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

OUTCOME BASED EDUCATION
WITH
CHOICE BASED CREDIT SYSTEM

BACHELOR OF TECHNOLOGY
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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

ACADEMIC REGULATIONS

B.Tech. Regular Four Year Degree Program
(for the batches admitted from the academic year 2018 - 19)
&
B.Tech. (Lateral Entry Scheme)
(for the batches admitted from the academic year 2019 - 20)

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. The supplementary semester is provided to help the student in not losing an academic year. It is optional for a student to make use of supplementary semester. **Supplementary semester is a special semester and the student cannot demand it as a matter of right** and will be offered based on availability of faculty and other institute resources.

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

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

4.6 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

S. No	Branch	Code
1	Aeronautical Engineering	AE
2	Computer Science and Engineering	CS
3	Information Technology	IT
4	Electronics and Communication Engineering	EC
5	Electrical and Electronics Engineering	EE
6	Mechanical Engineering	ME
7	Civil Engineering	CE

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

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

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

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

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 and

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 modules carries equal weightage in terms of marks distribution. The question paper pattern is as follows.

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

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

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

8.1.2 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

COMPONENT	THEORY			TOTAL MARKS
Type of Assessment	CIE Exam	Quiz	AAT	
Max. CIA Marks	20	05	05	30

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

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

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

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

8.7 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)

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

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

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

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

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

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

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

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,

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

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

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

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

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

16.0 ILLUSTRATION OF COMPUTATION OF SGPA AND CGPA

16.1 Illustration for SGPA

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

$$Thus, SGPA = 139 / 20 = 6.95$$

16.2 Illustration for CGPA

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

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

17.0 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) upto 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 5.0, shall forfeit his/her degree and his/her admission stands cancelled.

19.3 A student of a lateral entry program who fails to earn 123 credits within six consecutive academic years from the year of his/her admission with a minimum CGPA of 5.0, shall forfeit his/her degree and his/her admission stands cancelled.

20.0 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:

CGPA ≥ 8.0	CGPA ≥ 6.5 and < 8.0	CGPA ≥ 5.5 and < 6.5	CGPA ≥ 5.0 and < 5.5	CGPA < 5.0
First Class with Distinction	**First Class**	**Second Class**	**Pass Class**	**Fail**

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

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

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

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

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

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

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

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

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

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

21.8 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.

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.

21 B.TECH WITH HONOURS OR ADDITIONAL MINORS IN ENGINEERING

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

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

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

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

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

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

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

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

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

22.1. B.Tech with Honours

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

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

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

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

21.2 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 the previous semester under JNTUH regulations and the credits prescribed for the semester in which a candidate joined after transfer and subsequent semesters under the autonomous status. The class will be awarded based on the academic performance of a student in the autonomous pattern.

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

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

e) Readmission from IARE-R16 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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad – 500043

AERONAUTICAL ENGINEERING

COURSE STRUCTURE

I SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
AHSB02	Linear Algebra and Calculus	BSC	Foundation	3	1	0	4	30	70	100
AHSB04	Waves and Optics	BSC	Foundation	3	1	0	4	30	70	100
ACSB01	Programming for Problem Solving	ESC	Foundation	3	0	0	3	30	70	100
PRACTICAL										
AHSB10	Engineering Physics Laboratory	BSC	Foundation	0	0	3	1.5	30	70	100
ACSB02	Programming for Problem Solving Laboratory	ESC	Foundation	0	0	4	2	30	70	100
AMEB01	Workshop / Manufacturing Practices Laboratory	ESC	Foundation	0	0	3	1.5	30	70	100
TOTAL				**09**	**02**	**10**	**16**	**180**	**420**	**600**

II SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
AHSB01	English	HSMC	Foundation	2	0	0	2	30	70	100
AHSB11	Mathematical Transform Techniques	BSC	Foundation	3	1	0	4	30	70	100
AHSB03	Engineering Chemistry	BSC	Foundation	3	1	0	4	30	70	100
AMEB03	Engineering Mechanics	ESC	Foundation	3	1	0	4	30	70	100
PRACTICAL										
AHSB08	English Language and Communication Skills Laboratory	HSMC	Foundation	0	0	2	1	30	70	100
AHSB09	Engineering Chemistry Laboratory	BSC	Foundation	0	0	3	1.5	30	70	100
AMEB02	Engineering Graphics and Design Laboratory	ESC	Foundation	1	0	4	3	30	70	100
AAEB01	Basic Simulation with MAT Laboratory	ESC	Foundation	0	0	3	1.5	30	70	100
TOTAL				**12**	**03**	**12**	**21**	**240**	**560**	**800**

III SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
AAEB02	Engineering Thermodynamics	PCC	Core	3	0	0	3	30	70	100
AEEB04	Basic Electrical and Electronics Engineering	PCC	Core	3	1	0	4	30	70	100
AHSB12	Probability and Statistics	BSC	Foundation	3	1	0	4	30	70	100
AAEB03	Fluid Dynamics	PCC	Core	3	1	0	4	30	70	100
AAEB04	Mechanics of Solids	PCC	Core	3	0	0	3	30	70	100
PRACTICAL										
AAEB05	Fluid Dynamics Laboratory	PCC	Core	0	0	2	1	30	70	100
AAEB06	Mechanics of Solids Laboratory	PCC	Core	0	0	2	1	30	70	100
AITB08	Object Oriented Programming through Python Laboratory	PCC	Core	1	0	2	2	30	70	100
TOTAL				**16**	**03**	**06**	**22**	**240**	**560**	**800**

IV SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
AAEB07	Aerospace Structures	PCC	Core	3	0	0	3	30	70	100
ACSB03	Data structures	PCC	Core	3	0	0	3	30	70	100
AAEB08	Aerospace Propulsion	PCC	Core	3	1	0	4	30	70	100
AAEB09	Flight Mechanics	PCC	Core	3	1	0	4	30	70	100
AAEB10	Aerodynamics	PCC	Core	3	1	0	4	30	70	100
AHSB07	Environmental Science	MC-I	---	0	0	0	0	30	70	100
PRACTICAL										
AAEB11	Aerospace Structures Laboratory	PCC	Core	0	0	3	1.5	30	70	100
AAEB12	Aerodynamics and Propulsion Laboratory	PCC	Core	0	0	2	1	30	70	100
ACSB05	Data structures Laboratory	PCC	Core	0	0	3	1.5	30	70	100
TOTAL				**15**	**03**	**08**	**22**	**270**	**630**	**900**

V SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
AAEB13	Aircraft Stability and Control	PCC	Core	3	0	0	3	30	70	100
AAEB14	Analysis of Aircraft Structures	PCC	Core	2	1	0	3	30	70	100
AAEB15	High speed Aerodynamics	PCC	Core	2	1	0	3	30	70	100
AAEB16	Aircraft Production Technology	PEC	Core	3	0	0	3	30	70	100
	Professional Elective - I	PEC	Elective	3	0	0	3	30	70	100
	Open Elective - I	OEC	Elective	3	0	0	3	30	70	100
AHSB15	Project Based Learning (Prototype / Design Building)	PCC	Core	2	0	0	2	30	70	100
PRACTICAL										
AAEB17	Computer Aided Design Laboratory	PCC	Core	0	0	2	1	30	70	100
AAEB18	Aircraft Production Technology Laboratory	PCC	Core	0	0	2	1	30	70	100
TOTAL				**18**	**02**	**04**	**22**	**270**	**630**	**900**

VI SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
AAEB19	Finite Element Analysis	PCC	Core	2	1	0	3	30	70	100
AAEB20	Computational Aerodynamics	PCC	Core	2	1	0	3	30	70	100
AAEB21	Aircraft Systems	PCC	Core	3	0	0	3	30	70	100
	Professional Elective - II	PEC	Elective	3	0	0	3	30	70	100
	Professional Elective - III	PEC	Elective	3	0	0	3	30	70	100
	Open Elective - II	OEC	Elective	3	0	0	3	30	70	100
AHSB16	Research Based Learning (Fabrication / Model Development)	PCC	Core	2	0	0	2	30	70	100
PRACTICAL										
AAEB22	Computational Aerodynamics Laboratory	PCC	Core	0	0	2	1	30	70	100
AAEB23	Computational Structural Analysis Laboratory	PCC	Core	0	0	2	1	30	70	100
TOTAL				**18**	**02**	**04**	**22**	**270**	**630**	**900**

VII SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
AAEB24	Flight Vehicle Design	PCC	Core	3	0	0	3	30	70	100
AAEB25	Aerospace Structural Dynamics	PCC	Core	3	0	0	3	30	70	100
	Professional Elective – IV	PEC	Elective	3	0	0	3	30	70	100
	Professional Elective - V	PEC	Elective	3	0	0	3	30	70	100
	Open Elective - III	OEC	Elective	3	0	0	3	30	70	100
AHSB17	Essence of Indian Traditional Knowledge	MC-II	---	0	0	0	0	30	70	100
PRACTICAL										
AAEB26	Flight Vehicle Design Laboratory	PCC	Core	0	0	3	1.5	30	70	100
AAEB27	Aerospace Structural Dynamics Laboratory	PCC	Core	0	0	3	1.5	30	70	100
AAEB56	Project work (phase – I)	PROJ	Project	0	0	10	5	30	70	100
TOTAL				**15**	**00**	**16**	**23**	**270**	**630**	**900**

VIII SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
	Professional Elective – VI	PCC	Core	3	0	0	3	30	70	100
	Open Elective - IV	OEC	Elective	3	0	0	3	30	70	100
PRACTICAL										
AAEB57	Project Work (phase – II) / Full Semester Internship	PROJ	Project	0	0	12	6	30	70	100
TOTAL				**06**	**00**	**12**	**12**	**90**	**210**	**300**

PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVES - I: AEROSPACE STRUCTURAL ENGINEERING

Course Code	Course Title
AAEB29	Experimental Stress Analysis
AAEB30	Design and Analysis of Composite Structures
AAEB31	Aeroelasticity
AAEB32	Unmanned Air Vehicles

PROFESSIONAL ELECTIVES - II: AERODYNAMICS / FLUID FLOWS

Course Code	Course Title
AAEB33	Ground Vehicle Aerodynamics
AAEB34	Advanced Computational Aerodynamics
AAEB35	Experimental Aerodynamics
AAEB36	Hypersonic Aerodynamics

PROFESSIONAL ELECTIVES - III: AEROSPACE PROPULSION SYSTEMS

Course Code	Course Title
AAEB37	Turbo Machinery
AAEB38	Heat Transfer
AAEB39	Cryogenics
AAEB40	Rocket and Missiles

PROFESSIONAL ELECTIVES - IV: AEROSPACE DESIGN AND MANUFACTURING ENGINEERING

Course Code	Course Title
AAEB41	Non Destructive Testing
AAEB42	CAD / CIM
AAEB43	Mechanism and Machine Design
AAEB44	Production Design and Development

PROFESSIONAL ELECTIVES - V: AVIATIONS

Course Code	Course Title
AAEB45	Avionics and Instrumentation
AAEB46	Air Transportation System
AAEB47	Airport Planning and Management
AAEB48	Flight Scheduling and Operations

PROFESSIONAL ELECTIVES - VI: FLIGHT MECHANICS

Course Code	Course Title
AAEB49	Automatic Control of Aircraft
AAEB50	Flight Simulation
AAEB51	Orbital Mechanics
AAEB52	Space Dynamics

OPEN ELECTIVE - I

Course	Course
AAEB53	Flight Control Theory
AAEB54	Airframe Structural Design
AMEB54	Mechanical Properties of Materials
AMEB55	Automation in Manufacturing
ACEB50	Remote Sensing and GIS
ACEB51	Project Safety Management

OPEN ELECTIVES – II

Course	Course
ACSB32	Computer Architecture
ACSB33	Analysis of Algorithms and Design
ACSB34	Relational Database Management Systems
AITB30	Advanced Data Structures
AITB31	Data Communications and Networks
AITB32	Network Security

OPEN ELECTIVE - III

Course	Course
AHSB18	Soft Skills and Interpersonal Communication
AHSB19	Cyber Law and Ethics
AHSB20	Economic Policies in India
AHSB21	Global Warming and Climate Change
AHSB22	Intellectual Property Rights
AHSB23	Entrepreneurship

OPEN ELECTIVE - IV

Course	Course
AECB55	Microprocessors and Interfacing
AECB56	Principles of Communication
AECB57	Image Processing
AEEB55	Electrical Materials
AEEB56	Non Conventional Energy Sources
AEEB57	Nanotechnology

MANDATORY COURSES

Course	Course Title
AHSB07	Environmental Sciences
AHSB17	Constitution of India / Essence of Indian Traditional Knowledge
AHSB24	Gender Sensitivity

SYLLABUS

LINEAR ALGEBRA AND CALCULUS

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB02	Foundation	3	1	-	4	30	70	100
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 $f(x) = x^n, e^{ax}v(x), xv(x)$; 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	Classes: 09

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:

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

Reference Books:

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

Web References:

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

E-Text Books:

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

WAVES AND OPTICS

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB04	Foundation	3	1	-	4	30	70	100
Contact Classes:45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

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, Davisson and Germer experiment, Time-independent Schrodinger equation for wave function, Born interpretation of the wave function, Schrodinger equation for one dimensional problems–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:

1. Dr. K Vijay Kumar and Dr. S Chandralingam, "Modern Engineering Physics" Volume-1&2, S Chand.Co, 2018.
2. I. G. Main, "Vibrations and Waves in Physics", Cambridge University Press, 1993.
3. R. K. Gaur, S. L. Gupta, "Engineering Physics", Dhanpat Rai Publications, 8th Edition, 2001.

