation equations, differential conservation equations, continuum postulates, acoustic speed and mach number, governing equations for compressible flows.</td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>MODULE-II</th>
<th>SHOCK AND EXPANSION WAVES</th>
<th>Classes: 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shocks and expansion waves: Development of governing equations for normal shock, stationery and moving normal shock waves, applications to aircrafts, supersonic wind tunnel, shock tubes, shock polars, supersonic pitot probes; oblique shocks, governing equations, reflection of shock, Prandtl-Meyer expansion flow, shock expansion method for flow over airfoil, introduction to shock wave boundary layer interaction.</td>
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</table>

<table>
<thead>
<tr>
<th>MODULE-III</th>
<th>ONE DIMENSIONAL AND QUASI ONE DIMENSIONAL FLOW</th>
<th>Classes: 08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quasi one dimensional flow: Isentropic flow in nozzles, area Mach relations, choked flow, under and over expanded nozzles, slip stream line. One dimensional flow: Flow in constant area duct with friction and heat transfer, Fanno flow and Rayleigh flow, flow tables and charts for Fanno flow and Rayleigh flow.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>MODULE-IV</th>
<th>APPLICATIONS OF COMPRESSIBLE FLOWS AND NUMERICAL TECHNIQUES</th>
<th>Classes: 08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small perturbation equations for subsonic, transonic, supersonic and hypersonic flow; Experimental characteristics of airfoils in compressible flow, supercritical airfoils, area rule; Theory of characteristics, determination of the characteristic lines and compatibility equations, supersonic nozzle design using method of characteristics.</td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>MODULE-V</th>
<th>EXPERIMENTAL METHODS IN COMPRESSIBLE FLOWS</th>
<th>Classes: 09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental methods: Subsonic wind tunnels, supersonic wind tunnels, shock tunnels, free-piston shock tunnel, detonation-driven shock tunnels, and expansion tubes and characteristic features, their operation and performance, flow visualization techniques for compressible flows.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Text Books :


## Reference Books:


## Web References:

2. https://www.uvm.edu/~dhitt/me346/?Page=exams.html

## E-Text Books:

1. https://www3.nd.edu/~powers/ame.30332/notes.pdf
## AIRCRAFT PRODUCTION TECHNOLOGY

### V Semester: AE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
<th>Credits</th>
<th>Maximum Marks</th>
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<td>3 - - 3 30 70 100</td>
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</table>

- **Contact Classes:** 45  
- **Tutorial Classes:** Nil  
- **Practical Classes:** Nil  
- **Total Classes:** 45

### OBJECTIVES:
**The course should enable the students to:**

I. Study the composition of microstructures of metals and alloys with their applications in aerospace industry.

II. Discuss the various manufacturing processes and selection of process for suitable applications.

III. Understand the working principles and applications of conventional and unconventional machining along with their advantages and disadvantages.

IV. Demonstrate the importance of composites with their applications in different areas of aerospace industry.

### MODULE-I  AIRCRAFT ENGINEERING MATERIALS  Classes: 09

Engineering materials  

### MODULE-II  CASTING, WELDING AND INSPECTION TECHNIQUES  Classes: 09

General principles of various casting processes  
- Sand casting, die-casting, centrifugal casting, investment casting, Shell molding types; Principles and equipment used in arc welding, gas welding, resistance welding, solid, laser welding, and electron beam welding, soldering and brazing techniques. Need for NDT, ultrasonic testing and Radiographic testing.

### MODULE-III  SHEET METAL PROCESSES IN AIRCRAFT INDUSTRY  Classes: 09

Sheet metal operations: shearing, punching, super plastic forming; operations in bending like stretch forming spinning drawing.

Riveting, types and techniques, equipment, fasteners, integral tanks, final assembly of aircraft, Jigs and Fixtures, stages of assembly, aircraft tooling concepts.

### MODULE-IV  CONVENTIONAL AND UNCONVENTIONAL MACHINING PROCESSES  Classes: 09

General working principles, applications and operations of lathe, shaper, milling machines, grinding, drilling machine, computer numeric control machining.

Working principles and applications of abrasive jet machining, ultrasonic machining, Electric discharge machining and electro chemical machining, laser beam, electron beam, plasma arc machining.

### MODULE-V  AIRCRAFT COMPOSITES  Classes: 09

Production of semi-fabricated forms, Aerospace applications, Plastics and rubber, Introduction to fiber reinforced plastics, glass and carbon composites; Fibers and resins; Characteristics and applications, Classification of aircraft materials; Materials used for aircraft components, Application of composite materials, Super alloys, indigenized alloys, emerging trends in aerospace materials.
### Text Books:


### Reference Books:


### Web References:

1. https://nptel.ac.in/courses/112107145/
2. https://nptel.ac.in/courses/112105126/

### E-Text Books:

1. https://books.google.co.in/books?id=6wFuw6uwfTMC&redir_esc
## COMPUTER AIDED DESIGN LABORATORY

![Table]

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
<th>Credits</th>
<th>Maximum Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAEB17</td>
<td>Core</td>
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<td></td>
<td>- - 2 1 30 70 100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Contact Classes:** Nil  
**Tutorial Classes:** Nil  
**Practical Classes:** 36  
**Total Classes:** 36

### OBJECTIVES:
The course should enable the students to:

I. Learn the concepts and various tools used in design module
II. Understand the design of typical Engineering components and assembly.
III. Knowledge in the design of typical aircraft components.

### LIST OF EXPERIMENTS

**Week-1**  
**SKETCHER**  
Interface, Sketch Tools, View Tool bar, Profile Tool bar, Operation Tool bar, Tools, Constrain tool bar, Transformation Tool bar, User Selection Filter, Standards, Visualizations.

**Week-2**  
**PART DESIGN**  
Sketch Based Features Dress up Features, Transformation Features, Reference Elements, Measure, Thickness, Boolean Operations.

**Week-3**  
**SHEET METAL DESIGN**  
Walls, Cutting and Stamping, Bending, Rolled Walls.

**Week-4**  
**SURFACE DESIGN**  
Surfacer, Operations, Wireframe, Replication.

**Week-5**  
**ASSEMBLY**  
Product Structure Tools, Constrains.

**Week-6**  
**GD&T**  
Introduction to Geometric Dimensioning and Tolerance, Weld Symbols, GD&T Symbols, Types of Tolerances, Types of views, Roughness Symbols.

**Week-7**  
**DRAFTING**  
Views, Annotations, Sheet Background.

**Week-8**  
**DESIGN OF AIRCRAFT WING**  
Design of any two types of Aircraft structures

**Week-9**  
**DESIGN OF FUSELAGE**  
Design of fuselage with internal components

**Week-10**  
**DESIGN OF NOSE CONE**  
Design of Nose cone structures

**Week-11**  
**DESIGN OF LANDING GEAR**  
Design of Main landing gear and nose landing gear

**Week-12**  
**REVISION**  
Revision

### Reference Books:
# OBJECTIVES:

The course should enable the students to:

I. Understand the basic material properties to identify the suitable applications in aerospace industries.

II. Illustrate other conventional machining techniques required for aircraft production.

III. Learn the tooling and material joining technique used in aircraft assembly.

## LIST OF EXPERIMENTS

<table>
<thead>
<tr>
<th>Week</th>
<th>Course Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BASIC METALLURGY -I</td>
<td>Preparation and study of microstructure of pure materials like Cu and Al. Hardenability of steels by Jominy End Quench test</td>
</tr>
<tr>
<td>3</td>
<td>LATHE OPERATIONS -I</td>
<td>Introduction- lathe machine, plain turning, Step turning &amp; grooving.</td>
</tr>
<tr>
<td>4</td>
<td>LATHE OPERATIONS -II</td>
<td>Taper turning-compound rest/offset method &amp; Drilling using lathe, External threading-Single start</td>
</tr>
<tr>
<td>5</td>
<td>SHAPING &amp; SLOTTING</td>
<td>Shaping-V-Block &amp; Slotting-Keyways.</td>
</tr>
<tr>
<td>6</td>
<td>MILLING</td>
<td>Milling-Face milling, End milling and Side milling</td>
</tr>
<tr>
<td>7</td>
<td>GRINDING</td>
<td>Grinding-Cylindrical /Surface/Tool &amp; cutter.</td>
</tr>
<tr>
<td>8</td>
<td>DRILLING</td>
<td>Drilling, reaming, counter boring, Counter sinking Taping.</td>
</tr>
<tr>
<td>9</td>
<td>WELDING PROCESSES I</td>
<td>Gas Welding, Brazing and Soldering.</td>
</tr>
<tr>
<td>10</td>
<td>WELDING PROCESS II</td>
<td>Arc welding. Spot welding and TIG welding.</td>
</tr>
<tr>
<td>11</td>
<td>BASIC CASTING</td>
<td>Preparation of casting with simple patterns.</td>
</tr>
<tr>
<td>12</td>
<td>RIVETING ALUMINUM SHEETS</td>
<td>Solid and Blind Rivets on aluminum sheets.</td>
</tr>
</tbody>
</table>
**Reference Books:**


**Web References:**

1. https://nptel.ac.in/courses/112107145/
2. https://nptel.ac.in/courses/112105126/
FINITE ELEMENT ANALYSIS

VI Semester: AE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
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</table>

Contact Classes: 30  Tutorial Classes: 15  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Understand the theoretical basics of governing equations and convergence criteria of finite element method.
II. Use the commercial Finite Element packages to build Finite Element models and solve a selected range of engineering problems.
III. Discuss the approximate Finite Element Solutions for the various field problems.

MODULE I  INTRODUCTION

MODULE II  ANALYSIS OF TRUSSES AND BEAMS
Analysis of Trusses: Stiffness matrix for plane Truss Elements, stress calculations and problems. Analysis of beams: Element stiffness matrix for two noded, two degrees of freedom per node beam element and simple problems.

MODULE III  CONTINUUM ELEMENTS
Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Estimation of load vector and stresses. Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements Two dimensional four nodedisoparametric elements and problems.

MODULE IV  STEADY STATE HEAT TRANSFER ANALYSIS
Steady state Heat Transfer Analysis: one dimensional analysis of slab, fin and two dimensional analysis of thin plate. Analysis of a uniform shaft subjected to torsion.

MODULE V  DYNAMIC ANALYSIS
Dynamic Analysis: Formulation of finite element model, element –Mass matrices, evaluation of Eigen values and Eigen Vectors for a stepped bar, truss. Finite element-formulation to 3D problems in stress analysis, convergence requirements, mesh generation, techniques such as semi automatic and fully automatic use of software such as ANSYS, NISA, NASTRAN etc.
### Text Books:


### Reference Books:


### Web References:

1. [www.home.iitk.ac.in/~sbasu/me623_2006/fem_notes_me623.pdf](http://www.home.iitk.ac.in/~sbasu/me623_2006/fem_notes_me623.pdf)
2. [www.nptel.ac.in/courses/112104116/](http://www.nptel.ac.in/courses/112104116/)
3. [www.me.berkeley.edu/~lwlin/me128/FEMNotes.pdf](http://www.me.berkeley.edu/~lwlin/me128/FEMNotes.pdf)

### E-Text Books:

2. [www.books.google.co.in/books/about/Finite_Element_Analysis_For_Engineering.html](http://www.books.google.co.in/books/about/Finite_Element_Analysis_For_Engineering.html)
COMPUTATIONAL AERODYNAMICS

VI Semester: AE

<table>
<thead>
<tr>
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<th>Category</th>
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</table>

Contact Classes: 30  Tutorial Classes: 15  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Discuss the fundamental aspects of numerical discretization and the major theories, approaches and methodologies used in computational aerodynamics.
II. Analyze to build up the skills in the actual implementation of computational aerodynamics methods boundary conditions, turbulence modeling etc by using commercial CFD codes.
III. Demonstrate the applications of CFD for classic fluid dynamics problems and basic thoughts and philosophy associated with CFD.
IV. Understand the various grids used in practice, including some recommendations related to grid quality and choose appropriate data structure to solve problems in real world.

MODULE-I  INTRODUCTION TO COMPUTATIONAL AERODYNAMICS  Classes: 09

Need of computational fluid dynamics, philosophy of CFD, CFD as a research tool as a design tool, applications in various branches of engineering, models of fluid flow finite control volume, infinitesimal fluid element, substantial derivative physical meaning of divergence of velocity, derivation of continuity, momentum and energy equations, physical boundary conditions significance of conservation and non-conservation forms and their implication on CFD applications strong and weak conservation forms shock capturing and shock fitting approaches.

MODULE-II  MATHEMATICAL BEHAVIOR OF PARTIAL DIFFERENTIAL EQUATIONS AND THEIR IMPACT ON COMPUTATIONAL AERODYNAMICS  Classes: 09

Classification of quasi-linear partial differential equations by Cramer’s rule and Eigen value method, general behavior of different classes of partial differential equations and their importance in understanding physical and CFD aspects of aerodynamic problems at different Mach numbers involving hyperbolic, parabolic and elliptic equations: domain of dependence and range of influence for hyperbolic equations, well-posed problems.

MODULE-III  BASIC ASPECTS OF DISCRETIZATION  Classes: 09

Introduction to finite difference: finite difference approximation for first order, second order and mixed derivatives, explicit and implicit approaches, truncation and round-off errors, consistency, stability, accuracy, convergence, efficiency of numerical solutions. Von Neumann stability analysis, physical significance of CFL stability condition.

Need for grid generation, structured grids artesian grids, stretched (compressed) grids, body fitted structured grids, H-mesh, C-mesh, O-mesh, I-mesh, multi-block grids, C-H mesh, H-O-H mesh, overset grids, adaptive grids, unstructured grids: triangular, tetrahedral cells, hybrid grids, quadrilateral, hexahedral cells.

MODULE-IV  CFD TECHNIQUES  Classes: 09

Lax-Wendroff technique, MacCormack’s technique, Crank Nicholson technique, Relaxation technique, aspects of numerical dissipation and dispersion. Alternating-Direction-Implicit (ADI) Technique, pressure correction
technique: application to incompressible viscous flow, need for staggered grid. Philosophy of pressure correction method, pressure correction formula. Numerical procedures: SIMPLE, SIMPLER, SIMPLEC and PISO algorithms, boundary conditions for the pressure correction method.

<table>
<thead>
<tr>
<th>MODULE-V</th>
<th>FINITE VOLUME METHODS</th>
<th>Classes: 09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basis of finite volume method, conditions on the finite volume selections, cell-centered and cell vertex approaches. Definition of finite volume discretization, general formulation of a numerical scheme, two dimensional finite volume method with example.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Text Books:**


**Reference Books:**


**Web References:**


**E-Text Books:**

2. https://www.topajka-shaw.co.nz/UCFD.htm
# AIRCRAFT SYSTEMS

## VI Semester: AE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
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<tr>
<th>Contact Classes: 45</th>
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</table>

## OBJECTIVES:
The course should enable the students to:

I. Understand the concept and meaning of system and classify the various systems required for aircraft and their contribution in order to fulfill the aircraft tasks.

II. Describe the various types of Electrical power generations and distribution in aircraft.

III. Impart the knowledge of pneumatic, hydraulic and environmental control system.

IV. Demonstrate different actuators, flight control system and advanced flight actuation system.

## MODULE-I
**INTRODUCTION TO AIRCRAFT SYSTEMS**

Classes: 10

System concepts, sub-systems; Generic system definition, inputs, outputs, feedback, external influence. Aircraft systems- airframe systems, vehicle systems, avionics systems, mission systems and their sub-systems; Specification of requirements, mission requirements, performance requirements.

## MODULE-II
**ELECTRICAL SYSTEMS AND AIR CONDITIONING, PRESSURIZING SYSTEMS**

Classes: 10

Electrical loads in aircraft. Electrical power generation and control- DC, AC- types. Power distribution- primary, secondary. Power conversion and energy storage; Load protection; Electrical load management systems, 270 V DC systems;

Basic air cycle systems; Vapour cycle systems, boost-strap air cycle system; Evaporative Vapour cycle systems;

Evaporative air cycle systems; Oxygen systems; deicing and anti-icing systems.

## MODULE-III
**HYDRAULIC SYSTEMS AND PNEUMATIC SYSTEMS**

Classes: 09

Hydraulic systems: function, merits, application, system loads, design requirements; Principal components;

Hydraulic fluid: required properties; Hydraulic piping, pumps, reservoir, accumulator;

Pneumatic systems ; Advantages;- Working principles ; Typical air pressure system ; Brake system; Typical pneumatic power system ; Components, landing gear systems ; Landing gear and brake management systems.

## MODULE-IV
**ENGINE CONTROL AND FUEL SYSTEMS**

Classes: 08

Principle of operation of aircraft gas turbine engines; Engine - airframe interfaces; Control of fuel flow, air flow, Limited authority control systems, full authority control systems- examples; Power off takes- need, types; Fuel systems- characteristics, components, operating modes; Fuel tank safety- fuel inserting system.

## MODULE-V
**AIRPLANE CONTROL SYSTEMS**

Classes: 08

Flight control systems- primary and secondary flight control conventional systems; Power assisted and fully powered flight controls ; Power actuated systems; Engine control systems; Push pull rod system, flexible push full rod system; Control linkages, actuation- types, description and redundancy. Components; Modern control systems; Digital fly by wire systems, control laws, implementation; Auto pilot system.
### Text Books:

### Reference Books:

### Web References:
1. https://www.aircraftsystemscomjet.com/

### E-Text Books:
1. https://www.amazon.in/Aircraft-Systems-Mechanical-ElectricalIntegration/dp/0470059966
VI Semester: AE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
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</table>

Contact Classes: Nil  
Tutorial Classes: Nil  
Practical Classes: 24  
Total Classes: 24

OBJECTIVES:
The course should enable the students to:
I. Experience in computing aerodynamic problems and understanding flow physics over the objects.
II. Knowledge in estimating flow characteristics of different geometries.
III. Determining the aerodynamic forces like lift, drag and visualize shock formation over different geometries.
IV. Analyze the errors and cause of errors in computational analysis.

LIST OF EXPERIMENTS

Week-1 | INTRODUCTION
Introduction to computational aerodynamics, the major theories, approaches and methodologies used in computational aerodynamics. Applications of computational aerodynamics for classical aerodynamic’s problems.

Week-2 | INTRODUCTION TO ICEM CFD
Introduction to ICEM CFD, geometry creation, suitable meshing types and boundary conditions.

Week-3 | INTRODUCTION TO FLUENT
Introduction to fluent, boundary conditions, solver conditions and post processing results.

Week-4 | FLOW OVER A FLAT PLATE
Flow over a flat plate at low Reynolds numbers, observe the boundary layer phenomena, no slip condition and velocity profile inside the boundary layer.