Reference Books:

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

Web References:

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

E-Text Books:

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

PROGRAMMING FOR PROBLEM SOLVING

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
ACSB01	Foundation	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. 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	Classes: 08

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:

1. Byron Gottfried, "Programming with C", Schaum's Outlines Series, McGraw Hill Education, 3rd Edition, 2017.
2. E. Balagurusamy, "Programming in ANSI C", McGraw Hill Education, 6th Edition, 2012.

Reference Books:

1. W. Kernighan Brian, Dennis M. Ritchie, "The C Programming Language", PHI Learning, 2nd Edition, 1988.
2. YashavantKanetkar, "Exploring C", BPB Publishers, 2nd Edition, 2003.
3. Schildt Herbert, "C: The Complete Reference", Tata McGraw Hill Education, 4th Edition, 2014.
4. R. S. Bichkar, "Programming with C", Universities Press, 2nd Edition, 2012.
5. Dey Pradeep, Manas Ghosh, "Computer Fundamentals and Programming in C", Oxford University Press, 2nd Edition, 2006.
6. Stephen G. Kochan, "Programming in C", Addison-Wesley Professional, 4th Edition, 2014.

Web References:

1. https://www.bfoit.org/itp/Programming.html
2. https://www.khanacademy.org/computing/computer-programming
3. https://www.edx.org/course/programming-basics-iitbombayx-cs101-1x-0
4. https://www.edx.org/course/introduction-computer-science-harvardx-cs50x

E-Text Books:

1. http://www.freebookcentre.net/Language/Free-C-Programming-Books-Download.htm
2. http://www.imada.sdu.dk/~svalle/courses/dm14-2005/mirror/c/
3. http://www.enggnotebook.weebly.com/uploads/2/2/7/1/22718186/ge6151-notes.pdf

MOOC Course

1. https://www.alison.com/courses/Introduction-to-Programming-in-c
2. http://www.ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-s096-effective-programming-in-c-and-c-january-iap-2014/index.htm

ENGINEERING PHYSICS LABORATORY

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB10	Foundation	-	-	3	1.5	30	70	100
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-l	**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.	

Week-10	**PLANK'S CONSTANT**
Determination of Plank's constant using LED.	
Week-11	**LIGHT EMITTING DIODE**
Studying V-I characteristics of LED	
Week-12	**NEWTONS RINGS**
Determination of radius of curvature of a given plano-convex lens.	
Week-13	**SINGLE SLIT DIFFRACTION**
Determination of width of a given single slit.	
Manuals:	
1. C. L. Arora, "Practical Physics", S. Chand & Co., New Delhi, 3rd Edition, 2012. 2. Vijay Kumar, Dr. T. Radhakrishna, "Practical Physics for Engineering Students", S M Enterprises, 2nd Edition, 2014.	
Web Reference:	
http://www.iare.ac.in	

PROGRAMMING FOR PROBLEM SOLVING LABORATORY

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
ACSB02	Foundation	-	-	4	2	30	70	100
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.

Characters	ASCII values
A–Z	65 –90
a – z	97 –122
0 – 9	48 – 57
Special symbols	0 – 47, 58 – 64, 91 – 96, 123 –127

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 profitor 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:

$$sum = 1 - x^2/2! + x^4/4! - x^6/6! + x^8/8! - x^{10}/10!$$

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

```
1
1 2
1 2 3
1 2 3 4
```

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 1if 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: $1+x+x^2+x^3+\ldots\ldots\ldots\ldots+x^n$. For example: if n is 3 and x is 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 is less than 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 to400.

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 15meters.
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.

Week-12	COMMAND LINE ARGUMENTS AND NUMERICAL METHODS

a. Write a C program to read two numbers at the command line and perform arithmetic operations on it.
b. Write a C program to read a file name at the command line and display its contents.
c. Write a C program to solve numerical methods problems (root finding, numerical differentiation and numerical integration)

Reference Books:

1. Yashavant Kanetkar, "Let Us C", BPB Publications, New Delhi, 13th Edition, 2012.
2. Oualline Steve, "Practical C Programming", O'Reilly Media, 3rd Edition, 1997.
3. King KN, "C Programming: A Modern Approach", Atlantic Publishers, 2nd Edition, 2015.
4. Kochan Stephen G, "Programming in C: A Complete Introduction to the C Programming Language", Sam's Publishers, 3rd Edition, 2004.
5. Linden Peter V, "Expert C Programming: Deep C Secrets", Pearson India, 1st Edition, 1994.

Web References:

1. http://www.sanfoundry.com/c-programming-examples
2. http://www.geeksforgeeks.org/c
3. http://www.cprogramming.com/tutorial/c
4. http://www.cs.princeton.edu

WORKSHOP / MANUFACTURING PRACTICES LABORATORY

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AMEB01	Foundation	-	-	3	1.5	30	70	100
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 dove tail joint as per given taper angle.	
Week-6	**CARPENTRY-II**
Batch I: Preparation of dove tail joint as per given taper angle. Batch II: Preparation of lap joint as per given dimensions.	
Week-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.	
Week-8	**WELDING**

Batch I: Arc welding & Gas Welding. Batch II: Gas welding & Arc Welding.	
Week-9	**MOULD PREPARATION**
Batch I: Prepare a wheel flange mould using a given wooden pattern. Batch II: Prepare a bearing housing using an aluminum pattern.	
Week-10	**MOULD PREPARATION**
Batch I: Prepare a bearing housing using an aluminum pattern. Batch II: Prepare a wheel flange mould using a given wooden pattern.	
Week-11	**BLACKSMITHY- I, TINSMITHY- I,**
Batch I: Prepare S-bend & J-bend for given MS rod using open hearth furnace. Batch II: Prepare the development of a surface and make a rectangular tray and a round tin.	
Week-12	**TINSMITHY- I, BLACKSMITHY- I**
Batch I: Prepare the development of a surface and make a rectangular tray and a round tin. Batch II: Prepare S-bend & J-bend of given MS rod using open hearth furnace.	
Week-13	**PLASTIC MOULDING, INJECTION MOULDING, GLASS CUTTING**
Batch I: Plastic Moulding and Glass cutting. Batch II: Plastic Moulding and Glass cutting.	
Week-14	**BLOW MOULDING**
Batch I& II: Blow Moulding.	

Reference Books:

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

Web References:

http://www.iare.ac.in

ENGLISH

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB01	Foundation	2	-	-	2	30	70	100
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 LISTENIG 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:

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

Web References:

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

E-Text Books:

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

MATHEMATICAL TRANSFORM TECHNIQUES

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB11	Foundation	3	1	-	4	30	70	100
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:

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

Reference Books:

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

Web References:

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

E-Text Books:

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

ENGINEERING CHEMISTRY

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB03	Foundation	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

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

Electro chemical 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 ozonization; 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 N_2, O_2,F_2 ,CO and 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 SN^1, 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 $KMnO_4$ and chromicacid; Reduction reactions: Reduction of carbonyl compounds using $LiAlH_4$ & $NaBH_4$; 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:

1. P. C. Jain, Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company, 16th Edition, 2017.
2. Shasi Chawla, "Text Book of Engineering Chemistry", Dhantpat Rai Publishing Company, New Delhi, 2017.
2. R.T. Morrison, RN Boyd and SK Bhattacharya "Organic Chemistry", Pearson, 7th Edition, 2011.
3. K.F. Purcell and J.C. Kotz, "Inorganic Chemistry", Cengage learning, 2017.

Reference Books:

1. K.P.C. Volhardt and N. E. Schore, "Organic Chemistry Structure and Functions", Oxford Publications, 7th Edition.
2. B. H. Mahan, "University Chemistry", Narosa Publishers, 4th Edition, 2009.

Web References:

1. Engineering Chemistry (NPTEL Web-book), by B.L.Tembe, Kamaluddin and M.S.Krishnan.

ENGINEERING MECHANICS

II Semester: AE | III Semester: ME / CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AMEB03	Foundation	3	1	-	4	30	70	100
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**	**Classes: 08**

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:

1. Irving H. Shames (2006), "Engineering Mechanics", Prentice Hall, 4th Edition, 2013
2. F. P. Beer and E. R. Johnston (2011), "Vector Mechanics for Engineers", Vol I - Statics, Vol II, – Dynamics, Tata McGraw Hill , 9th Edition, 2013.
3. R. C. Hibbler (2006), "Engineering Mechanics: Principles of Statics and Dynamics", Pearson Press.

Reference Books:

1. S.Bhavikatti, "A Text Book of Engineering Mechanics", New Age International, 1st Edition, 2012.
2. A.K.Tayal, "Engineering Mechanics", Uma Publications, 14th Edition, 2013.
3. R. K. Bansal "Engineering Mechanics", Laxmi Publication, 8th Edition, 2013.
4. Basudeb Bhattacharya, "Engineering Mechanics", Oxford University Press, 2nd Edition, 2014.
5. K.Vijay Reddy, J. Suresh Kumar, "Singer's Engineering Mechanics Statics and Dynamics", B S Publishers, 1st Edition, 2013.

Web References:

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

E-Text Books:

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

ENGLISH LANGUAGE AND COMMUNICATION SKILLS LABORATORY

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB08	Foundation	-	-	2	1	30	70	100
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-l	**LISTENING SKILL**

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

Week-2	**LISTENING SKILL**

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

Week-3	**SPEAKING SKILL**

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

Week-4	**SPEAKING SKILL**

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

Week-5	**SPEAKING SKILL**

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

Week-6	**READING SKILL**

a. Intonation. b. Reading newspaper and magazine articles; Reading selective autobiographies for critical commentary.	
Week-7	**READING SKILL**
a. Improving pronunciation through tongue twisters. b. Reading advertisements, pamphlets; Reading comprehension exercises with critical and analytical questions based on context.	
Week-8	**WRITING SKILL**
a. Listening to inspirational short stories. b. Writing messages, leaflets, Notice; Writing tasks; Flashcards – Exercises.	
Week-9	**WRITING SKILL**
a. Write the review on a video clipping of short duration (5 to 10minutes). b. Write a slogan related to the image; Write a short story of 6-10 lines based on the hints given.	
Week-10	**WRITING SKILL**
a. Minimizing Mother Tongue Influence to improve fluency through watching educational videos. b. Writing practices – précis writing; Essay writing.	
Week-11	**THINKING SKILL**
a. Correcting common errors in day to day conversations. b. Practice in preparing thinking blocks to decode diagrammatical representations into English words, expressions, idioms, proverbs.	
Week-12	**THINKING SKILL**
a. Correcting common errors in day to day conversations. b. Making pictures and improvising diagrams to form English words, phrases and proverbs.	
Reference Books:	
1. Meenakshi Raman, Sangeetha Sharma, "Technical Communication Principles and Practices", Oxford University Press, New Delhi, 3rd Edition, 2015. 2. Rhirdion, Daniel, "Technical Communication", Cengage Learning, New Delhi, 1st Edition, 2009.	
Web References:	
1. http://learnenglish.britishcouncil.org 2. http://www.esl-lab.com/ 3. http://www.elllo.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

ENGINEERING CHEMISTRY LABORATORY

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

Course Code	Category	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB09	Foundation	-	-	3	1.5	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 42				Total Classes: 42		

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-l	**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 Fe^{2+} by Potentiometry using $KMnO_4$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:

1. Vogel's, "Quantitative Chemical Analysis", Prentice Hall, 6th Edition, 2000.
2. Gary D. Christian, "Analytical Chemistry", Wiley India, 6th Edition, 2007.

Web References:

http://www.iare.ac.in

LIST OF EQUIPMENT REQUIRED FOR A BATCH OF 30 STUDENTS:

S. No	Name of the Apparatus	Apparatus Required	Quantity
1	Analytical balance	04	100 gm
2	Beaker	30	100 ml
3	Burette	30	50 ml
4	Burette Stand	30	Metal
5	Clamps with Boss heads	30	Metal
6	Conical Flask	30	250 ml
7	Conductivity cell	10	K=1
8	Calomel electrode	10	Glass
9	Digital Potentiometer	10	EI
10	Digital Conductivity meter	10	EI
11	Digital electronic balance	01	RI
12	Distilled water bottle	30	500 ml
13	Funnel	30	Small
14	Glass rods	30	20 cm length
15	Measuring Cylinders	10	10 ml

16	Oswald Viscometer	30	Glass
17	Pipette	30	20 ml
18	Platinum Electrode	10	PP
19	Porcelain Tiles	30	White
20	Reagent bottle	30	250 ml
21	Standard Flask	30	100 ml
22	Stalagmo meter	30	Glass
23	TLC Plates	40	--
24	UV Chamber	02	--

ENGINEERING GRAPHICS AND DESIGN LABORATORY

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AMEB02	Foundation	1	0	4	3	30	70	100
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

1. N. D. Bhatt (2012), "Engineering Drawing", Charotar Publications, New Delhi, 49th Edition, 2010.
2. C.M. Agarwal, Basant Agarwal, "Engineering Drawing", Tata McGrawHill, 2nd Edition, 2013.

Reference Books:

1. K. Venugopal, "Engineering Drawing and Graphics". New Age Publications, 2nd Edition, 2010.
2. Dhananjay. A. Johle, "Engineering Drawing", Tata McGraw Hill, 1st Edition, 2008.
3. S.Trymbaka Murthy, "Computer Aided Engineering Drawing", I.K. International Publishers, 3rd Edition, 2011.
4. A. K. Sarkar, A.P Rastogi, "Engineering graphics with Auto CAD", PHI Learning, 1st Edition, 2010.

Web References:

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

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 MAT LABORATORY

II Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
AAEB01	Foundation	-	-	3	1.5	30	70	100
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-l	**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.

Week-7	**DIFFERENTIATION AND INTEGRATION**

a. Higher order differential equations. b. Double integrals. c. Triple integrals.	
Week-8	**NUMERICAL DIFFERENTION AND INTEGRATION**
a. Trapezoidal, Simpson's method. b. Euler method. c. Runge Kutta method	
Week-9	**3D PLOTTING**
a. Line plotting. b. Surface plotting. a. Volume plotting.	
Week-10	**DEFLECTION OF SIMPLY SUPPORTED BEAM**
a. Calculating vertical displacement with point load. b. Calculating vertical displacement with uniformly distributed load. c. Calculating vertical displacement with uniformly varying load.	
Week-11	**DEFLECTION OF CANTILEVER BEAM**
b. Calculating vertical displacement with point load. c. Calculating vertical displacement with uniformly distributed load. c. Calculating vertical displacement with uniformly varying load	
Week-12	**FORMULATION OF IDEAL AND REAL GAS EQUATIONS**
a. Calculating the pressure, temperature, density for Earth's atmospheric conditions at different altitudes. b. Calculating the pressure, temperature, density for other planets at different altitudes.	
Reference Books:	
1. Cleve Moler, "Numerical Computing with MATLAB", SIAM, Philadelphia, 2nd Edition, 2008. 2. Dean G. Duffy, "Advanced Engineering Mathematics with MATLAB", CRC Press, Taylor & Francis Group, 6th Edition, 2015. 3. Delores M. Etter, David C. Kuncicky, Holly Moore, "Introduction to MATLAB 7", Pearson Education Inc, 1st Edition, 2009. 4. Rao. V. Dukkipati , "MATLAB for ME Engineers", New Age Science, 1st Edition, 2008.	
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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB02	Core	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. 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

Limitations of the first law: thermal reservoir, heat engine, heat pump, parameters of performance, second Law of thermodynamics, Kelvin Planck and Clausius statements and their equivalence, Corollaries, PMM of second kind, Carnot's principle, Carnot cycle and its specialties, thermodynamic scale of temperature, Clausius inequality, Entropy, principle of Entropy increase, availability and irreversibility, thermodynamic potentials, Gibbs and Helmholtz functions, Maxwell relations, Third Law of thermodynamics.

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	Classes: 09

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	Classes : 09

Basic concepts of Heat Transfer: Conduction, Convection and Radiation, Heat Exchangers, Types of Heat Exchangers. Basic concepts of: Gas Compressors, Air Compressors, Single-Stage Reciprocating Air

Compressor, Multi-Stage Compression, Volumetric Efficiency, Air Motors, Rotary Compressors.

Text Books:

1. P. K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill, 4th Edition, 2008.
2. Yunus Cengel, Michael A. Boles, "Thermodynamics-An Engineering Approach", Tata McGraw-Hill, 7th Edition, 2011.

Reference Books:

1. J. B. Jones, R. E. Dugan, "Engineering Thermodynamics", Prentice Hall of India Learning, 1st Edition, 2009.
2. Y. V. C. Rao, "An Introduction to Thermodynamics", Universities Press, 3rd Edition, 2013.
3. K. Ramakrishna, "Engineering Thermodynamics", Anuradha Publishers, 2nd Edition, 2011.
4. Holman. J.P, "Thermodynamics", Tata McGraw-Hill, 4th Edition, 2013.

Web References:

1. https://en.wikipedia.org/wiki/Thermodynamics
2. https://en.wikipedia.org/wiki/Laws_of_thermodynamics
3. http://www.livescience.com/50776-thermodynamics.html
4. https://www3.nd.edu/~powers/ame.20231/planckdover.pdf

E-Text Book:

1. https://www3.nd.edu/~powers/ame.20231/planckdover.pdf
2. http://www.ebookdownloadz.net/2014/08/engineering-thermodynamics-by-pknag.html

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

I Semester: CE | II Semester: ME | III Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AEEB04	Core	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil			Total Classes: 60			

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

Electrical Circuits: Basic definitions, types of elements, Ohm's Law, resistive networks, inductive networks, capacitive networks, Kirchhoff's Laws, series, parallel circuits and star delta transformations, simple problems, Faradays law of electromagnetic induction; **Instruments:** Basic principles of indicating instruments, permanent magnet moving coil and moving iron instruments.

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.

Three phase induction motor: Principle of operation, slip, slip torque characteristics, efficiency, applications; Alternator: Principle of operation, EMF Equation, efficiency, regulation by synchronous impedance method.

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:

1. A Chakrabarti, “Circuit Theory”, Dhanpat Rai Publications, 6th Edition, 2004.
2. K S Suresh Kumar, “Electric Circuit Analysis”, Pearson Education, 1st Edition, 2013.

3. Willianm Hayt, Jack E Kemmerly S.M.Durbin, “Engineering Circuit Analysis”, Tata McGraw Hill, 7th Edition, 2010.
4. J P J Millman, C C Halkias, Satyabrata Jit, “Millman‟s Electronic Devices and Circuits”, Tata McGraw Hill, 2nd Edition, 1998.
5. R L Boylestad, Louis Nashelsky, “Electronic Devices and Circuits”, PEI/PHI, 9th Edition, 2006.
6. V K Mehta, Rohit Mehta, “Principles of electrical engineering”, S CHAND, 1st Edition, 2003.

Reference Books:

1. David A Bell, “Electric Circuits”, Oxford University Press, 9th Edition, 2016.
2. M Arshad, “Network Analysis and Circuits”, Infinity Science Press, 9th Edition, 2016.
3. A Bruce Carlson, “Circuits”, Cengage Learning, 1st Edition, 2008.
4. M Arshad, “Network Analysis and Circuits”, Infinity Science Press, 9th Edition, 2016.
5. A Bruce Carlson, “Circuits”, Cengage Learning, 1st Edition, 2008

Web References:

1. https://www.kuet.ac.bd/webportal/ppmv2/uploads/1364120248DC%20Machines2.pdftextofvideo.nptel.iitm.ac.in
2. https://www.eleccompengineering.files.wordpress.com/2014/08/a-textbook-of-electrical-technology-volume-ii-ac-and-dc-machines-b-l-thferaja.pdf
3. https://www.geosci.uchicago.edu/~moyer/GEOS24705/Readings/Klempner_Ch1.pdf
4. https://www.ibiblio.org/kuphaldt/electricCircuits/DC/DC.pdf
5. https://www.users.ece.cmu.edu/~dwg/personal/sample.pdf.
6. https://www.djm.cc/library/Principles_of_Alternating_Current_Machinery_Lawrence_edited.pdf

E-Text Books:

1. https://www.kisi.deu.edu.tr/aytac.goren/ELK2015/w10.pdfwww.bookboon.com.
2. https://www.ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-071j-introduction-to-electronics-signals-and-measurement-spring-2006/lecture-notes/19_bjt_1.pdf.
3. https://www.google.co.in/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=half+and+full+wave+rectifier+pdf.
4. https://www.leka.lt/sites/default/files/vaizdai/concepts-in-electric-circuits.pdf.
5. https://www.ktustudents.in

Course Home Page:

PROBABILITY AND STATISTICS

III Semester: AE / ME / CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB12	Foundation	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

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	Classes: 09

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	Classes: 09

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	Classes: 09

Correlation: Karle 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	Classes: 09

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	Classes: 09

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:

1. Erwin Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons Publishers, 9th Edition, 2014.
2. B. S. Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 42nd Edition, 2012.

Reference Books:

1. S. C. Gupta, V. K. Kapoor, “Fundamentals of Mathematical Statistics”, S. Chand & Co., 10th Edition, 2000.
2. N. P. Bali, “Engineering Mathematics”, Laxmi Publications, 9th Edition, 2016.
3. Richard Arnold Johnson, Irwin Miller and John E. Freund, “Probability and Statistics for Engineers”, Prentice Hall, 8th Edition, 2013.

Web References:

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

E-Text Books:

1. http://www.keralatechnologicaluniversity.blogspot.in/2015/06/erwin-kreyszig-advanced-engineering-mathematics-ktu-ebook-download.html
2. http://www.faadooengineers.com/threads/13449-Engineering-Maths-II-eBooks

FLUID DYNAMICS

III Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB03	Core	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

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 STATICS	Classes: 10

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	Classes: 10

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	Classes: 10

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	Classes: 09

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	Classes: 09

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:

1. D.J Tritton, "Physical Fluid Dynamics", Oxford university press, 2nd edition 2016.
2. R. K Bansal, "Fluid mechanics and hydraulic machines", Laxmi publications ltd, 9th Edition, 2011.
3. Robert W Fox, Alan T McDonald, "Introduction to fluid Mechanics", John Wiley and Sons, 6th Edition,

1995.
4. Streeter V. L, Wylie, E.B., “Fluid Mechanics”, McGraw-Hill, 9th Edition, 1983.

Reference Books:

1. Yuan S W, “Foundations of fluid Mechanics”, Prentice-Hall, 2nd Edition, 1987.
2. Milne Thompson L M, “Theoretical Hydrodynamics”, MacMillan, 5th Edition, 1968.
3. Rathakrishnan. E, “Fundamentals of Fluid Mechanics”, Prentice-Hall, 5th Edition, 2007.
4. Som S. K, Biswas. G, “Introduction to fluid mechanics and fluid machines”, Tata McGraw-Hill, 2nd Edition, 2004.

Web References:

1. https://nptel.ac.in/courses/112105171/1
2. https://textofvideo.nptel.iitm.ac.in/112105171/lec1.pdf
3. https://www.fkm.utm.my/~syahruls/3-teaching/2-fluid-II/fluid-II-enote/32-pump-2.pdf
4. https://www.scribd.com/doc/16605891/Fluid-Mechanics

E-Text Books:

1. https://bookboon.com/en/engineering-fluid-mechanics-ebook
2. https://www.slideshare.net/asifzhcet/fluid-mechanics-and-hydraulic-machines-dr-r-k-bansal
3. https://eprints.staffs.ac.uk/222/1/engineering-fluid-mechanics%5B1%5D.pdf
4. https://www.engr.uky.edu/~acfd/me330-lctrs.pdf

MECHANICS OF SOLIDS

III Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB04	Core	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. 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	Classes: 10

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 solids, Concept of Stain Energy.