Week-5 | FLOW THROUGH PIPE
Flow through pipe at different Reynolds numbers; observe the velocity changes for laminar and turbulent flows.

Week-6 | FLOW OVER A CIRCULAR CYLINDER
Flow over a circular cylinder at different Reynolds numbers, observe the properties at separation region and wake region.

Week-7 | FLOW OVER A CAMBERED AEROFOIL
Flow over a cambered aerofoil at different Reynolds number, observe flow properties and compare the computation results with experimental results (consider the model from aerodynamics laboratory).

Week-8 | FLOW OVER A SYMMETRIC AEROFOIL
Flow over a symmetric aerofoil at different Reynolds number, observe flow properties and compare the computation results with experimental results (consider the model from aerodynamics laboratory).

Week-9 | FLOW OVER WEDGE
Flow over wedge body at supersonic Mach number; observe the shock wave phenomena and change of properties across the shock wave.

<table>
<thead>
<tr>
<th>Week-10</th>
<th>FLOW OVER A CONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow over a cone at supersonic Mach number; observe the shock waves and 3D relieving effect.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week-11</th>
<th>CODE DEVELOPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution for the following equations using finite difference method</td>
<td></td>
</tr>
<tr>
<td>I. One dimensional wave equation using explicit method of lax.</td>
<td></td>
</tr>
<tr>
<td>II. One dimensional heat conduction equation using explicit method.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week-12</th>
<th>CODE DEVELOPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation of the following grids</td>
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</tr>
<tr>
<td>I. Algebraic grids.</td>
<td></td>
</tr>
<tr>
<td>II. Elliptic grids.</td>
<td></td>
</tr>
</tbody>
</table>

**Reference Books:**


**Web References:**

2. [https://cfd.ninja/tutorials/ansys-fluent](https://cfd.ninja/tutorials/ansys-fluent)
3. [https://confluence.cornell.edu/display/SIMULATION/FLUENT+Learning+Modules](https://confluence.cornell.edu/display/SIMULATION/FLUENT+Learning+Modules)

**Course Home Page:**
VI Semester: AE

<table>
<thead>
<tr>
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</table>

Contact Classes: Nil  Tutorial Classes: Nil  Practical Classes: 24  Total Classes: 24

OBJECTIVES:
The course should enable the students to:
I. Make the student familiar with latest computational techniques and software used for structural analysis.
II. Enable the student to get a feeling of how real-life structures behavior for static and dynamics loads.
III. Become familiar with professional and contemporary issues in the design and fabrication.

LIST OF EXPERIMENTS

Week-1  INTRODUCTION AND BASIC FUNCTIONS
a. Starting up of ANSYS/Nastran
b. Description of user interface

Week-2  STATIC ANALYSIS: TRUSS AND FRAME STRUCTURES
a. 2-D truss structures
b. 3-D truss structures

Week-3  STATIC ANALYSIS: BEAMS
a. Straight beams
b. Tapered beams

Week-4  STATIC ANALYSIS: TWO DIMENSIONAL PROBLEMS
a. 2-D structure with various loadings
b. 2-D structures with different materials
c. Plate with hole

Week-5  DYNAMIC ANALYSIS: MODAL AND TRANSIENT ANALYSES
a. Modal analysis
b. Transient Response (spring-mass system)

Week-6  THERMAL ANALYSIS
a. Bars and beams
b. 2D structures

Week-7  NON-LINEAR ANALYSIS
a. Nonlinear behavior (Large deflections)
b. Nonlinear behavior (Materials)

Week-8  HARMONIC RESPONSE ANALYSIS
a. Random Vibration Analysis of a Deep Simply-Supported Beam
b. Harmonic Response of a Spring-Mass System
<table>
<thead>
<tr>
<th>Week-9</th>
<th>ANALYSIS OF AIRCRAFT STRUCTURE: WING</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Static analysis of Aircraft wing structure</td>
</tr>
<tr>
<td>b.</td>
<td>Modal analysis of aircraft wing structure</td>
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</table>

<table>
<thead>
<tr>
<th>Week-10</th>
<th>ANALYSIS OF AIRCRAFT STRUCTURE: FUSELAGE</th>
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</thead>
<tbody>
<tr>
<td>a.</td>
<td>Static analysis of Aircraft Semi monoque fuselage structure</td>
</tr>
<tr>
<td>b.</td>
<td>Modal analysis of aircraft Semi monoque fuselage structure</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Week-11</th>
<th>ANALYSIS OF AIRCRAFT STRUCTURE: LANDING GEAR</th>
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</thead>
<tbody>
<tr>
<td>a.</td>
<td>Static analysis of main landing gear</td>
</tr>
<tr>
<td>b.</td>
<td>Modal analysis of main landing gear</td>
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</tbody>
</table>

<table>
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<tr>
<th>Week-12</th>
<th>ANALYSIS OF COMPOSITE STRUCTURES</th>
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<tbody>
<tr>
<td>a.</td>
<td>Static analysis of composite bar and beam</td>
</tr>
<tr>
<td>b.</td>
<td>Static analysis of composite plate</td>
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**Reference Books:**

## FLIGHT VEHICLE DESIGN

<table>
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<td><strong>Course Code</strong></td>
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</table>

### OBJECTIVES:
The course should enable the students to:

I. Understand the basic skills involved in weight estimation for aircraft conceptual design process.

II. Illustrate relevant theoretical knowledge, applicable for initial sizing and configuration layout of aircraft.

III. Evaluate basic techniques in literature retrieval and query, also creative and have systematic scientific research methods and working abilities.

### MODULE-I

**OVERVIEW OF THE DESIGN PROCESS**

**Classes: 10**

Phases of aircraft design, aircraft conceptual design process, project brief / request for proposal, problem definition, information retrieval, integrated product development and aircraft design.

Initial conceptual sketches, takeoff gross weight estimation, airfoil selection, airfoil design, airfoil design considerations, wing geometry and wing vertical location, wing tip shapes, tail geometry and arrangements, thrust to weight ratio, thrust matching, wing loading performance, constraint analysis.

### MODULE-II

**INITIAL SIZING AND CONFIGURATION LAYOUT**

**Classes: 09**

Sizing with fixed engine and with rubber engine. Geometry sizing of fuselage, wing, tail, control surfaces, development of configuration layout from conceptual sketch. The inboard profile drawing, lofting definition, significance and methods, flat wrap lofting, special consideration in configuration layout, Isobar tailoring, Sears-Haack volume distribution, structural load paths, radar, IR, visual detectability, aural signature, considerations of vulnerability, crashworthiness, producibility, maintainability, fuselage design, crew station, passengers and payload.

### MODULE-III

**PROPULSION, FUEL SYSTEM INTEGRATION, LANDING GEAR AND BASELINE DESIGN ANALYSIS - I**

**Classes: 10**

Propulsion selection, jet engine integration, propeller engine integration, engine design considerations, engine size estimation, fuel system design and integration, landing gear and sub systems arrangements, guidelines and significance of design layout, report of initial specifications.

Estimation of lift curve slope, maximum lift coefficient, complete drag build up, installed performance of an engine, installed thrust methodology, net propulsive force, part power operation, aircraft structures and loads categories, air load distribution on lifting surfaces, review of methods of structural analysis, material selection, weights and moments statistical group estimation method, centre of gravity excursion control.

### MODULE-IV

**BASELINE DESIGN ANALYSIS - II**

**Classes: 09**

Estimation of static pitch stability, velocity stability and trim, estimation of stability and control derivatives, static lateral, directional stability and trim. Estimation of aircraft dynamical characteristics, handling qualities, Cooper – Harper scale, relation to aircraft dynamic characteristics, performance analysis and constraint analysis – steady level flight, minimum thrust required for level flight, range and loiter endurance, steady climbing and descending flight, best angle and rate of climb, time to climb and fuel to climb, level turning flight, gliding flight, energy maneuverability methods of optimal climb trajectories and turns, the aircraft operating envelope, take off analysis, balanced field length, landing analysis, fighter performance measures of
merit, effects of wind on aircraft performance, initial technical report of baseline design analysis and evaluation, refined baseline design and report of specifications.

<table>
<thead>
<tr>
<th>MODULE-V</th>
<th>COST ESTIMATION, PARAMETRIC ANALYSIS, OPTIMISATION, REFINED SIZING AND TRADE STUDIES</th>
<th>Classes: 07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elements of life cycle cost, cost estimating method, RDT&amp;E and production costs, operation and maintenance costs, cost measures of merit, aircraft and airline economics, DOC and IOC, airline revenue, breakeven analysis, investment cost analysis, parametric analysis and optimization, improved conceptual sizing methods, sizing matrix plot and carpet plot, trade studies, design trades, requirement trades, growth sensitivities, multivariable design optimization methods, measures of merit, determination of final baseline design configuration, preparation of type specification report. case studies on design of DC-3 and Boeing B-707 &amp; 747; General dynamics F-16, SR-71 Blackbird, Northrop-Grumman B-2 Stealth Bomber</td>
<td></td>
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</tbody>
</table>

**Text Books:**


**Reference Books:**


**Web References:**


**E-Text Books:**

1. http://jntuaerobooks.blogspot.in/p/aero-3-2-books.html
2. https://uta-ir.tdl.org/uta-ir/bitstream/handle/.../WALKER_uta_2502M_12539.pdf
AEROSPACE STRUCTURAL DYNAMICS

VII SEMESTER: AE

<table>
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Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Demonstrate the knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.
II. Understand to identify, formulate and solve engineering problems. This will be accomplished by having students model, analyze and modify a vibratory structure order to achieve specified requirements.
III. Introduce to structural vibrations which may affect safety and reliability of engineering systems.
IV. Describe structural dynamic and steady and unsteady aerodynamics aspects of airframe and its components of space structures.

MODULE-I  SINGLE-DEGREE-OF-FREEDOM LINEAR SYSTEMS  Classes: 10
Introduction to theory of vibration, equation of motion, free vibration, response to harmonic excitation, response to an impulsive excitation, response to a step excitation, response to periodic excitation (Fourier series), response to a periodic excitation (Fourier transform), Laplace transform (Transfer Function).

MODULE-II  TWO-DEGREE-OF-FREEDOM SYSTEMS  Classes: 10

MODULE-III  MULTI-DEGREE-OF-FREEDOM LINEAR SYSTEMS  Classes: 08
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.

MODULE-IV  DYNAMICS OF CONTINUOUS ELASTIC BODIES  Classes: 09
Introduction, transverse vibration of a string or cable, longitudinal vibration of a bar or rod, torsional vibration of shaft or rod, lateral vibration of beams, the Rayleigh-Ritz method.

MODULE-V  INTRODUCTION TO AEROELASTICITY  Classes: 08
**Text Books:**


**Reference Books:**


**Web References:**


**E-Text Books:**

2. [https://aerocastle.files.wordpress.com/2012/10/mechanical_vibrations_5th-edition_s-s-rao.pdf](https://aerocastle.files.wordpress.com/2012/10/mechanical_vibrations_5th-edition_s-s-rao.pdf)
FLIGHT VEHICLE DESIGN LABORATORY

VII Semester: AE

<table>
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</table>

Contact Classes: Nil  Tutorial Classes: Nil  Practical Classes: 36  Total Classes: 36

OBJECTIVES:
The course should enable the students to:
I. Draw conceptual sketch of aircrafts based on client requirements such as type, role, payload, mission, aerodynamic & performance requirements.
II. Estimate total takeoff gross weight, thrust-weight ratio, wing loading parameters using data sheets.
III. Develop initial layouts for major components such as fuselage, empennage, landing gears and wings.

LIST OF EXPERIMENTS

Week-1  OBJECTIVES AND REQUIREMENTS OF THE VEHICLE
Data collection for conceptual sketch from existing aircraft includes :
- Type, Role, Mission.
- Payload
- Aerodynamic & performance requirements.

Week-2  CONCEPTUAL SKETCH AND WEIGHT ESTIMATION
- Conceptual sketch of candidate aircraft (3-view).
- First estimation of gross take-off weight with trade-off studies.

Week-3  AIRFOIL DESIGN AND CONSTRAINT ANALYSIS
- Airfoil and wing geometry selection

Week-4  CONSTRAINT ANALYSIS
- Determination of Thrust-to-Weight ratio and Wing Loading

Week-5  INITIAL SIZING-I
- Rubber engine & fixed engine sizing.

Week-6  INITIAL SIZING-II
- Configuration layout, crew station, passengers and payload

Week-7  PERFORMANCE ESTIMATIONS
- Performance constraint analysis

Week-8  LOAD ESTIMATIONS-I
- Landing gear loads

Week-9  LOAD ESTIMATIONS-II
- Propulsion system load.
<table>
<thead>
<tr>
<th>Week-10</th>
<th>COST ESTIMATION</th>
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<tbody>
<tr>
<td>a.</td>
<td>Cost estimation and parametric analysis</td>
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<td></td>
<td>b. Optimization and trade studies</td>
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<tr>
<th>Week-11</th>
<th>DESIGN CASE STUDY-I</th>
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<tbody>
<tr>
<td>a.</td>
<td>Design study of DC-3</td>
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<td>b. Design study B-747</td>
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<table>
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<tr>
<th>Week-12</th>
<th>DESIGN CASE STUDY-II</th>
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</thead>
<tbody>
<tr>
<td>a.</td>
<td>Dynamics of F-16</td>
</tr>
<tr>
<td></td>
<td>b. Dynamics of SR-71</td>
</tr>
</tbody>
</table>

**REFERENCES:**

## AEROSPACE STRUCTURAL DYNAMICS LABORATORY

### VII Semester: AE

<table>
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Contact Classes: Nil  
Tutorial Classes: Nil  
Practical Classes: 36  
Total Classes: 36

### OBJECTIVES:
The course should enable the students to:

I. Understand the basic principles of kinematics and the related terminology of machines.
II. Discriminate mobility; enumerate links and joints in the mechanisms.
III. Formulate the concept of analysis of different mechanisms. Explore the new concepts of aerodynamics propulsion and fuel system integration.

### LIST OF EXPERIMENTS

| Week-1 | GOVERNORS  
To study the function of a Governor. |
|---|---|
| Week-2 | GYROSCOPE  
To determine the Gyroscope couple. |
| Week-3 | STATIC FORCE ANALYSIS  
To draw free body diagram and determine forces under static condition. |
| Week-4 | DYNAMIC FORCE ANALYSIS  
To draw free body diagram and determine forces under dynamic condition. |
| Week-5 | BALANCING  
To determine balancing forces and reciprocating masses. |
| Week-6 | BEARINGS  
To determine the bearing life. |
| Week-7 | LONGITUDINAL AND LATERAL VIBRATIONS  
To determine the longitudinal and transfer vibration. |
| Week-8 | VIBRATION ANALYSIS OF SHAFT  
To determine critical speed of a shaft. |
| Week-9 | MECHANISMS  
To design various mechanism and their inversions. |
| Week-10 | DIFFERENTIAL GEAR BOX  
To study automobile differential gear box. |
| Week-11 | FREE AND FORCED VIBRATION OF CANTIEVER BEAM  
To study Vibrations in beam Structures |
<table>
<thead>
<tr>
<th>Week-12</th>
<th>EXAMINATIONS</th>
</tr>
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</table>

**REFERENCES:**

PROJECT WORK - I

VII Semester: Common for all branches

<table>
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<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
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Contact Classes: Nil  Tutorial Classes: Nil  Practical Classes: 150  Total Classes: 150

The object of Project Work I is to enable the student to take up investigative study in the broad field of Electronics & Communication 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 / Modelling / 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.

PROJECT WORK - II

VIII Semester: Common for all branches

<table>
<thead>
<tr>
<th>Course Code</th>
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<td>L  T  P  C  CIA  SEE  Total</td>
<td>0 0 12 6 30 70 100</td>
<td></td>
</tr>
</tbody>
</table>

Contact Classes: Nil  Tutorial Classes: Nil  Practical Classes: 180  Total Classes: 180

The object of Project Work II & Dissertation is to enable the student to extend further the investigative study taken up under EC 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 EEP1;
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 / Modelling / 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.
EXPERIMENTAL STRESS ANALYSIS

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
<th>Credits</th>
<th>Maximum Marks</th>
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</thead>
<tbody>
<tr>
<td>AAEB29</td>
<td>Elective</td>
<td>L T P C CIA SEE Total</td>
<td>3 - - 3 30 70 100</td>
<td></td>
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</tbody>
</table>

Contact Classes: 45 Tutorial Classes: Nil Practical Classes: Nil Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Bring awareness on experimental method of finding the response of the structure to different types of load.
II. Understand the relation between the mechanics theory, experimental stress analysis, and the mechanical, optical, pneumatic and electrical strain gauges for strain measurement.
III. Establish the fundamental concepts and newly experimental techniques and able to use the experimental techniques on the practical problems.
IV. Evaluate and make a fine presentation related to the experimental paper.

MODULE-I MEASUREMENTS & EXTENSOMETER Classes: 08
Principles of measurements, accuracy, sensitivity and range of measurements; Mechanical, optical acoustical and electrical extensometers and their uses, advantages and disadvantages.

MODULE-II ELECTRICAL RESISTANCE STRAIN GAGES Classes:09
Strain sensitivity in metallic alloys, gage construction, adhesives and mounting techniques, gage sensitivity and gage factor, performance characteristics, environmental effects, strain gage circuits; Potentiometer, wheat stone’s bridges, constant current circuits.

MODULE-III TWO AND THREE DIMENSIONAL PHOTO-ELASTICITY Classes: 10
Two dimensional photoelasticity; Concepts of light-photo-elastic effects, stress optic law-interpretation of fringe pattern-compensation and separation techniques; Photoelastic materials; Introduction to three dimensional photoelasticity.

Photoelastic (Birefringent) coatings, effects of coating thickness, brittle coatings, types of brittle coatings, advantages and brittle coating applications, crack detection methods and Moire methods: Applications and advantages.

MODULE-IV PHOTO-ELASTICITY Classes: 10
Nature of light, wave theory of light, optical interference, stress optic law, effect of stressed model in plane and circular polarisopes, isoclinics and isochromatics, fringe order determination fringe multiplication techniques, calibration photoelastic model materials.
Two element, three element rectangular and delta rosettes, correction for transverse strain effects, stress gauge, plane shear gauge, and stress intensity factor gauge.