MODULE -II	FORCES, DEFLECTION IN BEAMS	Classes: 09

Shear force and bending moment diagrams for different types of beams with point load, uniform distributed load and uniform varying load.

Deflection of beams by Double integration method, Macaulay's method, moment area method, Principle of superposition.

MODULE -III	STRESS IN BEAMS	Classes: 09

Bending stresses: Theory of simple bending, Bending stress, Position of neutral axis, Bending stresses in beams of symmetric and un-symmetric sections, Beams of uniform strength.

Shear stresses: Shearing stresses at a section in a loaded beam, Distribution of shearing stresses over different sections like Rectangular, Triangular, circular, I, L and T-sections.

MODULE -IV	COLUMNS	Classes: 08

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 -V	THEORY OF ELASTISITY	Classes: 09

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:

1. B C Punmia, “Mechanics of Materials”, Laxmi publications (P) Ltd, 2006.
2. T. H. G. Megson, “Aircraft Structures for Engineering Students”, Butterworth-Heinemann Ltd, 5th Edition, 2012.
3. Gere, Timoshenko, “Mechanics of Materials”, McGraw Hill, 3rd Edition, 1993.

Reference Books:

1. R. K Bansal, “Strength of Materials”, Laxmi publications, 5th Edition, 2012.
2. Dym, C. L, Shames, I. H, “Solid Mechanics”, McGraw Hill, Kogakusha, Tokyo, 7th Edition, 2007.
3. Stephen Timoshenko, “Strength of Materials”, Vol I & II, CBS Publishers and Distributors, 3rd Edition, 2004.
4. R. K. Rajput, “Strength of Materials”, S. Chand and Co., 1st Edition, 1999.
5. Timoshenko, S, Young, D. H. “Elements of Strength of Materials”, T. Van Nostrand Co. Inc., Princeton N.J, 4th Edition, 1977.

Web References:

1. www.nptel.ac.in/courses/112107147/
2. www.vssut.ac.in/lecture_notes/lecture1423904647.pdf
3. www.web.mit.edu/emech/dontindex-build/

E-Text Books:

1. www.e-booksdirectory.com/listing.php?category=456
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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB05	Core	-	-	2	1	30	70	100
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

Week-1	**CALIBRATION**
Calibration of Venturimeter and Orifice meter.	
Week-2	**PIPE FLOW LOSSES**
Determination of pipe flow losses in rectangular and circular pipes	
Week-3	**BERNOULLI'S THEOREM**
Verification of Bernoulli's theorem.	
Week-4	**REYNOLDS EXPERIMENT**
Determination of Reynolds Number of fluid flow	
Week-5	**IMPACT OF JET ON VANES**
Study Impact of jet on Vanes.	
Week-6	**CENTRIFUGAL PUMPS**
Performance test on centrifugal pumps.	
Week-7	**RECIPROCATING PUMPS**
Performance test on reciprocating pumps.	
Week-8	**PELTON WHEEL TURBINE**
Performance test on piston wheel turbine.	
Week-9	**FRANCIS TURBINE**
Performance test on Francis turbine.	
Week-10	**FLOW THROUGH WEIRS**
Rate of discharge Flow through Weirs	

Week-11	FLOW THROUGH NOTCH
Flow through rectangular and V-Notch	
Week-12	**FLOW THOUGH ORIFICE MOUTH PIECE**
Flow analysis of different shapes of mouth pieces	

Reference Books:

1. Yuan S W, "Foundations of fluid Mechanics", Prentice-Hall, 2nd Edition, 1987.
2. Milne Thompson L M, "Theoretical Hydrodynamics", MacMillan, 5th Edition, 1968.
3. Rathakrishnan. E, "Fundamentals of Fluid Mechanics", Prentice-Hall, 5th Edition, 2007.
4. Som S. K., Biswas. G, "Introduction to fluid mechanics and fluid machines", Tata McGraw-Hill, 2nd Edition, 2004.

Web References:

1. https://nptel.ac.in/courses/112105171/1
2. https://textofvideo.nptel.iitm.ac.in/112105171/lec1.pdf
3. https://www.fkm.utm.my/~syahruls/3-teaching/2-fluid-II/fluid-II-enote/32-pump-2.pdf
4. https://www.scribd.com/doc/16605891/Fluid-Mechanics

MECHANICS OF SOLIDS LABORATORY

III Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB06	Core	-	-	2	1	30	70	100
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.	
Week-9	**TESTING OF SPRINGS**

Determine the stiffness of the spring and the Modulus of rigidity of wire material.	
Week-10	**DEFLECTION TEST FOR SSB AND CANTILEVER BEAM**
Determine the Young's modulus of the given material with the help of deflection of SSB and cantilever beam.	
Week-11	**REVIEW - I**
Spare session for additional repetitions and review.	
Week-12	**REVIEW - II**
Spare session for additional repetitions and review.	

Reference Books:

1. Gere, Timoshenko, "Mechanics of Materials", McGraw Hill, 3rd Edition, 1993.
2. R. S Kurmi, Gupta, "Strength of Materials", S. Chand, 24th Edition, 2005.
3. William Nash, "Strength of Materials", Tata McGraw Hill, 4th Edition, 2004.

Web References:

1. https://nptel.ac.in/courses/112107147/
2. https://vssut.ac.in/lecture_notes/lecture1423904647.pdf
3. https://web.mit.edu/emech/dontindex-build/

OBJECT ORIENTED PROGRAMMING THROUGH PYTHON LABORATORY

III Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AITB08	Core	1	0	2	2	30	70	100
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 correct order, for example "()" and "()[]{}" are valid but "[)", "({[)]" and "{{{" are invalid.
ii. Get all possible unique subsets from a set of distinct integers.

WEEK-7	METHODS
Write Python programs to do the following 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. ii. Create a Python class named Rectangle constructed by a length and width and a method which will compute the area of a rectangle.	
WEEK-8	**CONSTRUCTORS**
Write Python program to implement constructors.	
WEEK-9	**INHERITANCE**
Write Python program to implement inheritance.	
WEEK-10	**POLYMORPHISM**
Write Python program to implement Polymorphism.	
WEEK-11	**OVERRIDING MAGIC METHODS**
Write Python program to override Magic Methods	
WEEK-12	**EVENT-DRIVEN PROGRAMMING**
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.	
LIST OF REFERENCE BOOKS:	
1. Rance D. Necaise, "Object-Oriented Programming in Python Documentation Release 1", University of Cape Town and individual contributors, 2017.	
WEB REFERENCES:	
1. https://www.w3resource.com/python-exercises/class-exercises/ 2. https://www.rithmschool.com/courses/python-fundamentals-part-2/python-object-oriented-programming-exercises	

AEROSPACE STRUCUTRES

IV Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB07	Core	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. 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 COMPONENTSAND 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.

MODULE -V	ANALYSIS OF FUSELAGE, WING AND LANDING GEAR	Classes: 09

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:

1. T. H. G. Megson, "Aircraft Structures for Engineering Students", Butterworth-Heinemann Ltd, 5th Edition, 2012.
2. E. H. Bruhn, "Analysis and Design of Flight vehicles Structures", Tri-state off set company, USA, 4th Edition, 1965.

Reference Books:

1. B. K. Donaldson, "Analysis of Aircraft Structures - An Introduction", Mc Graw Hill, 3rd Edition, 1993.
2. S. Timoshenko, "Strength of Materials, Vols I and II", Princeton D. Von Nostrand Co., Reprint, 1977.

Web References:

1. https://nptel.ac.in/courses/112101095/
2. https://www.scribd.com/doc/244154727/theory-of-structures-timoshenko-pdf

E-Text Books:

1. https://www.freeengineeringbooks.com/AeroSpace/Aircraft-Structures-Books.php
2. https://docs.google.com/file/d/0Bw8MfqmgWLS4RlNqaE1oUzdOajQ/view?pref=2&pli=1

Course Home Page:

DATA STRUCTURES

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
ACSB03	Core	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

OBJECTIVES:

The students will try to learn:

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

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

MODULE - II	LINEAR DATA STRUCTURES	Classes: 09

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

MODULE - III	LINKED LISTS	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, threaded binary trees, application of trees, Graphs: Basic concept, graph terminology, Graph Representations - Adjacency matrix, Adjacency lists, graph implementation, Graph traversals – BFS, DFS, Application of graphs, Minimum spanning trees – Prims and Kruskal algorithms.

MODULE - V	BINARY TREES AND HASHING	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:

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

Reference Books:
1. S. Lipschutz, “Data Structures”, Tata McGraw Hill Education, 1st Edition, 2008. 2. D. Samanta, “Classic Data Structures”, PHI Learning, 2nd Edition, 2004.
Web References:
1. https://www.tutorialspoint.com/data_structures_algorithms/algorithms_basics.htm 2. https://www.codechef.com/certification/data-structures-and-algorithms/prepare 3. https://www.cs.auckland.ac.nz/software/AlgAnim/ds_ToC.html 4. https://online-learning.harvard.edu/course/data-structures-and-algorithms

AEROSPACE PROPULSION

IV Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB08	Core	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

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	Classes: 08
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.		

Text Books:

1. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison Wesley Longman INC, 1999.
2. Mattingly J.D., "Elements of Propulsion: Gas Turbines and Rocket", AIAA, 1991.

Reference Books:

1. Cohen, H.Rogers, G.F.C. and Saravanamuttoo, H.I.H. "Gas Turbine Theory", Longman, 1989.
2. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.

Web References:

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

E-Text Books:

1. https://as.wiley.com/WileyCDA/WileyTitle/productCd-1118806778.html
2. https://www.scribd.com/document/63588270/Aerospace-Propulsion-Systems
3. https://www.crcpress.com/Aircraft-Propulsion-and-Gas-Turbine-Engines/ElSayed/p/book/9780849391965

Course Home Page:

FLIGHT MECHANICS

IV Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB09	Core	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

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.

Energy height and specific excess power, energy methods for optimal climbs - minimum time, minimum fuel climbs. Measurement of best climb performance. Descent performance in Aircraft operations. Effect of wind on climb and decent performance.

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:

1. Anderson, J.D. Jr., "Aircraft Performance and Design", International edition McGraw Hill, 1st Edition, 1999, ISBN: 0-07-001971-1.
2. Eshelby, M.E., "Aircraft Performance theory and Practice", AIAA Education Series, AIAA, 2nd Edition, 2000, ISBN: 1-56347-398-4.

Reference Books:

1. McCormick, B.W, "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, 2nd Edition, 1995, ISBN: 0-471-57506-2.
2. Yechout, T.R. et al., "Introduction to Aircraft Flight Mechanics", AIAA Education Series, AIAA, 1st Edition, 2003, ISBN: 1-56347-577-4.
3. Shevel, R.S., "Fundamentals of Flight", Pearson Education, 2nd Edition, 1989, ISBN: 81-297-0514-1.

Web References:

1. www.myopencourses.com/subject/flight-dynamics-i-airplane-performance
2. www.scribd.com/doc/185026212/Introduction-to-Flight-Third-Edition-by-John-D-Anderson-Jr
3. www.scribd.com/book/282507871/Performance-and-Stability-of-Aircraft
4. www.scribd.com/doc/203462287/Aircraft-Performance-NPTEL
5. www.nptel.ac.in/courses/101106041/

E-Text Books:

1. www.scribd.com/doc/97544751/Anderson-Aircraft-Performance-and-Design

Course Home Page:

AERODYNAMICS

IV Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB10	Core	3	1	-	4	30	70	100
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 aero foils 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

Potential flow, velocity potential, stream function, Laplace equation, flow singularities-Uniform flow, source, sink, doublet, Vortex, Non lifting and lifting flow over a cylinder Kutta-Joukowski theorem.

MODULE -II	THIN AEROFOIL THEORY	Classes: 09

Aerofoil nomenclature, aerodynamic characteristics, centre of pressure and aerodynamic centre; Wing of infinite aspect ratio, C_L-α- 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 Helmhotz 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 LAYERTHEORY	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:

1. E. L. Houghton and P. W. Carpenter, "Aerodynamics for Engineering Students", Edward Arnold Publishers Ltd., London, 5th Edition, 1982,
2. J. D. Anderson, "Fundamentals of Aerodynamics", Mc Graw Hill Book Co., New York, 5th Edition, 1985.
3. John J. Bertin and Russell M. Cummings, "Aerodynamics for Engineering Students", Pearson, 5th Edition, 2009.