**Text Books:**


**Reference Books:**


**Web References:**

1. www.nptel.ac.in/syllabus/syllabus.php?subjectId=112106068
2. www.textofvideo.nptel.iitm.ac.in/112106068/lec1.pdf

**E-Text Books:**

2. www.apm.iitm.ac.in/smlab/kramesh/book_5.htm
DESIGN AND ANALYSIS OF COMPOSITE STRUCTURES

PE - I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
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<td>C 30 CIA 70 SEE 100</td>
<td>Total 100</td>
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</table>

Contact Classes: 45 Tutorial Classes: Practical Classes: Nil Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Understand the fabrication, analysis and design of composite materials & structures.
II. Explain basic composites technology, including materials and processes, manufacturing, structural design, maintenance, proof of structures and other considerations.
III. Identify the static testing procedure and repairing methodology of composite structural members and joints.
IV. Enrich to develop structural designs using composite materials.

MODULE-I  STRESS STRAIN RELATION Classes: 08
Introduction- Advantages and application of composite materials, reinforcements and matrices; Generalized Hooke’s Law; Elastic constants for anisotropic, orthotropic and isotropic materials.

MODULE-II  METHODS OF ANALYSIS Classes: 08
Micro mechanics: Mechanics of materials approach, elasticity approach to determine material properties; Macro Mechanics; Stress-strain relations with respect to natural axis, arbitrary axis; Determination of material properties; Experimental characterization of lamina.

MODULE-III  LAMINATED PLATES, SANDWICH CONSTRUCTIONS AND FABRICATION PROCESS Classes: 10
Governing differential equation for a general laminate, angle ply and cross ply laminates; Failure criteria for composites.
Basic design concepts of sandwich construction ; Materials used for sandwich construction ; Failure modes of sandwich panels; Various open and closed mould processes; Manufacture of fibers; Types of resins and properties and applications; Netting analysis.

MODULE-IV  DAMAGE TOLERANCE IN COMPOSITES Classes: 09
Introduction, sources of damage, types of damage, FAR requirements and advisory circulars, building block approach; Impact damages: Damage growth under fatigue loads; residual strength: Tests and analytical methods; Detailed design: Basics of projections, drawing standards and conventions, introduction to CADD, design of composite parts and assembly design; Optimization: Fundamentals of optimization, mathematical concepts in optimization, Optimization of composite plates.

MODULE-V  TESTING OF COMPOSITE STRUCTURES Classes: 10
Factors influencing testing, test environment, test methods and standards, introduction to static testing of composite structures and examples; Repair of composite aircraft structures: Introduction to repair, repair philosophy, repair sequence, repair criteria, damage assessment, classification of repair, selection of repair joints, repair procedures, certification of repair.
**Text Books:**


**Reference Books:**


**Web References:**

1. www.nptel.ac.in/courses/101104010/
2. www.freevideolectures.com/Course/94/Prestressed-Concrete-Structures/35

**E-Text Books:**

1. www.samples.sainsburysebooks.co.uk/9781118536957_sample_413689.pdf
2. www.samples.sainsburysebooks.co.uk/9780470972717_sample_386378.pdf
## AEROELASTICITY

### PE - I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
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<th>Credits</th>
<th>Maximum Marks</th>
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<td>Contact Classes: 45</td>
<td>Tutorial Classes: Nil</td>
<td>Practical Classes: Nil</td>
<td>Total Classes: 45</td>
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</tbody>
</table>

### OBJECTIVES:
The course should enable the students to:

I. Outline importance of aeroelasticity in flight vehicle design and classify static and dynamic aeroelastic problems.

II. Describe structural dynamic and steady and unsteady aerodynamics aspects of airframe and its components and their role in aeroelasticity.

III. Construct theoretical basis for the solution of static aeroelastic problems an estimate loads and other critical speeds.

IV. Construct theoretical basis for the solution of flutter problems and estimate of flutter speeds.

### MODULE-I

#### AEROELASTIC PHENOMENA

Classes: 08

- Stability versus response problems; The aeroelastic triangle of forces; Aero elasticity in aircraft design; Prevention of aero elastic instabilities; Influence and stiffness coefficients; Coupled oscillations.

### MODULE-II

#### DIVERGENCE OF A LIFTING SURFACE

Classes: 10

- Simple two dimensional idealizations; Strip theory, integral equation of the second kind exact solutions for simple rectangular wings, ‘Semi rigid’ assumption and approximate solutions; Generalized coordinates, successive approximations, numerical approximations using matrix equations.

### MODULE-III

#### STEADY STATE AEROELASTIC PROBLEMS

Classes: 08

- Loss and reversal of aileron control, critical aileron reversal speed, aileron efficiency, semi rigid theory and successive approximations.

- Lift distribution, rigid and elastic wings; Tail efficiency, effect of elastic deformation on static longitudinal stability.

### MODULE-IV

#### FLUTTER PHENOMENON

Classes: 10

- Non-dimensional parameters, stiffness criteria, dynamic mass balancing, dimensional similarity; Flutter analysis, two dimensional thin airfoils in steady incompressible flow, quasi steady aerodynamic derivatives; Galerkin method for critical flutter speed, stability of disturbed motion, solution of the flutter determinant, methods of determining the critical flutter speeds, flutter prevention and control.

### MODULE-V

#### EXAMPLES OF AEROELASTIC PROBLEMS

Classes: 09

- Galloping of transmission lines and Flow induced vibrations of transmission lines, tall slender structures and suspension bridges.
**Text Books:**


**Reference Books:**


**Web References:**

2. https://ocw.mit.edu/resources/#Mathematics

**E-Text Books:**

UNMANNED AIR VEHICLES

PE - I

<table>
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<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
<th>Credits</th>
<th>Maximum Marks</th>
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</table>

Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Introduce to the student about the basic ideas of Unmanned Air Vehicles.
II. Familiarize the students about the aerodynamics and airframe configurations.
III. Accustom the student to the wide variety of unmanned air vehicles.
IV. Acquaint the student about the various communication and navigation systems of unmanned air vehicles.

MODULE-I  INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS  Classes: 10
The systemic basis of UAS-system composition; Conceptual phase; Preliminary design; Selection of the system; Some applications of UAS.

MODULE-II  AERODYNAMICS AND AIRFRAME CONFIGURATIONS  Classes: 10
Lift-induced Drag; Parasitic Drag; Rotary-wing aerodynamics; Response to air turbulence; Airframe configurations scale effects; Packaging density; Aerodynamics; Structures and mechanisms; Selection of power-plants; Modular construction; Ancillary equipment.

MODULE-III  CHARACTERISTICS OF AIRCRAFT TYPES  Classes: 09
Long-endurance, long-range role aircraft; Medium-range, tactical aircraft; Close-range / battlefield aircraft;
MUAV types: MAV and NAV types; UCAV; Novel hybrid aircraft configurations; Research UAV.

MODULE-IV  COMMUNICATIONS NAVIGATION  Classes: 08
Communication media; Radio communication; Mid-air collision (MAC) avoidance; communications data rate and bandwidth usage; Antenna Types NAVSTAR Global Positioning System (GPS) - TACAN - LORAN C - Inertial Navigation - Radio Tracking - Way-point Navigation.

MODULE-V  CONTROL AND STABILITY  Classes: 08

Text Books:

Reference Books:
**Web References:**

2. www.dhl.com/en/about_us/logistics_insights/dhl_trend_research/
3. www.books.google.co.in/books?id=guGVDQAQBAJ&pg=PT3&lpg=PT3&dq

**E-Text Books:**

# GROUND VEHICLE AERODYNAMICS

**PE - II**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
<th>Credits</th>
<th>Maximum Marks</th>
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<td>AAEB33</td>
<td>Elective</td>
<td>L T P C CIA SEE Total</td>
<td>3 - - 3</td>
<td>30 70 100</td>
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</table>

**Contact Classes:** 45  
**Tutorial Classes:** Nil  
**Practical Classes:** Nil  
**Total Classes:** 45

**OBJECTIVES:**  
The course should enable the students to:  
I. Understand the basics of vehicle aerodynamics, history of developments and apply the concepts of fluid mechanics to automobiles.  
II. Estimate the drag on ground vehicles and analyze the effects of various configurations of cars on drag.  
III. Analyze the stability and handling qualities based of ground vehicles due to side wind loads and dirt accumulation.  
IV. Apply the above concepts to race car design and understand various experimental techniques applied in automotive aerodynamics.

**MODULE-I**  
**OVERVIEW AND INTRODUCTION**  
Classes: 10  
Historical developments and trends, fundamentals of fluid mechanics, flow phenomenon related to vehicles, external and internal flow problem, resistance to vehicle motion, mechanics of air flow around a vehicle, pressure distribution, aerodynamic forces, vehicle drag and types, side and lift forces, performance potential of vehicle aerodynamics.

**MODULE-II**  
**AERODYNAMIC DRAG AND SHAPE OPTIMIZATION OF CARS**  
Classes: 10  
Cars as a bluff body, flow field around a car, analysis of aerodynamic drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles. Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back, dust flow patterns at the rear, effect of rear configuration, effect of fasteners.

**MODULE-III**  
**VEHICLE HANDLING AND STABILITY**  
Classes: 09  
Origin, characteristics and effects of forces and moments on a vehicle, lateral stability problems. Vehicle dynamics under side winds, dirt accumulation on the vehicle, wind noise: Mechanisms and generation design features, measurement and techniques.

**MODULE-IV**  
**RACE CAR AERODYNAMICS**  
Classes: 08  
Basic vehicle body concepts, aerodynamics of the complete vehicle, flow over wheels, sliding seal and skirts, under body channels, simple add on: spoilers, strakes and wickers, internal flow, race car wings, most current examples in detail design.

**MODULE-V**  
**MEASUREMENT AND TEST TECHNIQUES**  
Classes: 08  
Wind tunnel scope, fundamental techniques, simulation limitations, prototype tests, wind tunnel types and testing methods, test techniques: scope, measuring equipment and transducers, road testing methods.

**Text Books:**

**Reference Books:**

<table>
<thead>
<tr>
<th>Reference</th>
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</table>

**Web References:**

<table>
<thead>
<tr>
<th>Reference</th>
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<tbody>
<tr>
<td>4. <a href="https://www.slideshare.net/friendsrtg/vehicle-body-engineering-aerodynamics">https://www.slideshare.net/friendsrtg/vehicle-body-engineering-aerodynamics</a></td>
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</table>

**E-Text Books:**

<table>
<thead>
<tr>
<th>Reference</th>
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<tbody>
<tr>
<td>1. <a href="https://dlx.bookzz.org/genesis/1111000/58a5c1c372f8f523a0c58e26c3c531eb/_as/%5BWolf-Heinrich_Hucho_(Eds.)_Aerodynamics_of_Road_(BookZZ.org).pdf">https://dlx.bookzz.org/genesis/1111000/58a5c1c372f8f523a0c58e26c3c531eb/_as/[Wolf-Heinrich_Hucho_(Eds.)_Aerodynamics_of_Road_(BookZZ.org).pdf</a></td>
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<td>2. <a href="https://dlx.bookzz.org/genesis/555000/2c09a10c7a7c0f3deaeb9ddc4251c26/_as/%5BJoseph_Katz%5D_Race_Car_Aerodynamics_Designing_for(BookZZ.org).pdf">https://dlx.bookzz.org/genesis/555000/2c09a10c7a7c0f3deaeb9ddc4251c26/_as/[Joseph_Katz]_Race_Car_Aerodynamics_Designing_for(BookZZ.org).pdf</a></td>
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ADVANCED COMPUTATIONAL AERODYNAMICS

PE- II

<table>
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<th>Category</th>
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<th>Credits</th>
<th>Maximum Marks</th>
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<td>3  -  -</td>
<td>30  70</td>
<td>100</td>
</tr>
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</table>

Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:

I. Explain the concept of panel methods, analyze various boundary conditions applied and demonstrate several searching and sorting algorithms.

II. Describe the initial methods applied in the process of CFD tools development their advantages and disadvantages over modern developed methods.

III. Demonstrate different methods evolved in analyzing numerical stability of solutions and evaluate the parameters over which the stability depends and their range of values.

IV. Understand advanced techniques and methods in time marching steps and identify different boundary conditions for different cases in CFD techniques.

MODULE-I  NUMERICAL SOLUTIONS  Classes: 10

Euler equations: Flux approach, Lax-Wendroff method, basic principles of upwind schemes, flux vector splitting, Steger Warming flux vector splitting, Van Leer flux vector splitting, Upwind reconstruction, evolution, Godunov’s first order upwind method, Roe’s first order upwind method.

MODULE-II  TIME DEPENDENT METHODS  Classes: 10


MODULE-III  BOUNDARY CONDITIONS  Classes: 09

Boundary Layer Equations: Setting up the boundary layer equations, flat plate boundary layer solution, boundary layer transformations, explicit and implicit discretization, solution of the implicit difference equations, integration of the continuity equation, boundary layer edge and wall shear stress, Keller-box scheme.

Concept of dummy cells, solid wall inviscid flow, viscous flow, farfield concept of characteristic variables, modifications for lifting bodies inlet outlet boundary, injection boundary, symmetry plane, coordinate cut, periodic boundaries, interface between grid blocks, flow gradients at boundaries of unstructured grids.

MODULE-IV  METHOD OF CHARACTERISTICS  Classes: 08

Philosophy of method of characteristics, determination of characteristic lines, two dimensional irrotational flow, determination of compatibility equations, MODULE processes, supersonic nozzle design by the method of characteristics, supersonic wind tunnel nozzle, minimum length nozzles, domain of dependence and range of influence.

MODULE-V  PANEL METHODS  Classes: 08

Basic formulation, boundary conditions, physical considerations, reduction of a problem to a set of linear algebraic equations, aerodynamic loads, preliminary considerations prior to establishing numerical solution, steps toward constructing a numerical solution, solution of thin airfoil with lumped vortex filament, accounting for effects of compressibility and viscosity.
**Text Books:**


**Reference Books:**


**Web References:**

2. www.wind.civil.aau.dk/lecture/8sem_CFD/Lecture1/Lecture1.pdf
3. personalpages.manchester.ac.uk/staff/david.d.apsley/lectures/comphydr/timedep.pdf

**E-Text Books:**

1. https://books.google.co.in/books/about/Advanced_Computational_Fluid_and_Aerodyn.html?id=dWS4jgEACAAJ&redir_esc=y
# EXPERIMENTAL AERODYNAMICS

<table>
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<tr>
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<td>3 L - T - P</td>
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<td>30 CIA 70 SEE 100 Total</td>
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</table>

Contact Classes: 45  
Tutorial Classes: Nil  
Practical Classes: Nil  
Total Classes: 45

**OBJECTIVES:**  
The course should enable the students to:  
I. Describe basic fundamentals of Aerodynamics experiments, their need in comparison with numerical computation and theoretical studies.  
II. Develop concepts of flow similarity and evaluate the loss coefficients of wind tunnel components.  
III. Analyze the concept of force and moment measurements using wind tunnel balance and extrapolate it to new balance development.  
IV. Summarize various techniques for pressure, velocity, temperature measurement and flow visualization.

## MODULE-I  
**FUNDAMENTALS OF EXPERIMENTS IN AERODYNAMICS**  
Classes: 08  
Forms of aerodynamic experiments, observations, measurement objectives. History: Wright Brother’s wind tunnel, model testing, wind tunnel principles, scaling laws, scale parameters, geometric similarity, kinematic similarity& dynamic similarity. Wind tunnels: low speed tunnel, high speed tunnels, transonic, supersonic and hypersonic tunnels, shock tubes. Special tunnels: low turbulence tunnels, high Reynolds number tunnels, environmental tunnels, automobile tunnels, distinctive features, application.

## MODULE-II  
**WIND TUNNEL EXPERIMENTATION CONSIDERATIONS**  
Classes: 10  
Low speed wind tunnels, principal components. Function, description, design requirements, constraints and loss coefficients. Wind tunnel performance flow quality, power losses, wind tunnel corrections, sources of inaccuracies: buoyancy, solid blockage, wake blockage, streamline curvature causes, estimation and correction.

## MODULE-III  
**WIND TUNNEL BALANCE**  
Classes: 08  
Load measurement: low speed wind tunnel balances, mechanical & Strain gauge types, null displacement methods & strain method, sensitivity, weigh beams, steel yard type and current balance type, balance linkages, levers and pivots.  
Model support three point wire support, three point strut support, platform balance, yoke balance, strain gauge, 3-component strain gauge balance, description, application.

## MODULE-IV  
**PRESSURE, VELOCITY & TEMPERATURE MEASUREMENTS**  
Classes: 11  
Pressure: static pressure, surface pressure orifice, static probes, pitot probe for total pressure, static pressure and flow angularity, pressure sensitive paints, steady and unsteady pressure measurement and various types of pressure probes and transducers, errors in pressure measurement. Temperature: measurement of temperature using thermocouples, resistance thermometers, temperature sensitive paints and liquid crystals. Velocity: measurement of airspeed, Mach number from pressure measurements, flow direction, boundary layer profile using pitot static probe, 5 hole probe yaw meter, total head rake, hot wire anemometry, laser doppler anemometry, particle image velocimetry, working principle description of equipment, settings, calibration, measurement, data processing, applications.
## MODULE-V

<table>
<thead>
<tr>
<th>FLOW VISUALIZATION TECHNIQUES</th>
<th>Classes: 08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow visualization: necessity, streamlines, streak lines, path lines, time lines, tufts, china clay, oil film, smoke, hydrogen bubble. Optical methods: density and refractive index, schlieren system, convex lenses, concave mirrors, shadowgraph, interferometry, working principle, description, setting up, operation, observation, recording, interpretation of imagery, relative merits and applications.</td>
<td></td>
</tr>
</tbody>
</table>

### Text Books:


### Reference Books:


### Web References:

1. https://nptel.ac.in/courses/101106040/
3. https://www.mace.manchester.ac.uk/our-research/research-themes/aerospaceengineering/specialisms/aerodynamics/
4. https://www.ara.co.uk/services/experimental-aerodynamics/
5. https://soliton.ae.gatech.edu/labs/windtunl/

### E-Text Books:

HYPERSONIC AERODYNAMICS

**Course Code** | **Category** | **Hours / Week** | **Credits** | **Maximum Marks**
--- | --- | --- | --- | ---
AAEB36 | 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

**OBJECTIVES:**  
The course should enable the students to:  
I. Apply the basics of aerodynamics to know the boundary layer and variation of properties at different velocities.  
II. Compute aerodynamic forces and moments on different aerodynamic bodies at different conditions.  
III. Understand aerodynamic heating for bodies travelling at hypersonic speeds and importance of high entropy layer.  
IV. Analyze and appreciate the complementary role of experiments and numerical computations in handling hypersonic flows.

**MODULE-I**  
GENERAL CHARACTERIZATION OF HYPERSONIC FLOWS  
Classes: 09

Defining hypersonic flow, characterizing hypersonic flow using fluid dynamic phenomena, basic equations of motion, equilibrium and non-equilibrium flows, equilibrium conditions, dependent variables, transport properties, continuity, momentum and energy equations, general form of the equations of motion in conservation form.

**MODULE-II**  
DEFINING THE AEROTHERMODYNAMIC ENVIRONMENT, EXPERIMENTAL MEASUREMENTS OF HYPERSONIC FLOWS  
Classes: 10

Empirical correlations complemented by analytical techniques, general comments about computational fluid dynamics, computations based on a two layer flow model, techniques treating entire shock layer in a unified fashion, calibration and validation of the computational fluid dynamics codes, experimental measurements of hypersonic flows: ground-based simulation of hypersonic flows, ground-based hypersonic facilities, experimental data and model design considerations, flight tests, importance of interrelating computational fluid dynamics, ground test data and flight test data.

**MODULE-III**  
STAGNATION-REGION FLOW FIELD AND PRESSURE DISTRIBUTION  
Classes: 08

Stagnating streamline, stagnation-point convective heat transfer, radiative heat flux; pressure distribution, Newtonian flow models, departure from the Newtonian flow field.  
Shock wave boundary layer (viscous) interaction for two dimensional compression ramps, tangent cone and tangent wedge approximations, need for more sophisticated models, pressure distributions for a reacting gas, pressures in separated regions.

**MODULE-IV**  
BOUNDARY LAYER AND CONVECTIVE HEAT TRANSFER, VISCOS INTERACTIONS  
Classes: 09

Boundary conditions, metoric equivalent cross section radius, convective heat transfer and skin friction, effects of surface catalycity, base heat transfer in separated flow; viscous interactions: compression ramp flows, shock interactions, flow field perturbations around swept fins, corner flows, examples of viscous interactions for hypersonic vehicles: X-15, space shuttle orbiter, hypersonic air-breathing aircraft.
### MODULE-V

**AERODYNAMIC FORCES AND MOMENTS**

**AEROTHERMODYNAMICS AND DESIGN CONSIDERATIONS OF HYPERSONIC VEHICLES**

<table>
<thead>
<tr>
<th>Classes: 09</th>
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</table>

Newtonian aerodynamic coefficients, re entry capsule aerodynamics, shuttle orbiter aerodynamics, X-15 aerodynamics, hypersonic aerodynamics of research plane, dynamic stability considerations. Design considerations: re-entry vehicles, design philosophy, design considerations for rocket-launched glide reentry vehicles, air breathing vehicles, combined rocket and air breathing powered vehicles, design of a new vehicle.

### Text Books:


### Reference Books:


### Web References:

1. https://nptel.ac.in/courses/101103003/

### E-Text Books:

2. https://bookzz.org/book/1201615/e314e1
TURBO MACHINERY

PE - III

<table>
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<tr>
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<th>Category</th>
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</table>

Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:

I. Learn basic concepts of turbo machinery, hydraulic pumps and effects of flow parameters on the performance of the machine.
II. Analyze geometrical conditions and description of the main components in Centrifugal pumps, Pelton, Francis, Kaplan and gas-turbines.
III. To understand energy transfer and losses in centrifugal compressors, axial fans and steam turbines IV. Knowledge about Basic design of Wind turbines, Reversible Pumpturbines, multi-phase pumps and wet gas compressors. Main components in a Hydro Power Plant and Gas Power Plant. Analyze estimation of parameters required to design an efficient turbo machine.

MODULE-I  INTRODUCTION TO TURBOMACHINERY  Classes: 10

Classification of turbomachines, second law of thermodynamics applied to turbine and compressors work, nozzle, diffuser work, fluid equation, continuity, Euler’s, Bernoulli’s, equation and its applications, expansion and compression process, reheat factor, preheat factor

MODULE-II  FUNDAMENTAL CONCEPTS OF AXIAL AND RADIAL MACHINES  Classes: 10

Euler’s equation of energy transfer, vane congruent flow, influence of relative circulation, thickness of vanes, number of vanes on velocity triangles, slip factor, Stodola, Stanitz and Balje’s slip factor, suction pressure and net positive suction head, phenomena of cavitation in pumps, concept of specific speed, shape number, axial, radial and mixed flow machines, similarity laws.

MODULE-III  AXIAL COMPRESSOR AND FANS  Classes: 09

Flow through axial flow fans, principle of axial fan and propeller, application of fan for circulation and ventilation, stage pressure rise and work done.

Slip stream and blade element theory for propellers, performance and characteristics of axial fans, effects of cascading, degree of reaction, blade loading coefficient and blade loss.

MODULE-IV  CENTRIFUGAL COMPRESSORS  Classes: 08

Flow through centrifugal compressors, stage velocity triangles, specific work, forward, radial and backward swept vanes, enthalpy entropy diagrams, degree of reaction, slip factor, efficiency, vaneless and vane diffuser system, volute as spiral casing, surge and stall in compressors.

MODULE-V  AXIAL TURBINES  Classes: 08

Stage velocity triangles, work, efficiency, blade loading, flow coefficient, single stage impulse and reaction turbines, degree of reaction, 50% reaction turbine stage, radial equilibrium and actuator disc approach for design of turbine blades, partial admission problems in turbines, losses in turbomachines.
<table>
<thead>
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<th><strong>Text Books:</strong></th>
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<th><strong>Reference Books:</strong></th>
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<th><strong>Web References:</strong></th>
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<tbody>
<tr>
<td>1. <a href="https://www.cfd-online.com/Wiki/Turbomachinery">https://www.cfd-online.com/Wiki/Turbomachinery</a></td>
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<tr>
<th><strong>E-Text Books:</strong></th>
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<tbody>
<tr>
<td>1. <a href="https://elearning.vtu.ac.in/newvtuelc/courses/15/E-Notes/turbomachines/MODULE-I%20&amp;%20MODULE-II_GRS.pdf">https://elearning.vtu.ac.in/newvtuelc/courses/15/E-Notes/turbomachines/MODULE-I%20&amp;%20MODULE-II_GRS.pdf</a></td>
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## HEAT TRANSFER

### PE - III

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Contact Classes: 45

Tutorial Classes: Nil

Practical Classes: Nil

Total Classes: 45

### OBJECTIVES:
The course should enable the students to:

I. Understand the basic modes of heat transfer like conduction, convection radiation with and without phase change in solid liquids and gases.
II. Design and analyze thermal fluidic components in engineering systems to energy mechanisms (in the form of heat transfer) for steady and unsteady state.
III. Conduct experiments in laboratories and analyze the results with theoretical ones to evolve research oriented projects in the field of heat transfer as well as propulsion.
IV. Apply the concepts of heat transfer with convective mode in internal and external flows involved in engineering components and work in real time problems in Industry.

### MODULE-I  INTRODUCTION TO HEAT TRANSFER, CONDUCTION  
Classes: 10


### MODULE-II  CONVECTION, FORCED CONVECTION  
Classes: 08


### MODULE-III  FREE CONVECTION, CONDENSATION  
Classes: 10

Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes. Film boiling. Film wise and drop wise condensation, Nusselt’s theory of condensation on a vertical plate.

Film condensation on vertical and horizontal cylinders using empirical correlations. Application in Aero engines, Gas turbine combustion chamber – Working principle, correlation with convection and condensation.

### MODULE-IV  HEAT EXCHANGERS  
Classes: 08

Classification of heat exchangers, overall heat transfer Coefficient and fouling factor, Concepts of LMTD and NTU methods, Problems using LMTD and NTU Methods, Application in Aero engines.
<table>
<thead>
<tr>
<th>MODULE-V</th>
<th>RADIATION HEAT TRANSFER</th>
<th>Classes: 09</th>
</tr>
</thead>
</table>

**Text Books:**


**Reference Books:**


**Web References:**

1. https://nptel.ac.in/courses/112101097/
2. https://hyperphysics.phy-astr.gsu.edu/hbase/thermo/heatra.html

**E-Text Books:**

# CRYOGENICS

## PE - III

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Contact Classes: 45  
Tutorial Classes: Nil  
Practical Classes: Nil  
Total Classes: 45

## OBJECTIVES:

The course should enable the students to:

V. Understand the behavior of fluids at cryogenic temperatures and utilize the feature for cryogenic application in aerospace propulsion.

I. Analyze the behavior of solids at cryogenic temperatures and develop systems used in hybrid rocket propulsion systems.

II. Estimate thermodynamically gas liquefaction systems and elucidate the application of liquefied gas in aerospace propulsion.

III. Create thermodynamically gas separation systems and experiment in a sustained environment for possible synthesis of rarefied gases for testing.

## MODULE-I  INTRODUCTION TO CRYOGENICS  Classes: 10

Thermo physical and fluid dynamic properties of liquid and gas hydrogen, Thermo physical and fluid dynamic properties of liquid and gas helium. Liquefaction systems of hydrogen and helium gases, Liquefaction systems of hydrogen and helium gases, Refrigeration and liquefaction principals; Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion with their comparison.

## MODULE-II  PROPERTIES OF CRYOGENIC SUBSTANCE  Classes: 10

Cryogenic fluids, Solids at cryogenic temperatures; Superconductivity, Recuperative – Linde – Hampson, Claude, Cascade, Heylandt, Kapitza, Collins, Simon; Regenerative – Stirling cycle and refrigerator, Slovay refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas.

## MODULE-III  CRYOGENIC INSULATIONS  Classes: 08

Vacuum insulation, Evacuated porous insulation, Gas filled Powders and fibrous materials.

Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations.

## MODULE-IV  STORAGE AND INSTRUMENTATION OF CRYOGENIC LIQUIDS  Classes: 08

Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system; Cool-down of storage and transfer systems, Measurement of strain, pressure, flow, liquid level and Temperature in cryogenic environment; Cryostats.

## MODULE-V  CRYOGENIC EQUIPMENTS  Classes: 09

Cryogenic heat exchangers – recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders; Turbo alternators; Effect of component inefficiencies; System Optimization, Magneto-caloric refrigerator; 3He-4He Dilution refrigerator; Cryopumping; Cryogenic Engineering applications in energy, aeronautics, space, industry, biology, preservation Application of Cryogenic Engineering in Transport.
### Text Books:


### Reference Books:


### Web References:

1. [https://nptel.ac.in/courses/112101004/](https://nptel.ac.in/courses/112101004/)
2. [https://www.slac.stanford.edu/econf/C0605091/present/CERN.PDF](https://www.slac.stanford.edu/econf/C0605091/present/CERN.PDF)

### E-Text Books:

1. [https://bookzz.org/book/690085/5d838f](https://bookzz.org/book/690085/5d838f)
3. [https://bookzz.org/book/939475/a6994a](https://bookzz.org/book/939475/a6994a)
ROCKET AND MISSILES

PE - III

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Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Learn Fundamentals of rocket and missile systems, functions and disciplines and the full spectrum of rocket systems, uses and technologies.
II. Understand the Fundamentals and uses of solid, liquid and hybrid rocket systems and differences between systems built as weapons and those built for commerce.
III. Explain the use of low and high fidelity performance modeling, including performance loss factors, Staging theory, performance and practices for multi-stage rockets.
IV. Discuss the reliability issues in rocket systems, and strategies to improve reliability, including random and systematic failures, non-linear reliability curves.

MODULE-I  ROCKET DYNAMICS  Classes: 10
Classification of launch vehicles and missiles, rocket systems, airframe components, forces and moments acting on a rocket, propulsion, aerodynamics, gravity, inertial and non-inertial frames, coordinate transformation, equations of motion for three-dimensional motion through atmosphere and vacuum, earth's atmosphere, numerical problems.

MODULE-II  SOLID PROPULSION AND PYROTECHNICS  Classes: 10
Solid propellant rockets, classification, components and their design considerations, propellant grain design, grain mechanical properties, ballistics and burn rate design issues, igniter design, types of nozzles, thrust vector control, pyrotechnic devices and systems, classification, mechanisms and application of pyrotechnic devices in rockets and missiles; design problems in rocket systems.

MODULE-III  LIQUID PROPULSION AND CONTROL SYSTEMS  Classes: 09
Liquid propellant rockets, classification and components, thrust chamber, feed systems, propellant tanks, turbo-pumps, types of valves and applications, design considerations.
Different bipropellant systems like cryogenics and their characteristics, pogo and slosh engine gimbal systems and thrusters for control; Spacecraft propulsion and control systems design problems.

MODULE-IV  MULTI-STAGING OF ROCKET AND SEPERATION DYNAMICS  Classes: 08
Navigation and guidance systems in rockets and missiles, aerodynamic control systems of missiles, multi-staging of rockets, vehicle optimization techniques, stage separation system, dynamics, separation techniques, rocket flight dispersion, numerical problems.

MODULE-V  DESIGN, MATERIALS AND TESTING OF ROCKETS  Classes: 08
Design requirements and selection, performance evaluation and assessment, space environment on the selection of materials for rockets and spacecraft, material selection for specific requirements, advance materials, super alloys and composite materials, qualification of rocket and missile systems, types of testing and evaluation of design and function.

Text Books:

**Web References:**

2. https://www.geeksforgeeks.org/rockets_missiles/

**E-Text Books:**

NON DESTRUCTIVE TESTING

**Objective Classes: 45**
Tutorial Classes: Nil
Practical Classes: Nil
Total Classes: 45

**Objectives:**
The course should enable the students to:
I. Understanding the basic principles of various non destructive testing methods, fundamentals, discontinuities in different product forms.
II. Differentiate various defect types and select the appropriate non destructive testing methods for better evaluation of the specimen.
III. Implement and document a written procedure paving the way for further training in specific techniques of non destructive inspection of the experimental subject.
IV. Recognize the principles and operational techniques of the radiographic testing followed by its interpretation and evaluation.

**Module-I**
**Overview of Non Destructive Testing** Classes: 09
NDT versus mechanical testing, overview of the non destructive testing methods for the detection of manufacturing defects as well as material characterization; Relative merits and limitations, various physical characteristics of materials and their applications in NDT, visual inspection, unaided and aided.

**Module-II**
**Surface Non Destructive Examination Methods** Classes: 09

**Module-III**
**Thermography and Eddy Current Testing (ET)** Classes: 09
Thermography: Principles, contact and non contact inspection methods, techniques for applying liquid crystals.
Advantages and limitation, infrared radiation and infrared detectors, instrumentation and methods, applications; Eddy Current Testing; Generation of eddy currents, properties of eddy currents, Eddy current sensing elements, probes, instrumentation, types of arrangement, applications, advantages, limitations, interpretation/evaluation.

**Module-IV**
**Ultrasonic Testing (UT) and Acoustic Emission (AE)** Classes: 09
Ultrasonic Testing: Principle, transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A-scan, B-scan, C-scan; Phased array ultrasound, time of flight diffraction; Acoustic emission technique, V principle, AE parameters, applications.

**Module-V**
**Experimental Methods** Classes: 09
Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, inverse square, law, characteristics of films, graininess, density, speed, contrast, characteristic curves, pentameters, exposure charts, radiographic equivalence. Fluoroscopy; Xerox; Radiography, computed radiography, computed tomography.
### Text Books:


### Reference Books:


### Web References:

1. [https://nptel.ac.in/syllabus/syllabus_pdf/113106070.pdf](https://nptel.ac.in/syllabus/syllabus_pdf/113106070.pdf)
2. [https://nptel.ac.in/courses/113106070/24](https://nptel.ac.in/courses/113106070/24)

### E-Text Books:

2. [https://eprints.nmlindia.org/1850/1/177-193.PDF](https://eprints.nmlindia.org/1850/1/177-193.PDF)
PE - IV

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Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

Objectives:
The course should enable the students to:
I. Understand the basics of computer aided designing, computer aided manufacturing and computer integrated manufacturing.
II. To study about group technology, computer aided process planning, material requirement planning (MRP) Enterprise resource planning (ERP).
III. Gain knowledge about shop floor control and Flexible manufacturing systems (F.M.S).
IV. Emphasizes the integration of manufacturing enterprise using computer integrated manufacturing (CIM) technologies.

MODULE-I  INTRODUCTION  Classes: 08
Computers in industrial manufacturing, product cycle, CAD/CAM hardware, basic structure, CPU, memory types, input devices, display devices, hard copy devices, and storage devices, computer graphics, raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, three dimensional transformations, mathematics of projections, clipping, hidden surface removal.

MODULE-II  GEOMETRIC MODELLING  Classes: 10
Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods, modeling facilities desired, drafting and modeling systems, basic geometric commands, layers, display control commands, editing, dimensioning and solid modeling.

MODULE-III  GROUP TECHNOLOGY COMPUTER AIDED PROCESS PLANNING  Classes: 10
History of group technology, role of G.T in CAD/CAM integration, part families, classification and coding, DCLASS and MCLASS and OPTIZ coding systems, facility design using G.T, benefits of G.T, cellular manufacturing.
Process planning, role of process planning in CAD/CAM integration, approaches to computer aided process planning, variant approach and generative approaches, CAPP and CMPP systems.

MODULE-IV  COMPUTER AIDED PLANNING AND CONTROL, SHOP FLOOR CONTROL AND INTRODUCTION TO FMS  Classes: 09
Production planning and control, cost planning and control, inventory management, material requirements planning (ERP), control, phases, factory data collection system, automatic identification methods, bar code technology, automated data collection system; FMS, components of FMS, types, FMS workstation, material handling and storage system, FMS layout, computer control systems, applications and benefits.

MODULE-V  COMPUTER AIDED PLANNING AND CONTROL AND COMPUTER MONITORING  Classes: 08
Production planning and control, cost planning and control, inventory management, material requirements planning (MRP), shop floor control, lean and agile manufacturing, types of production monitoring systems, structure model of manufacturing, process control and strategies, direct digital control.
**Text Books:**


**Reference Books:**


**Web References:**


**E-Text Books:**

1. https://books.google.co.in/books?id=8W0E9eK2raMC
2. https://books.google.co.in/books?id=mzm9WuUI4mQC
3. https://books.google.co.in/books?id=F5d6CwAAQBAJ
MECHANISM AND MACHINE DESIGN

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<th>Course Code</th>
<th>Category</th>
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</table>

**Contact Classes: 45**  **Tutorial Classes: Nil**  **Practical Classes: Nil**  **Total Classes: 45**

**Objectives:**

The course should enable the students to:

I. Understand the basic mechanism involved in machine design and basic relative kinematics relations of two moving point.

II. Identify individual links and categorize the type of the connection of the links (joints) for the mechanism of machines.

III. Explain the fundamentals of specific link and joint combinations such as gyroscopic motion, followers, cam and gear systems.

IV. Define kinematic analysis and develop analytical equations describing the relative position, velocity and acceleration of all moving links.