Reference Books:

1. L. J. Clancy, "Aerodynamics", Pitman, 1st Edition, 1986.
2. L. H. Milne, S. Thomson, "Theoretical Aerodynamics", Dover, 2nd Edition, 1985.
3. K. Karamcheti, "Principles of Ideal-Fluid Aerodynamics", Krieger Pub Co; 2nd edition, 1980.

Web References:
1. https://www.loc.gov/rr/scitech/tracer-bullets/aerodynamicstb.html 2. https://www.myopencourses.com/subject/aerodynamics-2 3. https://tocs.ulb.tu-darmstadt.de/211658790.pdf 4. https://www.princeton.edu/~stengel/MAE331Lecture3.pdf
E-Text Books:
1. https://bookboon.com/en/a-first-course-on-aerodynamics-ebook 2. https://airspot.ru/book/file/22/houghton_aerodynamics_for_engineering_students.pdf 3. https://www.adl.gatech.edu/extrovert/Ebooks/ebook_Lowspeed.pdf 4. https://rahauav.com/Library/Aerodynamic/Aerodynamics%20for%20engineering%20students_6th_www.rahauav.com.pdf

AEROSPACE STRUCTURES LABORATORY

IV Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB11	Core	-	-	3	1.5	30	70	100
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,	

Week-11	**NON-DESTRUCTIVE TESTING**
Magnetic particle inspection and ultrasonic techniques.	
Week-12	**VIBRATION TEST**
Determination of natural frequency of beams under free and forced vibration using.	

Reference Books:

1. Megson, T.H.G., Aircraft Structures for Engineering Students, 4th edn., Elsevier, 2007, ISBN 0-750-667397.
2. Peery, D.J. and Azar, J.J., Aircraft Structures, 2nd edn, McGra-Hill, 1982, ISBN 0-07-049196-8.
3. Bruhn. E.H, Analysis and Design of Flight Vehicles Structures, Tri-state Off-set Company, USA, 1965.
4. Lakshmi Narasaiah, G., Aircraft Structures, BS Publications, 2010.

Web References:

1. httpa://nptel.ac.in/courses/112101095/
2. https://www.scribd.com/doc/244154727/theory-of-structures-timoshenko-pdf

AERODYNAMICS AND PROPULSIONLABORATORY

IV Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB12	Core	-	-	2	1	30	70	100
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, CAMBERED 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.	

Week-10	**NOZZEL PERFORMECE**
Calculation of various nozzle performance with airflow	
Week-11	**CALORIFIC VALUE OF DIFFERENT FUELS**
Calculation of calorific value of different fuels and materials using digital bomb calorimeter and optimizing astute fuels	
Week-12	**PROPELLER TEST RIG**
Calculation of propeller efficiency and thrust availability using propeller test rig at various blade pitch angles.	

Reference Books:

1. L. J. Clancy, "Aerodynamics", Pitman, 1st Edition, 1986.
2. Alan pope, "Low Speed Wind Tunnel Testing", John Wiley, 2nd Edition, 1999.
3. N. M. Komerath, "Low Speed Aerodynamics", Extrovert, 1st Edition, 2012.
4. https://www.cast-safety.org/pdf/3_engine_fundamentals.pdf
5. https://en.wikipedia.org/wiki/Reciprocating_engine

Web References:

1. www.loc.gov/rr/scitech/tracer-bullets/aerodynamicstb.html
2. www.myopencourses.com/subject/aerodynamics-2
3. www.tocs.ulb.tu-darmstadt.de/211658790.pdf
4. www.princeton.edu/~stengel/MAE331Lecture3.pdf

DATA STRUCTURES LABORATORY

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

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
ACSB05	Foundation	-	-	3	1.5	30	70	100
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 searching 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.

WEEK-7	IMPLEMENTATION OF CIRCULAR SINGLE LINKED LIST

Write Python programs for the following operations on circular linked List.
(i) Creation
(ii) Insertion
(iii) Deletion
(iv) Traversal

WEEK-8	IMPLEMENTATION OF DOUBLE LINKED LIST

Write Python programs for the following:
Uses functions to perform the following operations on Double Linked List.
(i) Creation
(ii) Insertion
(iii) Deletion
(iv) Traversal in both ways.

WEEK-9	IMPLEMENTATION OF STACK USING LINKED LIST

Write a Python program to implement Stack using linked list.

WEEK-10	IMPLEMENTATION OF QUEUE USING LINKED LIST

Write a Python program to implement Linear Queue using linked list.

WEEK-11	GRAPH TRAVERSAL TECHNIQUES

Write Python programs to implement the following graph traversal algorithms:
a. Depth first search.
b. Breadth first search.

WEEK-12	IMPLEMENTATION OF BINARY SEARCH TREE

Write a Python program to perform the following:
a. Create a binary search tree.
b. Traverse the above binary search tree recursively in pre-order, post-order and in-order.
c. Count the number of nodes in the binary search tree.

LIST OF REFERENCE BOOKS:

1. Y Daniel Liang, “Introduction to Programming using Python”, Pearson.
2. Benjamin Baka, David Julian, “Python Data Structures and Algorithms”, Packt Publishers,2017.
3. Rance D. Necaise, “Data Structures and Algorithms using Python”, Wiley Student Edition.
4. Martin Jones, “Python for Complete Beginners”, 2015.
5. Zed A. Shaw, “Learn Python the Hard Way: a very simple introduction to the terrifyingly beautiful world of computers and code”, 3e, Addison-Wesley, 2014.
6. Hemant Jain, “Problem Solving in Data Structures and Algorithms using Python: programming interview guide”, 2016.

WEB REFERENCES:

1. https://docs.python.org/3/tutorial/datastructures.html
2. http://interactivepython.org/runestone/static/pythonds/index.html
3. http://www.tutorialspoint.com/data_structures_algorithms
4. http://www.geeksforgeeks.org/data-structures/
5. http://www.studytonight.com/data-structures/
6. http://www.coursera.org/specializations/data-structures-algorithms

AIRCRAFT STABILITY AND CONTROL

V Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AAEB13	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	**-**	**-**	**3**	**30**	**70**	**100**
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		

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 linearzed 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**

Aircraft axes system, Definition: Equilibrium, stability, controllability, & maneuverability. Examples from simple mechanical systems for stability. Longitudinal static stability and dynamic stability for un accelerated flight. Criteria for longitudinal static stability and trim condition. Contribution of Principle components. Equations of equilibrium- stick fixed neutral point, elevator angle required to trim. Definition-static margin. Equations of motion in steady, symmetric pull-up maneuver, elevator effectiveness, elevator hinge moment, neutral point, maneuver point, static margin for stick fixed and stick free conditions, control force and control gradient. Trim tabs and types of trim tabs, Aerodynamic and mass balancing of control surfaces, forward and aft most limits of CG.

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**

Description of motion of Flight vehicle - systems of reference frames - earth, body, wind, stability axes - relative merits. Euler angles, angles of attack and sideslip– definitions- earth to body axis transformation, stability axis to body axis transformation. Rotating axis system- expressions for linear and angular moment of rigid body, time derivatives-inertia tensor, components of linear and angular velocities, accelerations.

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).

MODULE-V	**AIRCRAFT DYNAMIC STABILITY**	**Classes: 07**

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.

Text Books:

1. Yechout, T.R.etal., "Introduction to Aircraft Flight Mechanics", AIAA education Series, 2003, ISBN 1-56347-577-4.
2. Nelson, R.C., "Flight Stability and Automatic Control", 2nd Edn., Tata McGraw Hill, 2007, ISBN 0-07-066110-3.
3. Etkin, B and Reid, L.D., "Dynamics of Flight", 3rd Edn., John Wiley, 1998, ISBN0-47103418-5.

Reference Books:

1. Schmidt, L.V., "Introduction to Aircraft Flight Dynamics", AIAA Education Series, 1st Edition, 1998, ISBN A-56347-226-0.
2. McCormick, B.W., "Aerodynamics, Aeronautics, and Flight Mechanics", WileyIndia, 2nd Edition, 1995, ISBN 97.

Web References:

1. www.scribd.com/book/282507871/Performance-and-Stability-of-Aircraft
2. www.nptel.ac.in/courses/101106043/
3. www.nptel.ac.in/courses/101106042/
4. www.scribd.com/document/174035182/Flight-mechanics

E-Text Books:

1. www.csobeech.com/files/AirplanePerformanceStabilityandControl.pdf
2. www.books.google.co.in/books?isbn=1600860788

ANALYSIS OF AIRCRAFT STRUCTURES

V Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB14	Core	2	1	-	3	30	70	100
Contact Classes: 30	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 45		

OBJECTIVES:

The course should enable the students to:

I. The concepts of estimation of the endurance and failure mechanism of aircraft structural components for safe design.

II. The properties and analysis of composite structures for replacement of aluminium structures with composites for high strength to weight ratio.

III. The mechanism involved in thin walled closed and rectangular section beam subjected to torsion and Shear loads for design of modern aircrafts.

IV The concepts of Stresses and deflections of various open and closed section aircraft beam structures.

MODULE -I	FATIGUE OF AIRCRAFT STRUCTURE	Classes: 08

S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors - Plastic stress concentration factors - Notched S.N. curves.

MODULE -II	FRACTURE MECHANICS OF AIRCRAFT STRUCTURE	Classes: 10

Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin - Orwin extension of Griffith's theory to ductile materials - stress analysis of cracked bodies - Effect of thickness on fracture toughness - stress intensity factors for typical geometries. Crack growth mechanisms.

MODULE -III	LAMINATED AIRCRAFT COMPOSITE STRUCTURES	Classes: 09

Classification and characteristics of composite materials - Fibrous, Laminated Particulate, Combinations of composite materials, Mechanical Behavior. Basic terminology-laminae, laminates, Manufacture – Initial form of constituent Materials, Layup, Curing, Strength and stiffness Advantages, Cost Advantages, and Weight Advantages.

Applications- Military, Civil Aircraft, Space and Automotive. Elastic constants of a simple lamina, Stress–strain relationships for an orthotropic ply(macro- approach), Thin-walled composite beams.

MODULE -IV	STRUCTURAL AND LOADING DISCONTINUITIES - CLOSED SECTION BEAMS	Classes: 09

General aspects, Shear stress distribution at a built-in end of a closed section beam, Thin-walled rectangular section beam subjected to torsion, Shear lag.

MODULE-V	STRUCTURAL AND LOADING DISCONTINUITIES - OPEN SECTION BEAMS	Classes: 09

I-section beam subjected to torsion, Torsion of an arbitrary section beam, Distributed torque loading, Extension of the theory to allow for general systems of loading, Moment couple (bimoment).

Text Books:

1. Prasanth Kumar, "Elements of fracture mechanics", Wheeter Publication, 1999.
2. Jones, R.M, "Mechanics of Composite Materials", Taylor & Francis, 2nd Edition, 2010.
3. T. H. G. Megson, "Aircraft Structures for Engineering Students",Butterworth-Heinemann Ltd, 5th Edition, 2012.

Reference Books:

1. Barrois W, Ripely, E.L., "Fatigue of Aircraft Structure", Pe/gamon press. Oxford, 1983.
2. B. K. Donaldson, "Analysis of Aircraft Structures" - An Introduction", McGraw Hill, 3rd Edition, 1993.
3. E. H. Bruhn, "Analysis and Design of Flight Vehicles Structures", Tri-state off set company, USA, 4th Edition, 1965.
4. S. Timoshenko, "Strength of Materials, Vols I and II", Princeton D. Von Nostrand Co., Reprint, 1977.
5. J E shigley, C R Mischke, R G Budynas, K J Nisbett, "Mechanical Engineering Design" The McGraw Hill, 8th Edition, 2010.

Web References:

1. https://nptel.ac.in/courses/112101095/
2. https://www.scribd.com/doc/244154727/theory-of-structures-timoshenko-pdf

E-Text Books:

1. https://www.freeengineeringbooks.com/AeroSpace/Aircraft-Structures-Books.php
2. https://docs.google.com/file/d/0Bw8MfqmgWLS4RlNqaE1oUzdOajQ/view?pref=2&pli=1

HIGH SPEED AERODYNAMICS

V Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB15	Core	2	1	-	3	30	70	100
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.

MODULE-I	INTRODUCTION TO COMPRESSIBLE FLOWS	Classes: 10

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.

MODULE-II	SHOCK AND EXPANSION WAVES	Classes: 10

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.

MODULE-III	ONE DIMENSIONAL AND QUASI ONE DIMENSINAL FLOW	Classes: 08

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.

MODULE-IV	APPLICATIONS OF COMPRESSIBLE FLOWS AND NUMERICAL TECHNIQUES	Classes: 08

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.