---

**MODULE-I MECHANISMS & MACHINES**

Classes: 08

Elements of links, classification, rigid link, flexible and fluid link, types of kinematic pairs, sliding, turning, rolling, screw and spherical pairs, lower and higher pairs, closed and open pairs, constrained motion, completely, partially or successfully constrained, and incompletely constrained, mechanism and machines, classification, kinematic chain, inversion of mechanism, inversion of quadratic cycle, chain, single and double slider crank chains; Exact and approximate straight line mechanisms: Paucellier, hart t, Chibichef, pantograph.

---

**MODULE-II KINEMATIC ANALYSIS OF MECHANISMS**

Classes: 10

Velocity and acceleration, motion of link in machine, determination of velocity and acceleration diagrams, graphical method, application of relative velocity method for four bar chain, analysis of slider crank chain for displacement, velocity and acceleration of sliding, acceleration diagram for a given mechanism, Kleins construction, Coriolis acceleration, determination of Coriolis component of acceleration.

---

**MODULE-III PLANE MOTION OF BODY & GYROSCOPIC MOTION PRECESSION**

Classes: 10

Instantaneous centre of rotation, centroids and axodes, relative motion between two bodies, three centres in line theorem, graphical determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links.

The gyroscope, free and restrained, working principle, the free gyro, rate gyro, integrating gyro as motion measuring instruments, effect of precession on the stability of vehicles, motorbikes, automobiles, airplanes and ships, static and dynamic forces generated due to in precession in rotating mechanisms.

---

**MODULE-IV CAMS AND FOLLOWERS, STEERING GEARS**

Classes: 09

Cams and followers, definition uses, types, terminology, types of follower motion, uniform velocity, simple harmonic motion and uniform acceleration, maximum velocity and acceleration during outward and return strokes, roller follower, circular cam with straight, concave and convex flanks, condition for correct steering, Davis steering gear, Ackerman’s steering gear, velocity ratio, hook’s joint, single and double hooks joint, universal coupling, applications.

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**MODULE-V GEARs AND GEAR TRAINs, DESIGN OF FOUR BAR MECHANISMS**

Classes: 08
Introduction to gears: Types, law of gearing; Tooth profiles: Specifications, classification, helical, bevel and worm gears, simple and reverted gear train, epicyclic gear trains, velocity ratio or train value, four bar mechanism, Freudenstein equation, Precession point synthesis, Chebyshev’s method, structural error.

**Text Books:**


**Reference Books:**


**Web References:**


**E-Text Books:**

PRODUCT DESIGN AND DEVELOPMENT

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</table>

Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

Objectives:
The course should enable the students to:
I. Prioritize the growth of the organization and utilize the surplus capacity of the organization, such as physical facility, man power.
II. Develop the market share and to target new market segment and ensure complete product range in company’s portfolio.
III. Apply contemporary theories of effective product design through the adaptive and/or original redesign of consumer products.

MODULE-I  INTRODUCTION  Classes: 08
Significance of product design, product design and development process, sequential engineering design method, the challenges of product development, product planning and project selection: Identifying opportunities, evaluate and prioritize projects, allocation of resources.

MODULE-II  IDENTIFYING CUSTOMER NEEDS, PRODUCT SPECIFICATIONS AND CONCEPT GENERATION  Classes: 10
Interpret raw data in terms of customers’ needs, organize needs in hierarchy and establish the relative importance of needs; Establish target specifications, setting final specifications; Activities of concept generation, clarifying problem, search both internally and externally, explore the output.

MODULE-III  INDUSTRIAL DESIGN AND CONCEPT SELECTION  Classes: 10
Assessing need for industrial design, industrial design process, management, assessing quality of industrial design.
Overview, concept screening and concept scoring, methods of selection.

MODULE-IV  THEORY OF INVENTIVE PROBLEM SOLVING (TRIZ)  Classes: 09
Fundamentals, methods and techniques, general theory of innovation and TRIZ, value engineering applications in product development and design, model-based technology for generating innovative ideas.

MODULE-V  CONCEPT TESTING, INTELLECTUAL PROPERTY AND DESIGN FOR ENVIRONMENT  Classes: 08
Elements of testing: qualitative and quantitative methods including survey, measurement of customers’ response; Elements and outline, patenting procedures, claim procedure; Impact, regulations from government, ISO system.

Text Books:

Reference Books:
3. Semyon D. Savransky, “Engineering of Creativity: Introduction to TRIZ methodology of Inventive
<table>
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<tr>
<td><strong>Web References:</strong></td>
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<td>1.  <a href="https://nptel.ac.in/courses/105106049/#">https://nptel.ac.in/courses/105106049/#</a></td>
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<tr>
<td>2.  <a href="https://www.rqriley.com/pro-dev.htm">https://www.rqriley.com/pro-dev.htm</a></td>
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<td><strong>E-Text Books:</strong></td>
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<tr>
<td>1.  <a href="https://faculty1.aucegypt.edu/farag/presentations/Chapter1.pdf">https://faculty1.aucegypt.edu/farag/presentations/Chapter1.pdf</a></td>
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**AVIONICS AND INSTRUMENTATION**

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</table>

**OBJECTIVES:**
The course should enable the students to:

I. Impart the knowledge in various types of Avionics systems, its components & its applications in aerospace industries.

II. Offer a rigorous avionics technology, Review of the basic system integration and the different type of avionics architectures.

III. Provide necessary knowledge to study the aircraft instrumentation sensors, displays and different type of sensors.

IV. Give knowledge about military aircraft adaptation, avionics and mission system interface and gives the difference between civilian aircraft avionics and military aircraft avionics.

**MODULE-I**

**AVIONICS TECHNOLOGY**

Classes: 10

Evolution of electronics; The nature of microelectronic devices, processors, memory devices; Introduction to avionics, systems integration, need - data bus systems, MIL STD 1553 bus system, ARINC 429/ARINC 629 bus systems, optical data bus systems; Integrated modular avionics architectures, commercial off the shelf systems; Avionics packaging.

**MODULE-II**

**AIRCRAFT INSTRUMENTATION - SENSORS AND DISPLAYS**

Classes: 10

Air data sensors, magnetic sensing, inertial sensing, and radar shensors. The electromechanical instrumented flight deck, early flight deck instruments, attitude direction indicator, horizontal situation indicator, altimeter, airspeed indicator; Advanced flight deck display system architectures, display systems, display media, future flight deck displays.

**MODULE-III**

**COMMUNICATION AND NAVIGATION AIDS**

Classes: 09

Radio frequency spectrum, communication systems, HF, VHF, satellite communications; ATC transponder, traffic collision avoidance system; Navigational aids; Automatic direction finding, VHF Omni range, distance measuring equipment; TACAN, VORTAC; Satellite navigation systems, the GPS.

Basic navigation, radio, inertial navigations, satellite navigation; GPS, differential GPS, wide area augmentation systems, local area augmentation system, and GPS overlay program; Integrated navigation, sensor usage; Flight management system (FMS); FMS control and display MODULE; Lateral navigation.

**MODULE-IV**

**MILITARY AIRCRAFT ADAPTATION**

Classes: 08

Avionic and mission system interface, navigation and flight management; Navigation aids, flight deck displays, communications, aircraft systems; Applications, personnel, material and vehicle transport, air-to-air refueling, maritime patrol, airborne early warning, ground surveillance; Electronic warfare, the EW spectrum, electronic support measures, electronic countermeasures, electro-optics and the infra-red.

**MODULE-V**

**AIRBORNE RADAR, ASTRONICS - AVIONICS FOR SPACECRAFT**

Classes: 08

Propagation of Radar waves, functional elements of radar, antenna- transmitter; Types of radar- pulse Doppler, civil aviation applications, military applications; Attitude determination and control of spacecraft, magnetometers, sun sensors, star trackers, earth and horizon sensors; Command and telemetry.
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<th><strong>Text Books:</strong></th>
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<tr>
<th><strong>Reference Books:</strong></th>
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<th><strong>Web References:</strong></th>
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<tbody>
<tr>
<td>1. <a href="https://soaneemrana.org/onewebmedia/INTRODUCTION%20TO%20SPACE%20DYNAMICS1">https://soaneemrana.org/onewebmedia/INTRODUCTION%20TO%20SPACE%20DYNAMICS1</a></td>
</tr>
<tr>
<td>2. <a href="https://nptel.ac.in/courses/101105030/">https://nptel.ac.in/courses/101105030/</a></td>
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<tr>
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<tr>
<td>2. <a href="https://www.worldcat.org/title/introduction-to-space-dynamics/oclc/867680515">https://www.worldcat.org/title/introduction-to-space-dynamics/oclc/867680515</a></td>
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AIR TRANSPORTATION SYSTEMS

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<th>Credits</th>
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<td>3 - - 3 30 70 100</td>
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Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Understand complexity and transport operation systems.
II. Understand many transport issues involved in handling passengers, freight of aircraft.

MODULE-I  AVIATION INDUSTRY  Classes: 08

Introduction, history of aviation, evolution, development, growth, challenges; Aerospace industry, air transportation industry- economic impact, types and causes; Airline industry, structure and economic characteristics; Airlines as oligopolists, other unique economic characteristics; Significance of airline passenger load factors.

MODULE-II  NATURAL ENVIRONMENT, REGULATORY ENVIRONMENT AND OPERATIONAL ENVIRONMENT  Classes: 10

The earth as a habitat, The Earth: physical issues affecting demand- surface, core, continents; Shape of demand; Demand forecasting- based on historical data, comparative analysis, theoretical demand models; Reliability of forecasts; The breadth of regulation- ICAO, IATA, national authorities (DGCA, FAA); Service properties: service volumes, international air service agreements, deregulation, privatization; Evolution: Communication, navigation and surveillance systems (CNS); Radio communications: VHF, HF, ACARS, SSR, ADS; Navigation: NDB, VOR, DME, area-navigation systems( R-Nav), ILS, MLS, GPS, INS, laser-INS; Surveillance: SSR, ADS; Airborne elements: AFCS, PMS, electronic control and monitoring/engine instrumentation and central automated systems, EFIS, FMS, GPWS, TCAS- future trends.

MODULE-III  AIRCRAFT  Classes: 10

Costs- project cash-flow, aircraft price; Compatibility with the operational infrastructure; Direct and indirect operating costs; Balancing efficiency and effectiveness-payload-range, fuel efficiency.

Technical contribution to performance, operating speed and altitude, aircraft field length performance; Typical operating costs; Effectiveness- wake-vortices, cabin dimensions, flight deck.

MODULE-IV  AIRPORTS AND AIRLINES  Classes: 09

Setting up an airport: airport demand, airport sitting, runway characteristics, length, declared distances, aerodrome areas, obstacle safeguarding; Runway capacity, evaluating runway capacity, sustainable runway capacity; Setting up an airline, modern airline objectives; Route selection and development, airline fleet planning, annual utilization and aircraft size, seating arrangements; Indirect operating costs; Aircraft- buy or lease; Revenue generation, computerized reservation systems, yield management; Integrating service quality into the revenue-generation process; Marketing the seats; Airline scheduling; Evaluating success, financial viability, regulatory compliance, efficient use of resources, effective service.

MODULE-V  AIRSPACE  Classes: 08

Categories of airspace, separation minima, airspace sectors, capacity, demand and delay; Evolution of air traffic control system, procedural ATC system, procedural ATC with radar assistance, first generation ‘automated’ ATC system, current generation radar and computer-based ATC systems; Aerodrome air traffic
control equipment and operation - ICAO future air-navigation systems (FANS); Air-navigation service providers as businesses.

**Text Books:**


**Reference Books:**


**Web References:**

1. https://pdfs.semanticscholar.org/7f85/e5cfcdd85e25bd495b5762e1ca4facda739.pdf

**E-Text Books:**

AIRPORT PLANNING AND MANAGEMENT

PE - V

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Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Understand design and planning of airport operation systems.
II. Understand many operational issues involved in design of airports.

MODULE-I  AIRPORTS AND AIRPORT SYSTEMS  Classes: 08

Introduction: Airport management on an international level; The national plan of integrated airport systems; The nation’s airport system plan; The rules that govern airport management; Organizations that influence airport regulatory policies; A historical and legislative perspective: Introduction the formative period of aviation and airports, Airport growth: World War II and the postwar period airport modernization: The early jet age.

MODULE-II  COMPONENTS OF THE AIRPORT  Classes: 10

The components of an airport. The airfield. Navigational aids (NAVAIDS) located on airfields; Air traffic control and surveillance facilities located on the airfield; Weather reporting facilities located on airfields; Security infrastructure on airfields; Airspace and air traffic control: Brief history of air traffic control; The basics of air traffic control; Current and future enhancements to air traffic control; Airport terminals and ground access; The historical development of airport terminals; Components of the airport terminal; Airport ground access.

MODULE-III  AIRPORT OPERATIONS AND FINANCIAL MANAGEMENT  Classes: 10

Airport operations management: Introduction, pavement management, aircraft rescue and fire fighting (ARFF); Snow and ice control, safety inspection programs.

Bird and wildlife hazard management; Airport security: Security at commercial service airports, security at general aviation airports; The future of airport security.

MODULE-IV  AIRPORT FINANCIAL MANAGEMENT  Classes: 09

Airport financial accounting, revenue strategies at commercial airports, pricing of airport facilities and services, variation in the sources of operating revenues, rise in airport financial burdens, airport funding, grant programs, airport financing, private investment sale of the airport.

MODULE-V  AIRPORT CAPACITY AND DELAY  Classes: 08

Defining capacity, factors affecting capacity and delay, estimating capacity, analytical estimates of delay: The queuing diagram; The future of airport management: Introduction, restructuring of commercial air carriers, new large aircraft, small aircraft transportation systems.

Text Books:
**Reference Books:**


**Web References:**

2. https://books.google.co.in/books?id=RYR6cu4YSBcC&dq=Planning%20and%20Design%20of%20Airports&source=gbs_similarbooks

**E-Text Books:**

# FLIGHT SCHEDULING AND OPERATIONS

## OBJECTIVES:
The course should enable the students to:
I. Understand complexity and scheduling of airline operation systems.
II. Understand many operational issues involved in handling passengers, freight and aircraft at airports.

### MODULE-I: NETWORK FLOWS AND INTEGER PROGRAMMING MODELS

Complexity of airline planning, operations and dispatch, need for optimization, role of operations research and simulation; Networks: definitions, network flow models, shortest path problem, minimum cost flow problem, maximum flow problem, multi-commodity problem; Integer programming models, set covering/partitioning problems, travelling salesman problem, mathematical formulation, decision variables, objective function, constraints, methods of solution; Solution by simulation.

### MODULE-II: FLIGHT SCHEDULING, FLEET ASSIGNMENT AND AIRCRAFT ROUTING

Significance of flight scheduling; The route system of the airlines, point-to-point flights, hub and spoke flights; Schedule construction, operational feasibility, economic viability; Route development and flight scheduling process, load factor and frequency, case study; Purpose of fleet assignment; Fleet types, fleet diversity, fleet availability, performance measures, formulation of the fleet assignment problem, decision variables, objective function, constraints, solution; Goal of aircraft routing, maintenance requirements, other constraints; Routing cycles, route generators; Mathematical models of routing, decision variables, objective functions, alternatives, constraints- flight coverage and aircraft available; Example problems and solutions.

### MODULE-III: CREW AND MANPOWER SCHEDULING

Crew scheduling process, significance; Development of crew pairing, pairing generators, mathematical formulation of crew pairing problem, methods of solution.

Crew roistering, rostering practices; The crew rostering problem, formulation, solutions; Manpower scheduling, modeling, formulation of the problem, solutions.

### MODULE-IV: GATE ASSIGNMENT AND AIRCRAFT BOARDING STRATEGY, AIRLINE IRREGULAR OPERATION, DISRUPTION OF SCHEDULE AND RECOVERY

Gate assignment, significance, the problem, levels of handling-passenger flow, distance matrix- mathematical formulation, solution; Common strategies for aircraft boarding process, mathematical model, interferences, model description, aisle interferences; The problem statement, the time band approximation model- formulation of the problem, the scenarios - solution.

### MODULE-V: COMPUTATIONAL COMPLEXITY, CASE STUDIES OF AIRLINE OPERATIONS AND SCHEDULING AND SIMULATION.

Complexity theory, heuristic procedures; Case studies of airline operation and scheduling, study through simulation modeling, use of available software.
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# AUTOMATIC CONTROL OF AIRCRAFT

**Course Code:** AAEB49  
**Category:** Elective  
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**Contact Classes:** 45  
**Tutorial Classes:** Nil  
**Practical Classes:** Nil  
**Total Classes:** 45

**OBJECTIVES:**  
The course should enable the students to:  
I. Understand the guidance and control of aircraft and explain different augmentation system and concepts.  
II. Demonstrate different auto pilot systems, flight path stabilization and Automatic Flare Control.  
III. Discuss fly by wire flight control systems and different flight control law design using back stepping algorithm.  
IV. Illustrate operating principles and design of guidance laws, Launch Vehicle and Mission requirements.

## MODULE-I  
**INTRODUCTION**  
Classes: 04  
Introduction to Guidance and control: Definition, historical background.

## MODULE-II  
**AUGMENTATION SYSTEMS**  
Classes: 07  
Need for automatic flight control systems, stability augmentation systems, control augmentation systems, gain scheduling concepts.

## MODULE-III  
**LONGITUDINAL AUTOPilot**  
Classes: 12  
Displacement Autopilot: Pitch orientation control system, acceleration control system, glide slope coupler and automatic flare control.  
Flight path stabilization, longitudinal control law design using back stepping algorithm.

## MODULE-IV  
**LATERAL AUTOPilot**  
Classes: 10  
Damping of the dutch roll, methods of obtaining coordination, yaw orientation control system, turn compensation, automatic lateral beam guidance.

## MODULE-V  
**FLY BY WIRE FLIGHT CONTROL**  
Classes: 12  
Introduction to Fly-by-wire flight control systems, fly-by-wire flight control features and advantages, control laws, redundancy and failure survival, digital implementation, fly-by-light flight control.

**Text Books:**  

**Reference Books:**  
<table>
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<th>Web References:</th>
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<tr>
<td>1. <a href="https://ocw.mit.edu/courses/aeronautics-and-astronautics/16...aircraft.../lecture-16">https://ocw.mit.edu/courses/aeronautics-and-astronautics/16...aircraft.../lecture-16</a></td>
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<tr>
<td>2. <a href="www.fsd.mw.tum.de/research/flight-control/">www.fsd.mw.tum.de/research/flight-control/</a></td>
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<td>3. <a href="nptel.ac.in/courses/101108056/">nptel.ac.in/courses/101108056/</a></td>
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<tr>
<td>1. <a href="https://books.google.co.in/books?isbn=1118870972">https://books.google.co.in/books?isbn=1118870972</a></td>
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<tr>
<td>2. <a href="https://books.google.co.in/books?isbn=0387007261">https://books.google.co.in/books?isbn=0387007261</a></td>
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FLIGHT SIMULATION

PE-VI

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<th>Course Code</th>
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Contact Classes: 45  
Tutorial Classes: Nil  
Practical Classes: Nil  
Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Illustrate the history of flight simulation, role of simulation, aerodynamic models with examples.
II. Understand the principle of modeling and simulation of flight control systems, different equations of aircraft system.
III. Describe the dynamics of aircraft and model validation, the atmospheric conditions and different axis systems of aircraft.
IV. Define various model validation and visual systems, visual database management, projection systems, problems in visual systems.

MODULE-I  
INTRODUCTION  
Classes: 10

Historical Perspective, the first 40 years of flight 1905–1945, analogue computing, 1945–1965, digital computing 1965–1985, the microelectronics revolution, 1985 present, the case for simulation, safety, financial benefits, training transfer, engineering flight simulation, the changing role of simulation, the organization of a flight simulator, equations of motion, aerodynamic model, engine model, data acquisition, gear model, weather model, visual system, sound system, motion system, control loading, instrument displays, navigation systems, maintenance, the concept of real-time simulation, pilot cues, visual cueing, motion cueing, training versus simulation, examples of simulation, commercial flight training, military flight training. Ab initio flight training, land vehicle simulators, engineering flight simulators aptitude testing, computer-based training, maintenance training.

MODULE-II  
PRINCIPLES OF MODELLING  
Classes: 10

Modelling concepts, Newtonian mechanics, axes systems, differential equations, numerical integration, approximation methods, first order methods, higher order methods, real-time computing, data acquisition, data transmission, data acquisition, flight data, interpolation, distributed systems, a real-time protocol, and problems in modelling.

MODULE-III  
AIRCRAFT DYNAMICS  
Classes: 09

Principles of flight modelling, the atmosphere, forces, aerodynamic lift, aerodynamic side force, aerodynamic drag, propulsive forces, gravitational force, moments, static stability, aerodynamic moments, aerodynamic derivatives, axes systems, the body frame, stability axes, wind axes, inertial axes, transformation between axes. Earth-centred earth-fixed frame, latitude and longitude, quaternions, equations of motion; Propulsion, piston engines, jet engines, the landing gear, the equations collected; The equations revisited: Long range navigation, coriolis acceleration.

MODULE-IV  
SIMULATION OF FLIGHT CONTROL SYSTEMS  
Classes: 08

The Laplace transform, simulation of transfer functions; Proportional–integral–derivative control systems, trimming, aircraft flight control systems, the turn coordinator and the yaw damper, the auto-throttle, vertical speed management, altitude hold, heading hold, localizer tracking, auto-land systems, flight management systems.
### MODULE-V

<table>
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<tr>
<th>MODEL VALIDATION AND VISUAL SYSTEMS</th>
<th>Classes: 08</th>
</tr>
</thead>
</table>

Model validation: Simulator qualification and approval, model validation methods, cockpit geometry, open-loop tests, closed-loop tests, latency, performance analysis, longitudinal dynamics, lateral dynamics, model validation in perspective

Visual systems: Background, the visual system pipeline, graphics operations, real-time image generation, a rudimentary real time wireframe image generation system, an open GL real-time image generation system, an open GL real-time textured image generation system, an open scene graph image generation system, visual database management, projection systems, problems in visual systems.

### Text Books:


### Reference Books:


### Web References:


### E-Text Books:

3. https://leseprobe.buch.de/images-adb/ee/49/ee49f5fc-8dc1-4a07-ad7b-b18540b9fb60.pdf
## ORBITAL MECHANICS

### OBJECTIVES:
The course should enable the students to:

I. Impart the knowledge in two-body, restricted three-body and n-body problem, Hamiltonian dynamics, canonical transformations, Poincare surface sections.

II. Offer a rigorous vector analysis of rotational kinematics, Review of the basic Newtonian dynamics and Analysis of spacecraft altitude dynamics.

III. Provide necessary knowledge to study the satellite and interplanetary trajectories and Formal approaches for handling coordinate transformations.

IV. Solve the orbital problems related to Earth satellite orbits using Hamilton’s and generate interplanetary orbits in the frame work of restricted three-body problem.

V. Understand the rendezvous problems in orbital transfer problems, to provide the knowledge about link between two spacecrafts.

### MODULE-I  INTRODUCTION TO ORBITAL MECHANICS

- **Classes:** 10
- Fundamental principles and definitions, problem of two bodies, Kepler’s equation; Equation of motion in inertial frame, equations of relative motion, angular momentum and the orbit formulas; Central orbits, circular orbits, elliptical orbits.

### MODULE-II  ORBITAL POSITION AND ORBITS IN THREE DIMENSIONS

- **Classes:** 10
- Time since periapsis, parabolic trajectories, hyperbolic trajectories, geocentric right ascension-declination frame, state vector and the geocentric equatorial frame, orbital elements and the state vector; Coordinate transformation, transformation between geocentric equatorial and perifocal frames; Effects of the Earth’s oblateness.

### MODULE-III  PRELIMINARY ORBIT DETERMINATION

- **Classes:** 09
- Gibbs method of orbit determination from three position Lambert’s problem, sidereal time top centric coordinate system, top centric equatorial coordinate system, top centric horizon coordinate system.

### MODULE-IV  ORBITAL MANEUVERS

- **Classes:** 08
- Introduction, Impulsive maneuver, Kepler’s equation and Lambert’s theorem, force model, fundamentals of perturbation theory, perturbation in the elements, Lagrange’s and Hamilton's equations, the method of canonical transformations, the general integrals of the problem of n-bodies, the problem of three bodies, restricted three-body problem, periodic and quasi-periodic orbits, Poincare surface sections.

### MODULE-V  RELATIVE MOTION AND RENDEZVOUS

- **Classes:** 08

**Text Books:**


**Reference Books:**


**Web References:**

1. https://soaneemrana.org/oneyebmedia/INTRODUCTION%20TO%20SPACE%20DYNAMICS1

**E-Text Books:**

2. https://worldcat.org/title/introduction-to-space-dynamics/oclc/867680515
Space Dynamics

PE-VI

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<th>Category</th>
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Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

Objectives:
The course should enable the students to:
I. To impart the knowledge in two-body, restricted three-body and n-body problem, Hamiltonian dynamics, canonical transformations, poincare surface sections.
II. To offer a rigorous vector analysis of rotational kinematics, review of the basic newtonian dynamics and analysis of spacecraft altitude dynamics.
III. To provide necessary knowledge to study the satellite and interplanetary trajectories and formal approaches for handling coordinate transformations.
IV. To solve the space dynamic problems related to earth satellite orbits using Hamilton’s and generate interplanetary orbits in the frame work of restricted three-body problem.

Module-I  Introduction to Space Dynamics
Basic concepts: Atmospheric and space flight basic definitions, vector operations; Coordinate systems and rotation matrix, Euler axis and principal angle, Euler angles, Euler symmetric parameters (Quaternion), Rodriguez parameters, attitude kinematics.

Module-II  Fundamentals of Space Flight
Newton’s law of gravitation, gravitational potential, escapes velocity, mechanics of circular orbits and circular velocity non circular orbits; The two body problem, derivation of Kepler’s laws from Newton’s law.

Module-III  Space Flight Orbits and Atmosphere Entry
Orbit equation, space vehicle trajectories, transfer orbit changes.
Introduction to earth and planetary entry, equations of motion for atmosphere entry; Application to ballistic entry, case study.

Module-IV  Orbit Transfer
Coplanar transfer, Hohmann transfer and Bielliptic transfer; Orbital change due to impulsive thrust; Noncoplanar transfer; Interception and Rendezvous, continuous thrust transfer.

Module-V  Attitude Dynamics
Euler Equations of rotational motion, rotational kinetic energy; Principal body frame, torque free rotation of spacecraft, spacecraft with attitude thrusters, spacecraft with rotors, gravity gradient satellite, dual spin satellite.

Text Books:

Reference Books:

Web References:

1. https://soaneemrana.org/onewebmedia/INTRODUCTION%20TO%20SPACE%20DYNAMICS
2. https://nptel.ac.in/courses/101105030/

E-Text Books:

2. https://worldcat.org/title/introduction-to-space-dynamics/oclc/867680515
# FLIGHT CONTROL THEORY

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<td>Tutorial Classes: Nil</td>
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## OBJECTIVES:

The course should enable the students to:

I. Apply stability criteria to determine the stability of an aircraft, and specify the aircraft time-domain and frequency-domain response specifications.

II. Understand 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. Design control techniques for aircraft control systems, and study some feedback control applications.

IV. Study the controllability and observability of aerospace systems, and apply the modern control techniques to design enhanced flight control systems.

## MODULE I - INTRODUCTION TO CONTROL SYSTEMS

Classes: 10


## MODULE II - MATHEMATICAL MODELLING OF DYNAMIC SYSTEMS

Classes: 10


## MODULE III - STEADY STATE RESPONSE ANALYSIS

Classes: 10


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.

<table>
<thead>
<tr>
<th>MODULE-IV</th>
<th>AIRCRAFT RESPONSE TO CONTROLS</th>
<th>Classes: 07</th>
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<td>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.</td>
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**Text Books:**


**Reference Books:**


**E-Text Books:**

AIRFRAME STRUCTURAL DESIGN

OE - I

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<th>Course Code</th>
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Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:

I. Familiarize students with the important issues and methodologies of aircraft design.
II. Illustrate the process of aircraft synthesis as an outcome of the integration of the disciplines of aerodynamics, performance, stability and control, propulsion, structures and aero elasticity.
III. Understand role and lay-out of main structural members of load carrying airframe components as well as the relevant basic design philosophies.
IV. Develop the ability to function as a member of a team in a design setting; including the ability to conduct a peer review of the other team members.
V. Familiarize students with Federal Aviation Regulations as a means for ensuring passenger safety

MODULE-I  INTRODUCTION AIRWORTHINESS REQUIREMENTS  Classes: 10


MODULE-II  EXTERNAL LOADS-ESTIMATION, FASTENERS AND STRUCTURAL JOINTS  Classes: 10


MODULE -III  DESIGN OF WING, TAIL UNIT STRUCTURES  Classes: 10

The wing- role- summary of wing loads, structural components- wing box, leading and trailing edges. Wing layout- location of spars, ailerons and flaps, rib spacing and direction, root rib bulkhead, span wise stiffeners, wing covers- skin-stringer panels, integrally stiffened panels, access holes, attachment of leading edge and trailing edge panels.

Spars- general rules of spar design. Ribs and bulkheads- rib spacing and arrangement. Wing root joints, carry through structure. Fighter wing design- problems with swept wings. Wing box, root rib bulkhead-
estimation of loads, stress analysis, design parameters, optimisation, sizing, margins of safety. Leading and trailing edge assembly - control surfaces, flaps - structure

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<thead>
<tr>
<th>MODULE-IV</th>
<th>DESIGN OF FUSELAGE, LANDING GEAR, ENGINE MOUNTS</th>
<th>Classes: 07</th>
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<tbody>
<tr>
<td>Function of fuselage- loading, general requirements. Ultimate strength of stiffened cylindrical structure-review, Principal structural components- skin and stringers, frame and floor beam, pressure bulkhead, wing and fuselage intersection- lay out, loading, stress analysis, sizing. Forward fuselage, aft fuselage structures, fuselage openings- windows, doors- design considerations. Landing gear- purpose, types, general arrangement, loads- design considerations- ground handling, take-off, landing, braking, pavement loading, support structure. Stowage and retraction, gear lock- kinematic design. Shock absorbers- function, types, components, operation, loads, materials, design. Wheels and brakes, tire selection. Engine mounts- types- wing pod, rear fuselage, tail, fuselage mount, loads, design considerations</td>
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<table>
<thead>
<tr>
<th>MODULE - V</th>
<th>FATIGUE LIFE, DAMAGE TOLERANCE, FAIL-SAFE DESIGN- WEIGHT CONTROAND BALANCE</th>
<th>Classes: 08</th>
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</thead>
<tbody>
<tr>
<td>Catastrophic effects of fatigue failure- examples- modes of failure- design criteria- fatigue stress, fatigue performance, fatigue life. Fatigue design philosophy- fail-safe, safe life. Service behaviour of aircraft structures- effect of physical and load environment design and of detail of fabrication Structural life-methods of estimation- the scatter factor- significance Fail-safe design- the concept, requirements, damage tolerance-estimation of fatigue strength</td>
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**Text Books:**


**Reference Books:**


**E-Text Books:**


MECHANICAL PROPERTIES OF MATERIALS

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
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<td>Practical Classes: Nil</td>
<td>Total Classes: 45</td>
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</table>

OBJECTIVES:
The course should enable the students to:

I. Understand the physical and mechanical, metallurgical engineering concepts for metals and preparation of alloys.
II. Understand the stages of design process and evolution of materials.
III. Interpret the basis for material selection in engineering design through case studies.
IV. Explore the material property plots, database and optimization techniques to identify the best performing materials for a given application.
V. Estimate the material life and their impact on industries and environment.

MODULE-I STRUCTURE OF METALS

Structure of metals: Crystallography, Miller indices, packing efficiency, density calculations, grains and grain boundaries, effect of grain size on the properties, determination of grain size by different methods, constitution of alloys, necessity of alloying, types of solid solutions, Hume-Rothery rules, intermediate alloy phases.

MODULE-II MATERIAL SELECTION

The basics, metals and metallic structure, metallic alloys, ceramics and glasses, polymers and composites for mechanical design, material properties: surface and other functional properties, the selection strategy, Attribute limits and material indices, the selection procedure, shape factor, Computer-aided selection, and the structural index Case Studies: Diaphragms for pressure actuators, Deflection limited design with brittle polymers, Nylon bearings for ship rudders.

MODULE-III PROCESSES AND PROCESS SELECTION

Introduction and synopsis, classifying processes, the processes: shaping, joining, and finishing, Systematic process selection, Ranking: process cost, Computer - aided process selection, supporting information Case studies: Forming ceramic tape valves, Forming a silicon nitride micro-beam, Fabricating a pressure vessel.

MODULE-IV DESIGN PROCESS

Material Selection using Ashby method, micro-structural shape factors, exploring and comparing structural sections, multiple Constraints and objectives in material selection, optimal selection with and without shape factor, multiple objectives, role of materials in shaping the product character.

MODULE-V METHODS TO MINIMIZE COST OF MATERIAL HANDLING

Environmental Impact: Materials and the environment, the material life cycle, material and energy consuming systems, the eco-attributes of materials, eco-selection, Case studies-Drink containers and crash barriers. materials and industrial design: Introduction and synopsis, the requirements pyramid, product character, using materials and processes to create product personality.
# Text Books:

# Reference Books:

# Web References:
1. [http://nptel.ac.in/courses/112106138/](http://nptel.ac.in/courses/112106138/)

# E-Text Book:
1. [https://accessengineeringlibrary.com/browse/precision-engineering](https://accessengineeringlibrary.com/browse/precision-engineering)
### OBJECTIVES:
The course should enable the students to:

I. Describe the basic concepts of automation in manufacturing systems.
II. Acquire the fundamental concepts of automated flow lines and their analysis.
III. Classify automated material handling, automated storage and retrieval systems.
IV. Illustrate adaptive control systems and automated inspection methods.

### MODULE-I: INTRODUCTION AND MANUFACTURING OPERATIONS
Classes: 09

### MODULE-II: INDUSTRIAL CONTROL SYSTEM
Classes: 09

### MODULE-III: AUTOMATED MANUFACTURING SYSTEMS
Classes: 09
Components of Manufacturing systems, Classification of Manufacturing Systems, overview of Classification Scheme, Single Station Manned Workstations and Single Station Automated Cells.

### MODULE-IV: GROUP TECHNOLOGY AND FLEXIBLE MANUFACTURING SYSTEMS
Classes: 09

### MODULE-V: Manufacturing Support System
Classes: 09

### Text Books:

### Reference Books:

**Web References:**
2. http://nptel.ac.in/courses/112102011

**E-Text Book:**
1. https://docs.google.com/file/d/0B7uir_9DoCLFaGduckFqQmcwUnc/edit?usp=drive
REMOTE SENSING AND GIS

<table>
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<tr>
<td><strong>Contact Classes:</strong> 45</td>
<td><strong>Tutorial Classes:</strong></td>
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</table>

**OBJECTIVES:**

The course should enable the students to:

I. Understand the Photogrammetric techniques, concepts, components of Photogrammetry
II. Introduce the students to the basic concepts and principles of various components of remote sensing.
III. Provide an exposure to GIS and its practical applications in Civil Engineering.
IV. Analyze the energy interactions in the atmosphere and earth surface features.

**MODULE - I**

**INTRODUCTION TO PHOTOGRAMMETRY**

Principles & types of aerial photograph, geometry of vertical aerial photograph, Scale & Height measurement on single vertical aerial photograph, Height measurement based on relief displacement, Fundamentals of stereoscopy, fiducially points, parallax measurement using fiducially line.

**MODULE - II**

**REMOTE SENSING**

Basic concepts and foundation of remote sensing – elements involved in remote sensing, electromagnetic spectrum, remote sensing terminology and units, Energy resources, energy interactions with earth surface features and atmosphere, resolution, sensors and satellite visual interpretation techniques, basic elements, converging evidence, interpretation for terrain evaluation, spectral properties of water bodies, introduction to digital data analysis.

**MODULE - III**

**GEOGRAPHIC INFORMATION SYSTEM AND TYPES OF DATA REPRESENTATION**

Introduction, GIS definition and terminology, GIS categories, components of GIS, fundamental operations of GIS, A theoretical framework for GIS.


**MODULE - IV**

**GIS SPATIAL ANALYSIS**

Computational Analysis Methods (CAM), Visual Analysis Methods (VAM), Data storage - vector data storage, attribute data storage, overview of the data manipulation and analysis. Integrated analysis of the spatial and attribute data.

**MODULE - V**

**WATER RESOURCES APPLICATIONS**

Land use/Land cover in water resources, Surface water mapping and inventory, Rainfall – Runoff relations and runoff potential indices of watersheds, Flood and Drought impact assessment and monitoring, Watershed management for sustainable development and Watershed characteristics.
### Text Books:


### Reference Books:


### Web References:

1. https://nptel.ac.in/courses/105103193/
2. https://nptel.ac.in/courses/121107009/
3. https://nptel.ac.in/courses/105108077/

### E-Text Books:

PROJECT SAFETY MANAGEMENT

OE – I

<table>
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</table>

Contact Classes: 45  Tutorial Classes:  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Understand the various safety concepts and requirements applied to construction projects.
II. Study the of construction accidents, safety programmes, contractual obligations, and design for safety.
III. Understand the safety and health of persons at work in connection with the use of plant and machinery.
IV. A structured management approach to control safety risks in operations.