MODULE-V	EXPERIMENTAL METHODS IN COMPRESSIBLE FLOWS	Classes: 09

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.

Text Books :

1. John D. Anderson, "Modern Compressible flow with historical perspective", McGraw-Hill Education, 3rdEdition, 2002.
2. John D. Anderson, "Fundamentals of Aerodynamics", McGraw-Hill Education, 6thEdition, 2016.

Reference Books:

1. Ascher H. Shapiro, "The Dynamics and Thermodynamics of Compressible Fluid Flow" John Wiley & Sons; Volume 1st Edition, 1977.
2. Radhakrishnan Ethirajan, "Gas Dynamics", John Wiley & Sons, 2nd Edition 2010.
3. H W Liepmann and A Roshko, "Elements of Gas Dynamics", John Wiley & Sons, 4th Edition, 2003.

Web References:

1. https://nptel.ac.in/courses/101103004/pdf/mod8.pdf
2. https://www.uvm.edu/~dhitt/me346/?Page=exams.html

E-Text Books:

1. https://www3.nd.edu/~powers/ame.30332/notes.pdf
2. https://www.e-booksdirectory.com/details.php?ebook=11098
3. https://www.e-booksdirectory.com/details.php?ebook=4519

AIRCRAFT PRODUCTION TECHNOLOGY

V Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB16	Core	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. 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 Steels, study of iron, iron carbon phase diagram, heat treatment-annealing, normalizing, hardening and tempering of Aluminum and steel, Non-Ferrous metals and Alloys: Structure and properties of copper and its alloys, Aluminum and its alloys, Titanium and its alloys, Corrosion - Types of Corrosions - Prevention – Protective Treatments.

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:

1. S. Kalpakjian, Steven R. Schmid, "Manufacturing Engineering and Technology", Addison Wesley 5th Edition, 1991.
2. S. C. Keshu, K. K Ganapathy, "Aircraft production technology and management", Interline Publishing House, Bangalore, 3rd Edition, 1993.
3. Douglas F. Horne, "Aircraft production technology", Cambridge University Press, 1st Edition, 1986.

Reference Books:

1. S. C. Keshu, K. K Ganapathy, "Air craft production techniques", Interline Publishing House, Bangalore, 3rd Edition, 1993.
2. R. K. Jain, "Production technology", Mc Graw Hill, 1st Edition, 2002.
3. O. P. Khanna, M. Lal, "Production technology", Dhanpat Rai Publications, 5th Edition, 1997.

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=6wFuw6wufTMC&redir_esc
2. https://royalmechanicalbuzz.blogspot.in/2015/04/manufacturing-engineering-by-kalpakjian.html

COMPUTER AIDED DESIGN LABORATORY

V Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB17	Core	-	-	2	1	30	70	100
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-l	**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:

1. http://www.ehu.eus/asignaturasKO/DibujoInd/Manuales/R12_manual_catia_v5.pdf
2. http://www.engr.psu.edu/xinli/edsgn497k/TeaPotAssignment.pdf

AIRCRAFT PRODUCTION TECHNOLOGY LABORATORY

IV Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB18	Core	-	-	3	2	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 36				Total Classes: 36		

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.
IV.

LIST OF EXPERIMENTS

Week-1	**BASIC METALLURGY -I**
Preparation and study of microstructure of pure materials like Cu and Al. Hardenability of steels by Jominy End Quench test	
Week-2	**BASIC METALLURGY -II**
Study of microstructures of non-ferrous alloys. Study of microstructure of heat treated steel.	
Week-3	**LATHE OPERATIONS -I**
Introduction- lathe machine, plain turning, Step turning & grooving.	
Week-4	**LATHE OPERATIONS -II**
Taper turning-compound rest/offset method & Drilling using lathe, External threading-Single start	
Week-5	**SHAPING & SLOTTING**
Shaping-V-Block & Slotting-Keyways.	
Week-6	**MILLING**
Milling-Face milling, End milling and Side milling	
Week-7	**GRINDING**
Grinding-Cylindrical /Surface/Tool & cutter.	
Week-8	**DRILLING**
Drilling, reaming, counter boring, Counter sinking Taping.	
Week-9	**WELDING PROCESSES I**
Gas Welding, Brazing and Soldering.	
Week-10	**WELDING PROCESS II**
Arc welding. Spot welding and TIG welding.	
Week-11	**BASIC CASTING**
Preparation of casting with simple patterns.	
Week-12	**RIVETING ALUMINUM SHEETS**
Solid and Blind Rivets on aluminum sheets.	

Reference Books:
1. Keshu S. C, Ganapathy K. K, “Air craft production techniques”, Interline Publishing House, Bangalore, 3rd Edition, 1993. 2. R. K Jain-Khanna, “Production technology”, Mc Graw Hill, 1st Edition, 2002. 3. O. P Khanna, Lal. M. Dhanpat Rai, “Production technology, 5th Edition, 1997.
Web References:
1. https://nptel.ac.in/courses/112107145/ 2. https://nptel.ac.in/courses/112105126/

FINITE ELEMENT ANALYSIS

VI Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB19	Core	2	1	-	3	30	70	100
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	Classes: 10

Introduction to Finite Element Method for solving field problems. Stress and Equilibrium. Boundary conditions. Strain - displacement relations. Stress-strain relations for 2-D and3-D elastic problems. One Dimensional Problem: Finite element modeling coordinates and shape functions. Assembly of Global stiffness matrix and load vector. Finite element equations – Treatment of boundary conditions, Quadratic shape functions.

MODULE-II	ANALYSIS OF TRUSSES AND BEAMS	Classes: 10

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	Classes: 09

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	Classes: 09

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	Classes: 07

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:

1. Tirupathi. R. Chandrapatla, Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Printice Hall India, 3rd Edition, 2003.
2. Rao. S.S., "Finite Element Methods in Engineering," Butterworth and Heinemann, 2001.
3. Reddy J.N., "An Introduction to Finite Element Method", McGraw Hill, 2000.

Reference Books:

1. Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw Hill, 2000.
2. K. J. Bathe, E. L. Wilson, "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.
3. Robert D Cook, David S Malkus, Michael E Plesha, "Concepts and Applications of Finite Element Analysis", 4th edition, John Wiley and Sons, Inc., 2003.
4. Larry J Segerlind, "Applied Finite Element Analysis", 2nd Edition, John Wiley and Sons, Inc. 1984.

Web References:

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

E-Text Books:

1. www.civilenggforall.com/2015/09/finite-element-analysis-by-ss-bhavikatti-free-download-pdf-civilenggforall.com.html
2. www.books.google.co.in/books/about/Finite_Element_Analysis_For_Engineering.html

COMPUTATIONAL AERODYNAMICS

VI Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB20	Core	2	1	-	3	30	70	100
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.

MODULE-V	FINITE VOLUME METHODS	Classes: 09

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.

Text Books:

1. J. D. Anderson, Jr., "Computational Fluid Dynamics- The Basics with Applications", McGraw-Hill Inc, 2012.
2. D. A.Anderson, J.C.Tannehill, R.H. Pletcher, "Computational Fluid Mechanics and Heat Transfer", 1st edition, 1997.

Reference Books:

1. Hirsch, C., "Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics", Vol. I, Butter worth-Heinemann, 2nd edition, 2007.
2. Hoffmann, K. A. and Chiang, S. T., "Computational Fluid Dynamics for Engineers", Engineering Education Systems, 4thedition, 2000.
3. Patankar, S.V., "Numerical Heat Transfer and Fluid Flow", Hemisphere Pub. Corporation, 1st edition, 1980.

Web References:

1. https://www.mathematik.uni-dortmund.de/~kuzmin/cfdintro/lecture1.pdf
2. https://bookboon.com/en/computational-fluid-dynamics-ebook
3. https://www.sciencedirect.com/science/book/9780080445069
4. https://cg.informatik.uni-freiburg.de/course_notes/cfd.pdf

E-Text Books:

1. https://www.leka.lt/sites/default/files/dokumentai/computational-fluid-dynamics.pdf
2. https://www.topajka-shaw.co.nz/UCFD.htm
3. https://www.grc.nasa.gov/WWW/wind/valid/tutorial/tutorial.html
4. https://www.scribd.com/doc/311680146/eBook-PDF-Cfd-Fluent

AIRCRAFT SYSTEMS

VI Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB21	Core	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. 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:

1. Moir, I. and Sea bridge, A, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley, 3rd Edition 2008.
2. Moir, I. and Sea bridge, A, "Design and Development of Aircraft Systems- An Introduction", AIAA Education Series", AIAA, 2004.

Reference Books:

1. Pallett, E.H.J., "Aircraft Instruments and Integrated Systems", Longman Scientific &Technical 10th Edition, 1992.
2. Harris, D, "Flight Instruments and Automatic Flight Control Systems", 6th Edition, 2004.
3. Bolton, W., "Pneumatic and Hydraulic Systems", Butterworth-Heinemann.

Web References:

1. https://www.aircraftsystemscomjet.com/
2. https://www.srmuniv.ac.in/sites/default/files/downloads/Aircraft_ctrl_Systems.pdf
3. https://hydraulicspneumatics.com/other-technologies/chapter-5-pneumatic-and-hydraulic-systems
4. https://www.stahl.de/fileadmin/Dateien/download_publikationen/web havc_and_pressurization.pdf

E-Text Books:

1. https://www.amazon.in/Aircraft-Systems-Mechanical-ElectricalIntegration/dp/0470059966
2. https://www.scribd.com/book/142412367/Aircraft-Systems-Mechanical-Electrical-and Avionics-Subsystems-Integration
3. https://www.scribd.com/document/231235694/n-0447376

COMPUTATIONAL AERODYNAMICS LABORATORY

VI Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB22	Core	-	-	2	1	30	70	100
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.	
Week-10	**FLOW OVER A CONE**
Flow over a cone at supersonic Mach number; observe the shock waves and 3D relieving effect.	
Week-11	**CODE DEVELOPEMENT**
Solution for the following equations using finite difference method I. One dimensional wave equation using explicit method of lax. II. One dimensional heat conduction equation using explicit method.	
Week-12	**CODE DEVELOPEMENT**
Generation of the following grids I. Algebraic grids. II. Elliptic grids.	

Reference Books:

1. Anderson, J.D., Jr., Computational Fluid DynamicsThe Basics with Applications, McGraw-Hill Inc, 1st Edition 1998.
2. Hoffmann, K. A. and Chiang, S. T., "Computational Fluid Dynamics for Engineers", 4th Edition, Engineering Education Systems (2000).
3. Hirsch, C., "Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics", Vol. I, 2nd Edition., Butterworth-Heinemann (2007).
4. JAF. Thompson, Bharat K. Soni, Nigel P. Weatherill "Grid generation", 1st Edition 2000.

Web References:

1. https://www.scribd.com/doc/311680146/eBook-PDF-Cfd-Fluent.
2. https://cfd.ninja/tutorials/ansys-fluent
3. https://confluence.cornell.edu/display/SIMULATION/FLUENT+Learning+Modules

Course Home Page:

COMPUTATIONAL STRUCTURAL ANALYSIS LABORATORY

VI Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
AAEB23	Core	-	-	2	1	30	70	100
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-l	**INTRODUCTION AND BASIC FUCTIONS**

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

Week-9	**ANALYSIS OF AIRCARFT STRUCTURE: WING**
a. Static analysis of Aircraft wing structure b. Modal analysis of aircraft wing structure	
Week-10	**ANALYSIS OF AIRCARFT STRUCTURE: FUSELAGE**
a. Static analysis of Aircraft Semi monoque fuselage structure b. Modal analysis of aircraft Semi monoque fuselage structure	
Week-11	**ANALYSIS OF AIRCARFT STRUCTURE: LANDING GEAR**
a. Static analysis of main landing gear b. Modal analysis of main landing gear	
Week-12	**ANALYSIS OF COMPOSITE STRUCTURES**
a. Static analysis of composite bar and beam b. Static analysis of composite plate	
Reference Books:	
1. Huei-Huang Lee, "Finite Element Simulations with ANSYS Workbench 16", SDC publications, 2nd Edition, 2016. 2. Anderson, William J "MSC/Nastran: Interactive Training Program" Wiley 1st Edition 2015.	

FLIGHT VEHICLE DESIGN

VII Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB24	Core	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. 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 lay out from conceptual sketch. the inboard profile drawing, lofting- definition, significance and methods, flat wrap lofting, special consideration in configuration lay out, 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, passengersand 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.

MODULE-V	COST ESTIMATION, PARAMETRIC ANALYSIS, OPTIMISATION, REFINED SIZING AND TRADE STUDIES	Classes: 07

Elements of life cycle cost, cost estimating method, RDT&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&747; General dynamics F-16, SR-71 Blackbird, Northrop-Grumman B-2 Stealth Bomber

Text Books:

1. Daniel P. Raymer, “Aircraft Design: A Conceptual Approach”, AIAA Educational Series, USA, 4th Edition, 2006.
2. J. F. Marchman, L. R. Jenkinson, “Aircraft Design Projects for Engineering students”, AIAA Publishers, USA, 2003.
3. Ajoy Kumar Kunda, “Aircraft Design”, Cambridge University Press, UK, 2010.

Reference Books:

1. E. Torenbeek, “Synthesis of Subsonic Airplane Design”, Delft University Press, New York, 1986.
2. E. H Bruhn, “Analysis and Design of Flight Vehicles Structures”, Jacobs Publishing House, USA, New Edition, 1973.
3. E. E Scheler, L.G Dunn, “Airplane Structural Analysis and Design”, John Wiley & Sons, USA, 1963.
4. D. Howe, “Aircraft conceptual Design Synthesis”, John Wiley and Sons Publishers, USA, 2005.

Web References:

1. http://www.arabiceng.com/?page=articles_file_download&id=80
2. http://a.moirier.free.fr/Conception/Bouquins/Torenbeek%20~%20Synthesis%20Of%20Subsonic%20Airplane%20Design.pdf

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
3. https://www.scribd.com/doc/220947115/Analysis-and-Design-of-Flight-Vehicle-Structures-by-E-F-Bruhn-pdf

AEROSPACE STRUCTURAL DYNAMICS

VII SEMESTER: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB25	Core	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. 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**

Introduction, Equations of Motion for Forced Vibration, Free Vibration Analysis of an Undamped System, Torsional System, Coordinate Coupling and Principal Coordinates, Forced-Vibration Analysis, Semi definite Systems, Self-Excitation and Stability Analysis, Transfer- Function Approach, Solutions Using Laplace Transform, Solutions Using Frequency Transfer Functions.

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**

Static Aeroelasticity; Typical Section Model of an Airfoil: Typical Section Model with Control Surface, Typical Section Model—Nonlinear Effects. One Dimensional Aeroelastic Model of Airfoils: Beam-Rod Representation of Large Aspect Ratio Wing, Eigenvalue and Eigen function Approach, Galerkin's Method. **Dynamic Aeroelasticity;** Hamilton's Principle: Single Particle, Many Particles, Continuous Body, Potential Energy, Non potential Forces, Lagrange's Equations.

Text Books:

1. Bismarck-Nasr, M.N., "Structural Dynamics in Aeronautical Engineering", AIAA Education Series, 2nd Edition, 1999.
2. Rao, S.S., "Mechanical Vibrations", Prentice-Hall, 5th Edition, 2011.
3. Earl H. Dowell, "A Modern Course in Aeroelasticity" Volume 217, Duke University, Durham, NC, USA.

Reference Books:

1. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, "Aeroelasticity", Addison Wesley Publishing Co., Inc., 2nd Edition, 1996.
2. Leissa, A.W., Vibration of continuous system, The McGraw-Hill Company, 2nd Edition, 2011.
3. Inman, D.J., Vibration Engineering, Prentice Hall Int., Inc., 3rd Edition, 2001.

Web References:

1. http://ase.sbu.ac.ir/FA/Staff/abbasrahi/Lists/Dars/Attachments/11/Vibrations%20of%20Continuous%20Systems.pdf
2. http://arc-test.aiaa.org/doi/book/10.2514/4.862458
3. http://arc-test.aiaa.org/doi/abs/10.2514/5.9781600862373.0719.0728

E-Text Books:

1. http://www.gregorypaulblog.com/structural-dynamics-in-aeronautical-engineering-aiaa-education-series.pdf
2. https://aerocastle.files.wordpress.com/2012/10/mechanical_vibrations_5th-edition_s-s-rao.pdf

FLIGHT VEHICLE DESIGN LABORATORY

VII Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB26	Core	-	-	3	1.5	30	70	100
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 :
a. Type, Role, Mission.
b. Payload
c. Aerodynamic & performance requirements.

Week-2	**CONCEPTUAL SKETCH AND WEIGHT ESTIMATION**

a. Conceptual sketch of candidate aircraft (3-view).
b. First estimation of gross take-off weight with trade-off studies.

Week-3	**AIRFOIL DESIGN AND CONSTRAINT ANALYSIS**

a. Airfoil and wing geometry selection

Week-4	**CONSTRAINT ANALYSIS**

a. Determination of Thrust-to-Weight ratio and Wing Loading

Week-5	**INITIAL SIZING-I**

a. Rubber engine & fixed engine sizing.

Week-6	**INITIAL SIZING-II**

a. Configuration layout, crew station, passengers and payload

Week-7	**PERFORMANCE ESTIMATIONS**

a. Performance constraint analysis

Week-8	**LOAD ESTIMATIONS-I**

a. Landing gear loads

Week-9	**LOAD ESTIMATIONS-II**

a. Propulsion system load.

Week-10	COST ESTIMATION
a. Cost estimation and parametric analysis b. Optimization and trade studies	
Week-11	**DESIGN CASE STUDY-I**
a. Design study of DC-3 b. Design study B-747	
Week-12	**DESIGN CASE STUDY-II**
a. Dynamics of F-16 b. Dynamics of SR-71	
REFERENCES:	
1. Daniel P. Raymer "Aircraft Design a Conceptual Approach", 5th Edition 1999.	

AEROSPACE STRUCTURAL DYNAMICS LABORATORY

VII Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB27	Core	-	-	3	1.5	30	70	100
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	

Week-12	EXAMINATIONS

REFERENCES:

1. Joseph E. Shigley, “Theory of Machines and Mechanisms”, Oxford University Press, 4th Edition, 2010.
2. Thomas Bevan, “Theory of Machines”, Pearson, 3rd Edition, 2009.

PROJECT WORK (phase – I)

VII Semester: Common for all branches								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AAEB56	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		0	0	10	5	30	70	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 150**				**Total Classes: 150**		

The object of Project Work (phase – I) is to enable the student to take up investigative study in the broad field of Aeronautical 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 (phase – II)

VIII Semester: Common for all branches								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AAEB57	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		0	0	12	6	30	70	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 180**				**Total Classes: 180**		

The object of Project Work (phase – II) & Dissertation is to enable the student to extend further the investigative study taken up under AE 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 AE P1;
2. Review and finalization of the Approach to the Problem relating to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including team work;
4. Detailed Analysis / 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

PE - I

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB29	Elective	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. 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 polariscopes, isoclinics and isochromatics, fringe order determination fringe multiplication techniques, calibration photoelastic model materials.

MODULE-V	STRAIN ANALYSIS METHODS	Classes: 08

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:

1. Dally and Riley, "Experimental Stress Analysis", McGraw-Hill, New York, 1978.
2. Sadhu Singh, "Experimental Stress Analysis", Khanna Publisher, 4th Edition, 2009.
3. Srinath L.S tata , "Experimental stress Analysis", McGraw-Hill, 3rd Edition, 2012.

Reference Books:

1. M.M.Frocht, John Wiley & sons, "Photoelasticity Vol I and Vol II", McGraw Hill, 2nd Edition, 1969.
2. Perry and Lissner , "Strain Gauge Primer", McGraw Hill, 2nd Edition, 1969.

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:

1. www.scribd.com/doc/241582542/Experimental-Stress-Analysis-by-Dally-and-Riley-P-1554n
2. www.apm.iitm.ac.in/smlab/kramesh/book_5.htm
3. www.myopencourses.com/subject/experimental-stress-analysis-1
4. https://www.amazon.com/Data-Structures-C-Noel-Kalicharan/dp/1438253273

DESIGN AND ANALYSIS OF COMPOSITE STRUCTURES

PE - I

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB30	Elective	3	-	-	3	30	70	100
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:

1. Gibson, R.F, "Principles of Composite Material Mechanics", CRC Press, 2nd Edition, 2007.
2. Jones, R.M, Taylor & Francis, "Mechanics of Composite Materials", 2nd Edition, 2010 (Indian Print).
3. Reddy, J.N., "Mechanics of Laminated Composite Plates and Shells – Theory and Analysis", CRC Press, 2nd Edition, 2004.

Reference Books:

1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995.
2. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989.
3. Autar K.Kaw "Mechanics of Composite Materials", 2nd Edition, CRC Press, 2005.

Web References:

1. www.nptel.ac.in/courses/101104010/
2. www.freevideolectures.com/Course/94/Prestressed-Concrete-Structures/35
3. www.adturtle.biz/LP_TA/index.cfm?T=436857.

E-Text Books:

1. www.samples.sainsburysebooks.co.uk/9781118536957_sample_413689.pdf
2. www.samples.sainsburysebooks.co.uk/9780470972717_sample_386378.pdf
3. www.safaribooksonline.com/library/view/design-and-analysis/9781118536940/
4. https://www.amazon.com/Data-Structures-C-Noel-Kalicharan/dp/1438253273.

AEROELASTICITY

PE - I

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB31	Elective	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. 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 AEROLASTIC 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:

1. Y.C. Fung, "An Introduction to the Theory of Aeroelasticity", John Wiley & Sons Inc., New York, 2008.
2. E.G. Broadbent, "Elementary Theory of Aeroelasticity", Bun Hill Publications Ltd., 1986.

Reference Books:

1. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, "Aeroelasticity", Edition Addison Wesley Publishing Co., Inc., 2nd Edition, 1996.
2. R.H. Scanlan and R. Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.

Web References:

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

E-Text Books:

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

UNMANNED AIR VEHICLES

PE - I

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB32	Elective	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. 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

HTOL Aircraft - Helicopters - OTE/OTE/SPH - Convertible Rotor Aircraft - Payload Control -Sensors –culmon filter- Autonomy.

Text Books:

1. Reg Austin., Unmanned Aircraft Systems, John Wiley and Sons., 2010.

Reference Books:

1. Milman & Halkias, “Integrated Electronics”, McGraw Hill, 1999.
2. Malvino & Leach, “Digital Principles & Applications”, McGraw Hill, 1986.
3. Collinson R.P.G, “Introduction to Avionics”, Chapman and Hall, India, 1996.
4. Bernad Etikin, “Dynamic of flight stability and control”, John Wiley, 1972.

Web References:
1. www.tc.gc.ca/eng/civilaviation/publications/page-6557.html 2. www.dhl.com/en/about_us/logistics_insights/dhl_trend_research/ 3. www.books.google.co.in/books?id=guGVDQAAQBAJ&pg=PT3&lpg=PT3&dq
E-Text Books:
www.ebookstrust.com/9048197066/Ebooks%20Textbooks%20Handbook%20Of%20Unmanned.

GROUND VEHICLE AERODYNAMICS

PE - II

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB33	Elective	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. 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 OPTMIZATION 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:

1. Wolf- Heinrich Hucho, “Aerodynamics of Road vehicles”, SAE International 1998.
2. Joseph Katz, “Race Car Aerodynamics Designing for Speed”, Bentley Publishers, 2nd Edition, 1996.

Reference Books:

1. Alan Pope, “Wind Tunnel Testing”, John Wiley & Sons, 2nd Edition, 1974.

Web References:

1. https://www.buildyourownracecar.com/race-car-aerodynamics-basics-and-design/
2. https://www.ara.bme.hu/oktatas/letolt/Vehicleaerodyn/Vehicleaerodyn.pdf
3. https://auto.howstuffworks.com/fuel-efficiency/fuel-economy/aerodynamics.html
4. https://www.slideshare.net/friendsrtg/vehicle-body-engineering-aerodynamics

E-Text Books:

1. https://dlx.bookzz.org/genesis/1111000/58a5c1c372f8f523a0c58e26c3c531eb/_as/[Wolf-Heinrich_Hucho_(Eds.)]_Aerodynamics_of_Road_(BookZZ.org).pdf
2. https://dlx.bookzz.org/genesis/555000/2c09a10c7a7c0f3deaeeb9ddc4251c26/_as/[Joseph_Katz]_Race_Car_Aerodynamics_Designing_for(BookZZ.org).pdf

ADVANCED COMPUTATIONAL AERODYNAMICS

PE- II

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB34	Elective	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. 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

Stability of solution, explicit methods, FTFS, FTCS, FTBS, Leapfrog method, Lax method. Implicit methods: Euler's FTCS, Crank Nicolson method, description of Lax- Wendroff scheme, McCormack two step predictor-corrector method, description of time split methods, approximate factorization schemes.