MODULE - I  CONSTRUCTION ACCIDENTS  Classes: 09

MODULE - II  SAFETY PROGRAMMES  Classes: 09

MODULE - III  CONTRACTUAL OBLIGATIONS  Classes: 09
Safety in Construction Contracts – Substance Abuse – Safety Record Keeping

MODULE - IV  DESIGNING FOR SAFETY  Classes: 09

MODULE - V  OWNERS’ AND DESIGNERS’ OUTLOOK  Classes: 09
Owner’s responsibility for safely – Owner preparedness – Role of designer in ensuring safety – Safety clause in design document.

Text Books:
### Reference Books:


### Web References:

1. https://nptel.ac.in/content/storage2/courses/114106039/Tutorial%20key.pdf

### E-Text Books:

**COMPUTER ARCHITECTURE**

**OE – II**

<table>
<thead>
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<th>Hours / Week</th>
<th>Credits</th>
<th>Maximum Marks</th>
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</table>

**Contact Classes: 45**  **Tutorial Classes: Nil**  **Practical Classes: Nil**  **Total Classes: 45**

**OBJECTIVES:**

The course should enable the students to:

I. Understand the organization and architecture of computer systems and electronic computers.

II. Study the assembly language program execution, instruction format and instruction cycle.

III. Design a simple computer using hardwired and micro programmed control methods.

IV. Study the basic components of computer systems besides the computer arithmetic.

V. Understand input-output organization, memory organization and management, and pipelining.

**MODULE - I  INTRODUCTION TO COMPUTER ORGANIZATION**  
Classes: 09

Basic computer organization, CPU organization, memory subsystem organization and interfacing, input or output subsystem organization and interfacing, a simple computer levels of programming languages, assembly language instructions, a simple instruction set architecture.

**MODULE -II  ORGANIZATION OF A COMPUTER**  
Classes: 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**  
Classes: 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**  
Classes: 09

Input or output organization: Input or output Interface, asynchronous data transfer, modes of transfer, priority interrupt, direct memory access.

**MODULE -V  MEMORY ORGANIZATION**  
Classes: 09

Memory organization: Memory hierarchy, main memory, auxiliary memory, associative memory, cache memory, virtual memory; Pipeline: Parallel processing, Instruction pipeline;

**Text Books:**

**Reference Books:**


**Web References:**

1. https://www.tutorialspoint.com/computer_logical_organization/
2. https://www.courseera.org/learn/comparch

**E-Text Books:**

ANALYSIS OF ALGORITHMS AND DESIGN

OE - II

<table>
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<th>Category</th>
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Contact Classes: 45 Tutorial Classes: Nil Practical Classes: Nil Total Classes: 45

OBJECTIVES:
The course should enable the students to:
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.
III. Choose the appropriate data structure and algorithm design method for a specified application.
IV. Solve problems using algorithm design methods such as the divide and conquer, greedy method, dynamic programming, branch and bound, backtracking.

MODULE - I INTRODUCTION Classes: 09
Algorithm: Pseudo code for expressing algorithms; Performance analysis: Space complexity, time complexity; Amortized Complexity, Asymptotic notations: Big O notation, omega notation, theta notation and little o notation.

MODULE - II DIVIDE AND CONQUER Classes: 09
Divide and Conquer: General method, applications: Binary search, quick sort, merge sort, Strassen’s matrix multiplication.

MODULE - III TRAVERSAL TECHNIQUES AND GREEDY METHOD Classes: 09
Efficient non recursive binary tree traversal algorithms, spanning trees; Graph traversals: Breadth first search, depth first search, connected components, biconnected components.

Greedy method: The general method, job sequencing with deadlines, knapsack problem, single source shortest paths.

MODULE - IV DYNAMIC PROGRAMMING Classes: 09
Dynamic programming: The general method, matrix chain multiplication, optimal binary search trees, 0/1 knapsack problem, all pairs shortest paths problem.

MODULE - V BRANCH AND BOUND, BACKTRACKING Classes: 09
Branch and bound: The general method, travelling salesperson problem; Backtracking: The general method, the 8 queens problem, graph coloring.

Text Books:
### Reference Books:


### Web References:

3. [http://www.facweb.iitkgp.ernet.in/~sourav/daa.html](http://www.facweb.iitkgp.ernet.in/~sourav/daa.html)

### E-Text Books:

1. [http://ebook/com/item/introduction_to_the_design_and_analysis_of_algorithms_3rd_editionananylevitin/](http://ebook/com/item/introduction_to_the_design_and_analysis_of_algorithms_3rd_editionananylevitin/)
2. [https://drive.google.com/file/d/0B_Y1VbyboEDBTDVxVXpVbnk4TVE/edit?pref=2&pli=1](https://drive.google.com/file/d/0B_Y1VbyboEDBTDVxVXpVbnk4TVE/edit?pref=2&pli=1)
RELATIONAL DATABASE MANAGEMENT SYSTEMS

OE – II

<table>
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<td>Practical Classes: Nil</td>
<td>Total Classes: 45</td>
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</table>

OBJECTIVES:
The course should enable the students to:
I. Understand the role of database management system in an organization and learn the database concepts.
II. Design databases using data modeling and Logical database design techniques.
III. Construct database queries using relational algebra and calculus and SQL.
IV. Understand the concept of a database transaction and related concurrent, recovery facilities.
V. Learn how to evaluate a set of queries in query processing.

MODULE -I  CONCEPTUAL MODELING INTRODUCTION  Classes: 09
Introduction to Databases and Database Management System - Database system Applications Advantages of DBMS over File System - Data Models – Instances and schema - View of Data - Database Languages - DDL-DML - Database Users and Administrator - Database System Structure.

MODULE -II  RELATIONAL APPROACH  Classes: 09

MODULE -III  SQL QUERY - BASICS , RDBMS - NORMALIZATION  Classes: 09
Introduction to the Relational Model – Structure of RDBMS - Integrity Constraints over Relations – Enforcing Integrity Constraints – Querying Relational Data - Relational Algebra and Calculus.

Introduction to SQL- Data Definition commands, Data Manipulation Commands, Basic Structure, Set operations Aggregate Operations - Join operations - Sub queries and correlated queries, SQL functions, views , Triggers, Embedded SQL

MODULE -IV  TRANSACTION MANAGEMENT  Classes: 09

MODULE -V  DATA STORAGE AND QUERY PROCESSING  Classes: 09
Transaction concept- Transaction state- Implementation of atomicity and Durability- Concurrent executions – Serializability, Recoverability; File Organization – Organization of records in file - Data Dictionary Storage – Indexing and Hashing – Basic Concepts , Ordered Indices,B+Tree Index files, B- tree index files
**Text Books:**


**Reference Books:**


**Web References:**

1. https://www.youtube.com/results?search_query=DBMS+online+classes
2. http://www.w3schools.in/dbms/

**E-Text Books:**

3. https://docs.google.com/file/d/0B9aJA_iV4kHYM2dieHZhMHhyRVE/edit

**MOOC Course**

1. https://onlinecourses.nptel.ac.in/noc18_cs15/preview
ADVANCED DATA STRUCTURES

OE - II

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</table>

Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Understand the basic data structures and techniques of algorithm analysis.
II. Understand dictionaries, hashing mechanisms and skip lists for faster data retrieval.
III. Comprehension of heaps, priority queues and its operations.
IV. Understand balanced trees and their operations.
V. Illustration of tries and pattern matching algorithms.

MODULE -I  OVERVIEW OF DATA STRUCTURES  Classes: 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  Classes: 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  Classes: 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  Classes: 09

MODULE -V  PATTERN MATCHING AND TRIES  Classes: 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.

Text Books:
**Reference Books:**


**Web References:**

2. https://www.geeksforgeeks.org/data-

**E-Text Books:**

1. https://pdfs.semanticscholar.org/19ec/55ed703eb24e1d98a4abd1a15387281cc0f8.pdf

**MOOC Course**

1. https://nptel.ac.in/courses/106103069/
DATA COMMUNICATIONS AND NETWORKS

OE - II

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
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Contact Classes: 45 Tutorial Classes: Nil Practical Classes: Nil Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Develop an understanding of modern network architectures from a design and performance perspective. 
II. Understand the basics and challenges of network communication. 
III. Provide an opportunity to do network programming using TCP/IP. 
IV. Understand the operation of the protocols that are used inside the Internet.

MODULE - I DATA COMMUNICATIONS Classes: 09

Components, Direction of Data flow, Networks, Components and Categories, Types of Connections, Topologies, Protocols and Standards, ISO / OSI model, Example Networks such as ATM, Frame Relay, ISDN.

MODULE – II THE PHYSICAL LAYER Classes: 09

Transmission modes, Switching, Circuit Switched Networks, Transmission Media, Datagram Networks, Virtual Circuit Networks.

MODULE – III THE DATALINK LAYER Classes: 09


MODULE – IV THE NETWORK LAYER Classes: 09

Logical Addressing, Internetworking, Tunneling, Address mapping, ICMP, IGMP, Forwarding, Uni-Cast Routing Protocols, Multicast Routing Protocols

MODULE – V THE TRANSPORT AND APPLICATION LAYER Classes: 09


Text Books:
### Reference Books:


### Web References:

1. [http://computer.howstuffworks.com/computer-networking-channel.htm](http://computer.howstuffworks.com/computer-networking-channel.htm)
2. [http://www.ietf.org](http://www.ietf.org)

### E-Text Books:

1. [http://www.freebookcentre.net/networking-books-download/Lecture-Notes-on-Computer-Networks.html](http://www.freebookcentre.net/networking-books-download/Lecture-Notes-on-Computer-Networks.html)

### MOOC Course

NETWORK SECURITY

<table>
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</table>

Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Learn the basic categories of threats to computers and networks.
II. Understand various cryptographic algorithms and be familiar with public-key cryptography.
III. Apply authentication functions for providing effective security.
IV. Analyze the application protocols to provide web security.
V. Discuss the place of ethics in the information security area.

MODULE-I  ATTACKS ON COMPUTERS AND COMPUTER SECURITY  Classes: 09
Attacks on computers and computer security: Introduction, the need for security, security approaches, principles of security, types of security attacks, security services, security mechanism, a model for network security; Cryptography concepts and techniques: Introduction, plain text and cipher text, substitution techniques, transposition techniques, encryption and decryption, symmetric and asymmetric key cryptography.

MODULE-II  SYMMETRIC AND ASYMMETRIC KEY CIPHERS  Classes: 09
Symmetric key ciphers: Block cipher principles and algorithms (DES,AES), block cipher modes of operation, stream ciphers, and placement of encryption function, key distribution; Asymmetric key ciphers: Principles of public key cryptosystems, algorithms (RSA Diffie-Hellman).

MODULE-III  MESSAGE AUTHENTICATION ALGORITHM AND HASH FUNCTIONS  Classes: 09
Message authentication algorithm and hash functions: Authentication requirements, functions, message, authentication codes.

MODULE-IV  E-MAIL SECURITY  Classes: 09
E-mail Security: Pretty Good Privacy; S/MIME
IP Security: IP security overview, IP security architecture, authentication header, encapsulating security payload, combining security associations, key management.

MODULE-V  WEB SECURITY  Classes: 09
Web security: Web security considerations, secure socket layer and transport layer security, secure electronic transaction.
Intruders; Virus and firewalls: Intruders, intrusion detection password management, virus and related threats, countermeasures, firewall design principles; Types of firewalls.

Text Books
### Reference Books


### Web References

2. https://books.google.co.in/books/about/Cryptography_Network_Security_Sie_2E.html?id=Kokjwdf0E7QC
3. https://books.google.co.in/books/about/Information_Security.html?id=Bh45pU0_E_4C

### E-Text Books

1. https://books.google.co.in/books/about/Information_Security.html
SOFT SKILLS AND INTERPERSONAL COMMUNICATION

<table>
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<th>Category</th>
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Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:

I. Communicate in a comprehensible English accent and pronunciation.
II. Use the four language skills i.e., Listening, Speaking, Reading and Writing effectively.
III. Develop the art of interpersonal communication skills to avail the global opportunities
IV. Enhances the understanding of soft skills resulting in an overall grooming of the skills

MODULE-I  SOFT SKILLS  Classes: 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  Classes: 09
Developing interpersonal relationships through effective soft skills; Define Listening, Speaking, Reading and Writing 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  Classes: 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  Classes: 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  Classes: 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.

Text Books:
Handbook of English for Communication (Prepared by Faculty of English, IARE)
**Reference Books:**


**Web References:**

1. www.edufind.com
2. www.myenglishpages.com

**E-Text Books:**

# CYBER LAW AND ETHICS

**OE - III**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
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| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | Total Classes: 45 |

### OBJECTIVES:
The course should enable the students to:

I. Understand key terms and concepts in cyber society, cyber ethics.
II. Analyze fundamentals of Cyber Law
III. Learn the importance of nine P’s in ethics.
IV. Understand artificial intelligence and Blockchain ethics.

## MODULE-I  CYBER SOCIETY

**Classes: 09**


## MODULE-II  CYBER LAW AND CYBER ETHICS

**Classes: 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

**Classes: 09**


## MODULE-IV  DISRUPTIVE CYBER TECHNOLOGIES AND AI ETHICS

**Classes: 09**

Disruptive Cyber Technologies and Ethics -I

## MODULE-V  DISRUPTIVE CYBER TECHNOLOGIES AND ETHICS -II

**Classes: 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, Decentralised or Majority-Owned, Ethically More Benefits or Dangers, future jobs in cyber society.
<table>
<thead>
<tr>
<th>Text Books:</th>
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<table>
<thead>
<tr>
<th>Reference Books:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dr. Farooq Ahmad, Cyber Law in India, Allahbad Law Agency- Faridabad.</td>
</tr>
<tr>
<td>2. J.P. Sharma, SunainaKanojia, Cyber Laws</td>
</tr>
<tr>
<td>3. Harish Chander, Cyber Laws and IT Protection</td>
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</tbody>
</table>

<table>
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<tr>
<th>E-Reference:</th>
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ECONOMIC POLICIES IN INDIA

OE - III

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</table>

Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:

I. Introduce the economic development elements and its measures
II. Provide inside knowledge on monetary policy and its importance in economic development
III. Communicate the importance of fiscal policies in promoting the economy
IV. Explore the policies and practices in resource base infrastructure
V. Discuss the industrial and exit policies related to the industries

MODULE-I  INTRODUCTION TO ECONOMIC DEVELOPMENT AND ITS DETERMINANTS  CLASSES: 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  CLASSES: 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  CLASSES: 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  CLASSES: 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  CLASSES: 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

Text Books:
2. The Strength of Economic Development by Albert Hirschman.
3. Money, Banking and Public Finance by Dr. V.C.Sinha
**Reference Books:**


**Web References:**

GLOBAL WARMING AND CLIMATE CHANGE

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Hours / Week</th>
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</table>

Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 60

OBJECTIVES:
The course should enable the students to:
I. Understand the importance of Ozone layer in the atmosphere.
II. Comprehend composition of atmosphere.
III. Understand impacts of climate change on ecosystem.
IV. Understand initiatives taken by different countries to reduce emission of greenhouse gases.

MODULE - I  EARTH’S CLIMATE SYSTEM  Classes: 09

MODULE - II  ATMOSPHERE AND ITS COMPONENTS  Classes: 09

MODULE - III  IMPACTS OF CLIMATE CHANGE  Classes: 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  Classes: 09

MODULE - V  CLIMATE CHANGE AND MITIGATION MEASURES  Classes: 09

Text Books:
**Reference Books:**


**E-Text Books:**

INTELLECTUAL PROPERTY RIGHTS

OE: III

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<th>Course Code</th>
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Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Gain knowledge in world trade organization and agreements between nations.
II. Safeguard the intellectual property with international trade agreements.
III. Understand types of intellectual property rights.
IV. Apply different laws in protection of intellectual property rights and its implementation.

MODULE - I  INTRODUCTION  Classes: 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 INTELLIGENCE PROPERTY ORGANIZATION  Classes: 08
Paris convention, Bern convention, Budapest treaty, Madrid agreement, huge agreement.

MODULE - III  PATENTS  Classes: 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  Classes: 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  Classes: 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.

Text Books:

Reference Books:

### Web References:

1. http://www.ebooks directory.com
2. http://Campus guides.lib.utah.edu

### E-Text Books:

## ENTREPRENEURSHIP

### OE - III

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<th>Course Code</th>
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**Contact Classes: 45**  **Tutorial Classes: Nil**  **Practical Classes: Nil**  **Total Classes: 45**

### OBJECTIVES:
The course should enable the students to:

I. Understand the Entrepreneurial process and also inspire them to be Entrepreneurs.

II. Adopting of the key steps in the elaboration of business idea.

III. Understand the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.

### MODULE-I  UNDERSTANDING ENTREPRENEURIAL MINDSET  Classes: 09


### MODULE-II  INDIVIDUAL ENTREPRENEURIAL MIND-SET AND PERSONALITY  Classes: 09


### MODULE-III  LAUNCHING ENTREPRENEURIAL VENTURES  Classes: 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  Classes: 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 -  Classes: 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.
### Text Books:


### Reference Books:

OBJECTIVES:
The course should enable the students to:
I. Understand the architecture of 8085 and 8086 microprocessors.
II. Analyze and develop the programming and interfacing techniques of 8086 microprocessor.
III. Understand the architecture of advanced microprocessors and microcontrollers.
IV. Analyse the basic concepts and programming of 8051 microcontroller.

MODULE - I
Introduction to 8 bit and 16 bit Microprocessor.

MODULE - II
Operation of 8086 and Interrupts.
Pin diagram of 8086-Minimum mode and maximum mode of operation with Timing diagrams. Interrupt structure of 8086: Vector interrupt table, Interrupt service routines. Introduction to DOS and BIOS interrupts.

MODULE - III
Interfacing with 8086.
Memory interfacing to 8086 (Static RAM & EPROM). Need for DMA, DMA data transfer Method, Interfacing with 8237/8257. 8259 PIC Architecture and interfacing cascading of interrupt controller and its importance. Serial data transfer schemes: Asynchronous and Synchronous data transfer schemes. 8251 USART architecture and interfacing. TTL to RS 232C and RS232C to TTL conversion.

MODULE - IV
ADVANCED MICRO PROCESSORS
Introduction to 80286, Salient Features of 80386, Real and Protected Mode Segmentation & Paging, Salient Features of Pentium, Branch Prediction, and Overview of RISC Processors.

MODULE - V
8051 MICROCONTROLLER ARCHITECTURE
8051 Microcontroller Architecture, Register set of 8051, Modes of timer operation, Serial port operation, Interrupt structure of 8051, Memory and I/O interfacing with 8051.

Text Books:

Reference Books:
<table>
<thead>
<tr>
<th>Web References:</th>
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<tbody>
<tr>
<td>1. <a href="http://www.nptel.ac.in/downloads/106108100/">http://www.nptel.ac.in/downloads/106108100/</a></td>
</tr>
<tr>
<td>2. <a href="http://www.the8051microcontroller.com/web-references">http://www.the8051microcontroller.com/web-references</a></td>
</tr>
<tr>
<td>3. <a href="http://www.iare.ac.in">http://www.iare.ac.in</a></td>
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<thead>
<tr>
<th>E-Text Books:</th>
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</thead>
<tbody>
<tr>
<td>1. <a href="https://books.google.co.in/books">https://books.google.co.in/books</a></td>
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</table>
# PRINCIPLES OF COMMUNICATION

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<td><strong>Course Code</strong></td>
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<td><strong>Contact Classes</strong>: 45</td>
<td><strong>Tutorial Classes</strong>: Nil</td>
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## OBJECTIVES:
The course should enable the students to:

- I. Determine the performance of analog modulation schemes in time and frequency domains
- II. Determine the performance of analog communication systems
- III. Understand the characteristics of pulse amplitude modulation, pulse position modulation and pulse code modulation systems.

## MODULE - I
### AMPLITUDE MODULATION


## MODULE - II
### DOUBLE SIDE BAND-SUPPRESSED CARRIER MODULATION

Time and Frequency – Domain description, Ring modulator, Coherent detection, Costas Receiver, Quadrature Carrier Multiplexing.

## MODULE - III
### SINGLE SIDE–BAND AND VESTIGIAL SIDEBAND METHODS OF MODULATION

SSB Modulation, VSB Modulation, Frequency Translation, Frequency-Division Multiplexing, Theme Example: VSB Transmission of Analog and Digital Television.

## MODULE - IV
### ANGLE MODULATION


## MODULE - V
### DIGITAL REPRESENTATION OF ANALOG SIGNALS


## Text Books:

## Reference Books:
### Web References:

1. [http://www.web.eecs.utk.edu](http://www.web.eecs.utk.edu)
2. [https://everythingvtu.wordpress.com](https://everythingvtu.wordpress.com)
3. [http://nptel.ac.in/](http://nptel.ac.in/)
4. [http://www.iare.ac.in](http://www.iare.ac.in)

### E-Text Books:

2. [http://www.jntubook.com](http://www.jntubook.com)
3. [http://www.smartzworld.com](http://www.smartzworld.com)
OE - IV

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Contact Classes: 45  
Tutorial Classes: Nil  
Practical Classes: Nil  
Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Understand the image fundamentals and mathematical transforms necessary for image processing.
II. Describe the image enhancement techniques.
III. Analyze the image compression procedures.
IV. Design the image segmentation and representation techniques.

MODULE - I  
DIGITAL IMAGE FUNDAMENTALS  
Classes: 10


MODULE - II  
IMAGE TRANSFORMS  
Classes: 09


MODULE - III  
IMAGE ENHANCEMENT  
Classes: 08


MODULE - IV  
IMAGE SEGMENTATION  
Classes: 08

Detection of discontinuities. Edge linking and boundary detection, Thresholding, Region oriented segmentation.

MODULE - V  
IMAGE COMPRESSION  
Classes: 10

Redundancies and their removal methods, Fidelity criteria, Image compression models, Source encoder and decoder, Error free compression, Lossy compression.

Text Books:

Reference Books:
<table>
<thead>
<tr>
<th>Web References:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <a href="https://imagingbook.com/">https://imagingbook.com/</a></td>
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<th>E-Text Books:</th>
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ELECTRICAL ENGINEERING MATERIALS

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Contact Classes: 45  Tutorial Classes: Nil  Practical Classes: Nil  Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Learn the basics of materials used in electrical engineering.
II. Realize the dielectric properties of insulators in static and alternating fields.
III. Explain the importance of magnetic properties and superconductivity.
IV. Explain the behavior of conductivity of metals and classifications of semiconductor materials.

MODULE-I  ELEMENTARY MATERIALS SCIENCE CONCEPTS  Classes: 06
Bonding and types of solids, crystalline state and their defects, classical theory of electrical and thermal conduction in solids, temperature dependence of resistivity, skin effect, hall effect.

MODULE-II  DIELECTRIC PROPERTIES OF INSULATORS IN STATIC AND ALTERNATING FIELD  Classes: 06
Dielectric constant of mono-atomic gases, poly-atomic molecules and solids, internal field in solids and liquids, properties of Ferro-Electric materials, polarization, piezoelectricity, frequency dependence of electronic and Ionic polarizability, complex dielectric constant of non-dipolar solids, dielectric losses.

MODULE-III  MAGNETIC PROPERTIES AND SUPER CONDUCTIVITY  Classes: 07
Magnetization of matter, magnetic material classification, ferromagnetic origin, curie-weiss law, soft and hard magnetic materials:
Superconductivity and its origin, zero resistance and Meissner effect, critical current density.

MODULE-IV  CONDUCTIVITY OF MATERIALS  Classes: 08
Ohm’s law and relaxation time of electrons, collision time and mean free path, electron scattering and resistivity of metals.

MODULE-V  SEMICONDUCTOR MATERIALS  Classes: 08
Classification of semiconductors, semiconductor conductivity, temperature dependence, carrier density and energy gap, trends in materials used in electrical equipment.

Text Books:
**Reference Books:**


**Web References:**


**E-Text Books:**

1. https://www.books.google.co.in/books/about/A_Textbook_of_Electrical_Engineering_Mat.html?id=Ee8ruUXkJeMC.
NON CONVENTIONAL ENERGY SOURCES

OE - IV

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</table>

Contact Classes: 45 Tutorial Classes: Nil Practical Classes: Nil Total Classes: 45

OBJECTIVES:
The course should enable the students to:
I. Understand the various types of renewable energy sources.
II. Analyze the principle and operation of direct energy conversion.
III. Understand and analyze the hybrid energy systems.
IV. Understand the renewable energy sources to real world electrical and electronics problems.

MODULE - I  PRINCIPLES OF SOLAR RADIATION  Classes: 08
Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

MODULE - II  SOLAR ENERGY COLLECTION AND SOLAR ENERGY STORAGE AND APPLICATIONS  Classes: 10
Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.
Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion

MODULE - III  WIND ENERGY AND BIO-MASS  Classes: 09
Wind Energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria.

MODULE - IV  GEOTHERMAL ENERGY AND OCEAN ENERGY  Classes: 10
Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India

MODULE - V  DIRECT ENERGY CONVERSION  Classes: 08
Need for DEC, Carnot cycle, limitations, principles of DEC.

Text Books:
<table>
<thead>
<tr>
<th>Reference Books:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.  Renewable Energy resources / Tiwari and Ghosal / Narosa</td>
</tr>
<tr>
<td>2.  Renewable Energy Technologies / Ramesh &amp; Kumar / Narosa</td>
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</tbody>
</table>
## NANO TECHNOLOGY

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<th>Course Code</th>
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</table>

- **Contact Classes:** Nil
- **Tutorial Classes:** Nil
- **Practical Classes:** Nil
- **Total Classes:** Nil

### OBJECTIVES:
The course should enable the students to:

I. Impart the basic knowledge in Nano Science and Technology.
II. Give insight into many aspects of Nano science, technology and their applications in the prospective of materials science.
III. Develop new devices and technologies for applications in a wide range of industrial sectors including information technology, medicine, manufacturing, high-performance materials.

### MODULE-I  INTRODUCTION

History and scope, can small things make a big difference, classification of nanostructured materials, fascinating nanostructures, applications of nanomaterials, Nature: The best of nanotechnologist, challenges, and future prospects.

### MODULE-II  UNIQUE PROPERTIES OF NANOMATERIALS

Microstructure and Defects in Nanocrystalline Materials: Dislocations, twins, stacking faults and voids, grain boundaries, triple, and disclinations, effect of Nano-dimensions on materials behavior: Elastic properties, melting point, diffusivity, grain growth characteristics, enhanced solid solubility; Magnetic Properties: Soft magnetic Nanocrystalline alloy, permanent magnetic Nanocrystalline materials, giant magnetic resonance, electrical properties, optical properties, thermal properties, and mechanical properties.

### MODULE-III  SYNTHESIS ROUTES

Bottom up approaches: Physical vapor deposition, inert gas condensation, laser ablation, chemical vapor deposition, molecular beam Epitaxy, solgel method, self assembly.

Top down approaches: Mechanical alloying, Nano-lithography, consolidation of Nano powders: Shock wave consolidation, hot isostatic pressing and cold isostatic pressing spark plasma sintering.

### MODULE-IV  TOOLS TO CHARACTERIZE NANOMATERIALS


### MODULE-V  APPLICATIONS OF NANOMATERIALS

Nano-electronics, micro- and Nano-electromechanical systems (MEMS/NEMS), Nanosensors, Nanocatalysts, food and agricultural industry, cosmetic and consumer goods, structure and engineering, automotive industry, water treatment and the environment, Nano-medical applications, textiles, paints, energy, defence and space applications, concerns and challenges of Nanotechnology.
**Text Books:**


**Reference Books**


**Web References:**

3. https://libguides.northwestern.edu › LibGuides

**E-Text Book:**

ENVIRONMENTAL SCIENCES

IV Semester: AE / CSE / IT / ECE / EEE / ME / CE

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Contact Classes: Nil Tutorial Classes: Nil Practical Classes: Nil Total Classes: Nil

COURSE OBJECTIVES:
The course should enable the students to:

I. Analyze the interrelationship between living organism and environment.
II. Understand the importance of environment by assessing its impact on the human world.
III. Enrich the knowledge on themes of biodiversity, natural resources, pollution control and waste management.
IV. Understand the constitutional protection given for environment.

MODULE-I ENVIRONMENT AND ECOSYSTEMS

Environment: Definition, scope and importance of environment, need for public awareness; Ecosystem: Definition, scope and importance of ecosystem, classification, structure and function of an ecosystem, food chains, food web and ecological pyramids, flow of energy; Biogeochemical cycles; Biomagnifications

MODULE-II NATURAL RESOURCES

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; Mineral resources: Use and exploitation; Land resources; Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy source, case studies.

MODULE-III BIODIVERSITY AND BIOTIC RESOURCES

Biodiversity and biotic resources: Introduction, definition, genetic, species and ecosystem diversity; Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and optional values; India as a mega diversity nation; Hot spots of biodiversity

Threats to biodiversity: Habitat loss, poaching of wildlife, human-wildlife conflicts; Conservation of biodiversity: In situ and ex situ conservation; National biodiversity act.

MODULE-IV ENVIRONMENTAL POLLUTION, POLLUTION CONTROL TECHNOLOGIES AND GLOBAL ENVIRONMENTAL PROBLEMS

Environmental pollution: Definition, causes and effects of air pollution, water pollution, soil pollution, noise pollution; Solid waste: Municipal solid waste management, composition and characteristics of e-waste and its management; Pollution control technologies: Waste water treatment methods, primary, secondary and tertiary; Concepts of bioremediation; Global environmental problems and global efforts: Climate change, ozone depletion, ozone depleting substances, deforestation and desertification

MODULE-V ENVIRONMENTAL LEGISLATIONS AND SUSTAINABLE DEVELOPMENT

Environmental legislations: Environmental protection act, air act1981, water act, forest act, wild life act, municipal solid waste management and handling rules, biomedical waste management and handling rules2016, hazardous waste management and handling rules, Environmental impact assessment(EIA); Towards sustainable future: Concept of sustainable development, population and its explosion, crazy
consumerism, environmental education, urban sprawl, concept of green building

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<thead>
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<th>Text Books:</th>
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<th>Reference Books:</th>
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<td>1. <a href="https://www.tndte.com">https://www.tndte.com</a></td>
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<td>2. <a href="https://www.nptel.ac.in/downloads">https://www.nptel.ac.in/downloads</a></td>
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<td>4. <a href="https://www.cuiet.info">https://www.cuiet.info</a></td>
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<td>5. <a href="https://www.sbtebihar.gov.in">https://www.sbtebihar.gov.in</a></td>
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<td>6. <a href="https://www.ritchennai.org">https://www.ritchennai.org</a></td>
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# ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

## VII Semester: AE / CSE / IT / ECE / EEE / ME / CE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Category</th>
<th>Hours / Week</th>
<th>Credits</th>
<th>Maximum Marks</th>
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<td>AHSB17</td>
<td>Mandatory</td>
<td>L T P C CIA SEE Total</td>
<td>30 70 100</td>
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### COURSE OBJECTIVES:

The course should enable the students to:

I. Understand the concept of Traditional knowledge and its importance

II. Know the need and importance of protecting traditional knowledge.

III. Know the various enactments related to the protection of traditional knowledge.

IV. Understand the concepts of Intellectual property to protect the traditional knowledge

### MODULE-I  INTRODUCTION TO TRADITIONAL KNOWLEDGE

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge

### MODULE-II  PROTECTION OF TRADITIONAL KNOWLEDGE

Protection of traditional knowledge: The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

### MODULE-III  LEGAL FRAMEWORK AND TK

A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act);


### 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:

2. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, Pratibha Prakashan 2012.
### Reference Books:

2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2
VISION AND MISSION OF THE INSTITUTE

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.

B.TECH - PROGRAM OUTCOMES (POs)

PO-1: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems (Engineering Knowledge).

PO-2: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences (Problem Analysis).

PO-3: 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 (Design/Development of Solutions).

PO-4: 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 (Conduct Investigations of Complex Problems).

PO-5: 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 (Modern Tool Usage).

PO-6: 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 (The Engineer and Society).

PO-7: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development (Environment and Sustainability).

PO-8: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice (Ethics).

PO-9: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (Individual and Team Work).

PO-10: 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 (Communication).

PO-11: 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.

PO-12: 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 (Life-long learning).
OBJECTIVES OF THE DEPARTMENT

DEPARTMENT OF AERONAUTICAL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEO’S)

A graduate of the Aeronautical Engineering Program should:

PEO – I: To prepare and provide student with an academic environment for students to excel in postgraduate programs or to succeed in industry / technical profession and the life-long learning needed for a successful professional career in Aeronautical Engineering and related fields (Preparation & Learning Environment).

PEO – II: To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve engineering problems and also to pursue higher studies (Core Competence).

PEO – III: To train students with good scientific and engineering breadth so as to comprehend, analyze, design, and create novel products and solutions for the real life problems (Breadth).

PEO – IV: To inculcate in students professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate engineering issues to broader social context (Professionalism).

PROGRAM SPECIFIC OUTCOMES (PSO’s)

PSO – I: Professional skills: Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products.

PSO – II: Professional skills: Imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles

PSO – III: Practical implementation and testing skills: Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies

PSO-IV: Successful Career And Entrepreneurship: To Prepare The Students With Broad Aerospace Knowledge To Design And Develop Systems And Subsystems Of Aerospace And Allied Systems And Become Technocrats
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 stakeholders know that we are an Autonomous College?**
   Autonomous status, once declared, shall be accepted by all the stakeholders. 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 70% external and 30% 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.

\[ SGPA = \frac{\sum_{i=1}^{n} (C_i \cdot G_i)}{\sum_{i=1}^{n} C_i} \]

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

17 What is a Cumulative Grade Point Average (CGPA)?
An up-to-date assessment of overall performance of a student from the time of his first registration is obtained by calculating a number called CGPA, which is weighted average of the grade points obtained in all the courses registered by the students since he entered the Institute.
\[ CGPA = \frac{\sum_{j=1}^{m} (C_j S_j)}{\sum_{j=1}^{m} C_j} \]

Where, \( S_j \) is the SGPA of the \( j^{th} \) semester and \( C_j \) is the total number of credits up to the semester and \( m \) represent the number of semesters completed in which a student registered up to 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 SGPA 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 make up 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 every body 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 Board 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.
# MALPRACTICES RULES

## DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

<table>
<thead>
<tr>
<th>S.No</th>
<th>Nature of Malpractices/Improper conduct</th>
<th>Punishment</th>
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<tbody>
<tr>
<td></td>
<td><em>If the candidate:</em></td>
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<tr>
<td>1.</td>
<td>(a) Possesses or keeps accessible in examination hall, any paper, note book, programmable calculator,</td>
<td>Expulsion from the examination hall and cancellation of the performance in that subject only.</td>
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<td>cell phone, pager, palm computer or any other form of material concerned with or related to the</td>
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<td>subject of the examination (theory or practical) in which he is appearing but has not made use of</td>
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<td>(material shall include any marks on the body of the candidate which can be used as an aid in the</td>
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<td>subject of the examination)</td>
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<td></td>
<td>(b) Gives assistance or guidance or receives it from any other candidate orally or by any other body</td>
<td>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.</td>
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<td>language methods or communicates through cell phones with any candidate or persons in or outside the</td>
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<td>exam hall in respect of any matter.</td>
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<tr>
<td>2.</td>
<td>Has copied in the examination hall from any paper, book, programmable calculators, palm computers or</td>
<td>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.</td>
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<td>any other form of material relevant to the subject of the examination (theory or practical) in which</td>
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<td>the candidate is appearing.</td>
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<td>3.</td>
<td>Impersonates any other candidate in connection with the examination.</td>
<td>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.</td>
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<td>4.</td>
<td>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.</td>
<td>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.</td>
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<tr>
<td>5.</td>
<td>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.</td>
<td>Cancellation of the performance in that subject.</td>
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<td>6.</td>
<td>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.</td>
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<tr>
<td>7.</td>
<td>Leaves the exam hall taking away answer script or intentionally tears off the script or any part thereof inside or outside the examination hall.</td>
<td>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.</td>
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<td></td>
<td>Possess any lethal weapon or firearm in the examination hall.</td>
<td>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.</td>
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<tr>
<td>9.</td>
<td>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.</td>
<td>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.</td>
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<td>10.</td>
<td>Comes in a drunken condition to the examination hall.</td>
<td>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.</td>
</tr>
<tr>
<td>11.</td>
<td>Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.</td>
<td>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.</td>
</tr>
<tr>
<td>12.</td>
<td>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.</td>
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</table>
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, Academic”.

I, Mr. / Ms. ________________________________ joining I Semester / III Semester for the academic year 2018-2019 / 2019-2020 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, 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 - R18 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