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:

1. Tannehill John C, Anderson Dale A, Pletcher Richard H, "Computational Fluid Mechanics and Heat Transfer", Taylor & Francis, 2nd Edition, 1997.
2. Chung T G, "Computational Fluid Dynamics", Cambridge University Press, 2nd Edition, 2010.
3. Katz Joseph and Plotkin Allen, "Low-Speed Aerodynamics", Cambridge University Press, 2nd Edition, 2006.

Reference Books:

1. Anderson J D, "Modern Compressible Fluid Flow", 2nd Edition, McGraw Hill, 1990.
2. Anderson J D, "Fundamentals of Aerodynamics", Tata McGraw Hill, 5th Edition, 2010.
3. Anderson J D, "Computational Fluid Dynamics", McGraw Hill, 1995.

Web References:

1. https://s6.aeromech.usyd.edu.au/aerodynamics/index.php/sample-page/subsonic-aerofoil-and-wing-theory/2d-panel-methods/
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.
2. https://www.scribd.com/doc/159468983/Low-Speed-Aerodynamics-Joseph-Katz-Alen-Plotkin
3. https://www.crcpress.com/Computational-Fluid-Mechanics-and-Heat-Transfer-Third-edition/Pletcher-Tannehill-Anderson/p/book/9781591690375.
4. https://www.faadooengineers.com/threads/8482-Computational-Fluid-Dynamics-Ebook-Ppt-Pdf-Download.

EXPERIMENTAL AERODYNAMICS

PE- II

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB35	Elective	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. 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 MEASUREMETNS	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	FLOW VISUALIZATION TECHNIQUES	Classes: 08

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.

Text Books:

1. Jewel B Barlow, William H Rae Jr. & Alan Pope, "Low Speed Wind Tunnel Testing", John Wiley& Sons Inc, Re-Print, 1999.
2. Alan Pope, Kennith L Goin, "High Speed Wind Tunnel Testing", John Wiley & Sons, Reprint, 1965.

Reference Books:

1. Gorlin S M & Slezinger I I, "Wind tunnels & Their Instrumentations", NASA publications, Translated version, 1966.
2. Jorge C Lerner & Ulfilas Boldes, "Wind Tunnels and Experimental Fluid Dynamics Research", InTech, 1st Edition, 2011.
3. Liepmann H W and Roshko A, "Elements of Gas Dynamics", John Wiley & Sons, 4th Edition, 2003.

Web References:

1. https://nptel.ac.in/courses/101106040/
2. https://ocw.metu.edu.tr/course/view.php?id=66
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:

1. https://www.scribd.com/doc/221788571/Wind-Tunnel-Testing-Barlow-Rae-Pope
2. https://www.scribd.com/document/84868596/Wind-Tunnelsibooksonline.com/library/view/data-structures-using/9789332524248/

HYPERSONIC AERODYNAMICS

PE - II

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB36	Elective	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, VISCOUS INTERACTIONS	Classes: 09

Boundary conditions, metricor 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	Classes: 09

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:

1. John J Bertin, "Hypersonic Aerothermodynamics, , AIAA Education Series, 1st Edition, 1994.
2. Mikhailov G K & Parton V Z, "Super and Hypersonic Aerodynamics and Heat Transfer", CRC publishers, 1st Edition, 1992.

Reference Books:

1. John D Anderson, " Hypersonic and High Temperature Gas Dynamics", AIAA Education Series, 2nd Edition, 2006.
2. Ernst H Hirshchel, "Basics of Aerothermodynamics", Springer-Verlag, 1st Edition, 2005.

Web References:

1. https://nptel.ac.in/courses/101103003/
2. https://www.grc.nasa.gov/www/BGH/

E-Text Books:

1. https://bookzz.org/book/678872/21935f
2. https://bookzz.org/book/1201615/e314e1
3. https://bookzz.org/book/592471/7e27f3

TURBO MACHINERY

PE - III

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB37	Elective	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. 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

Text Books:

1. Yahya S.M, “Turbines, Compressor and Fans”, TMH, 4th Edition, 2010.
2. Shepherd D.G., “Principles of Turbomachinery”, Collier Macmillan, 2nd Edition, 1961.
3. Venkanna B.K., “Fundamentals of Turbomachinery”, PHI, 3rd Edition, 2009.

Reference Books:

1. Peng W.W., “Fundamentals of Turbo machinery”, Wiley, 2nd Edition, 2007.
2. Korpela S.A., “Principles of Turbo machinery”, Wiley, 2nd Edition, 2011.
3. Turton R.K., “Principles of Turbo machinery”, Springer, 3rd Edition, 1994.

Web References:

1. https://www.cfd-online.com/Wiki/Turbomachinery
2. https://www.leka.lt/sites/default/files/dokumentai/key-concepts-in-turbo-machinery_1.pdf
3. https://www.sciencedirect.com/science/book/9781856177931

E-Text Books:

1. https://elearning.vtu.ac.in/newvtuelc/courses/15/E-Notes/turbomachines/MODULE-I%20&%20MODULE-II_GRS.pdf
2. https://engineering-e-book.blogspot.com/2008/01/turbomachinery-books.html
3. https://myopencourses.com/subject/computational-fluid-dynamics-for-turbomachinery

HEAT TRANSFER

PE - III

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB38	Elective	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. 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

Modes and mechanisms of heat transfer, Basic laws of heat transfer. Conduction heat transfer: Fourier rate equation, Steady and unsteady and periodic heat transfer -Initial and boundary conditions, Overall heat transfer coefficient, Electrical analogy, Critical radius of insulation, Extended surfaces (Fins) Long, Short and insulated tips. Application to error measurement of temperature. Significance of Biot and Fourier numbers, Chart solutions of transient conduction systems –concept of Functional Body.

MODULE-II	CONVECTION, FORCED CONVECTION	Classes: 08

Buckingham Pi Theorem, application for developing semi-empirical non-dimensional correlation for convection heat transfer-significance of non-dimensional numbers-Concepts of Continuity, Momentum and Energy Equations. Concepts of hydrodynamic and thermal boundary layer -Flat plates and Cylinders. Concepts about Hydrodynamic and Thermal Entry Lengths-division of internal flows based on this- use of empirical correlations for Horizontal Pipe Flow and annulus flow.

MODULE-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.

MODULE-V	RADIATION HEAT TRANSFER	Classes: 09
Emission characteristics, Laws of black-body radiation, Irradiation, Total and Monochromatic quantities, Laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann, Heat exchange between two black bodies, concepts of shape factor, Emissivity, heat exchange between grey bodies, radiation shields, electrical analogy for radiation networks. Application in Space Engineering		

Text Books:

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

Reference Books:

1. Holman, "Heat Transfer"Tata McGraw Hill education (P) Ltd, New Delhi, India. 10th Edition, 2012.
2. Ghoshdastidar, P. S. "Heat Transfer", Oxford University Press, New Delhi, India. 2nd Edition, 2012.

Web References:

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

E-Text Books:

1. https://bookzz.org/book/2556672/5ef6f5
2. https://bookzz.org/book/533930/66495a
3. https://bookzz.org/book/495953/61bfa5

CRYOGENICS

PE - III

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB39	Elective	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:

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:

1. Flynn, T.M., Dekker, Marcel “Cryogenic Engineering”, Plenum Press, USA, 2009.
2. Timmerhaus, K.D, Flynn, T.M, “Cryogenic Process Engineering”, Plenum Press, USA, 2009.

Reference Books:

1. Bose A. and Sengupta P.“Cryogenics: Applications and Progress”, Tata McGraw Hill, 2010.
2. Barron R., “Cryogenic Systems”, Oxford University Press, 2012.
3. Haselden, G.G.,“Cryogenic Fundamentals”, Academic Press, 2012.

Web References:

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

E-Text Books:

1. https://bookzz.org/book/690085/5d838f
2. https://bookzz.org/book/2121781/aff7cc
3. https://bookzz.org/book/939475/a6994a

ROCKET AND MISSILES

PE - III

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB40	Elective	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. 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-linier 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 slooh 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:

1. Sutton, G.P., et al., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York,

1993.
2. Martin J.L Turner , Rocket &space craft propulsion, Springers –oraxis publishing, 2001.

Reference Books:

1. Mathur, M., and Sharma, R.P., "Gas Turbines and Jet and Rocket Propulsion", Standard Publishers, New Delhi 1998.
2. Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W., Freeman & Co. Ltd., London, 1982.
3. Parker, E.R., "Materials for Missiles and Spacecraft", McGraw-Hill Book Co. Inc., 1982.

Web References:

1. https://www.tutorialspoint.com/materials for rockets & missiles.
2. https://www.geeksforgeeks.org/ rockets & missiles /
3. https://www.studytonight.com/ rockets & missiles/
4. https://www.coursera.org/specializations/ rockets & missiles –spacecraft.

E-Text Books:

1. https://www.scribd.com/doc/268924096/c-rockets&missiles-mathur-eBook
2. https://www.safaribooksonline.com/library/view/rockets&missiles-using/9789332524248/
3. https://www.amazon.com/rockets &missiles-C-sutton
4. https://www.scribd.com/doc/40147240/rockets and missiles-Using-c-by-parker-ER-946

NON DESTRUCTIVE TESTING

PE - IV

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB41	Elective	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. 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, v unaided and aided.

MODULE-II	SURFACE NON DESTRUCTIVE EXAMINATION METHODS	Classes: 09

Liquid Penetrant Testing: Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results; Magnetic particle testing; Theory of magnetism, inspection materials magnetisation methods, interpretation and evaluation of test indications, principles and methods of demagnetization, residual magnetism.

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, instrumentations 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 :

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Ravi Prakash, "Non-Destructive Testing Techniques", New Age International Publishers, 1st revised Edition, 2010.

Reference Books:

1. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, New Jersey, 2nd Edition, 2005.
2. Charles, J. Hellier, "Handbook of Non-destructive evaluation", McGraw Hill, New York 2001.

Web References:

1. https://nptel.ac.in/syllabus/syllabus_pdf/113106070.pdf
2. https://nptel.ac.in/courses/113106070/24

E-Text Books:

1. https://www.springer.com/la/book/9780412625008
2. https://eprints.nmlindia.org/1850/1/177-193.PDF
3. https://www.tower.com/non-destructive-test-evaluation-materials-prof-j-prasadpaperback/wapi/124712958

CAD / CIM

PE - IV

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB42	Elective	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. 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 TECHNOLGY 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 M ONITORING	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 :

1. A. Zimmers, P. Groover, “CAD/ CAM”, Prentice- Hall India, 2008.
2. Zeid, Ibrahim, “CAD / CAM Theory and Practice”, Tata McGraw-Hill, 1997.
3. Mikell. P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education 2001.
4. Ranky, Paul G., “Computer Integrated Manufacturing”, Prentice hall of India Pvt. Ltd.,2005
5. Yorem Koren, “Computer Integrated Manufacturing”, McGraw Hill, 2005.

Reference Books:

1. P. Groover, Automation, “Production Systems & Computer Integrated Manufacturing”, Pearson Education.2nd Edition 1989.
2. Lalit Narayan, “Computer Aided Design and Manufacturing”, Prentice-Hall India, 3rd Edition 2002.
3. Radhakrishnan, Subramanian, “CAD / CAM / CIM”, New Age, 4th Edition 2016.
4. Jami J Shah, Martti Mantyla, “Parametric and Feature-Based CAD/CAM: Concepts, Techniques, and Applications”, John Wiley & Sons Inc, 1995.
5. Alavala, “CAD/ CAM: Concepts and Applications”, PHI Publications, 4th Edition, 2016.
6. W. S. Seames, “Computer Numerical Control Concepts and Programming”, 4th Edition 1999.

Web References:

1. https://en.wikipedia.org/wiki/CAD/CAM_dentistry
2. https://en.wikipedia.org/wiki/Computer-aided_manufacturing
3. https://en.wikipedia.org/wiki/Computer-integrated_manufacturing

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

PE- IV

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
AAEB43	Elective	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. 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..

MODULE-II	KINEMATIC ANALYSIS OF MECHANISMS	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.

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.

MODULE-III	BELT DRIVES, AND CAMS AND FOLLOWERS	Classes: 10

Belt Drives: Types of Belts, Material used for Belts, Types of Flat Belt Drives, Velocity Ratio of Belt Drive. Length of Open Belt Drive. Power Transmitted by a Belt. Ratio of Driving Tensions for Flat Belt Drive. Centrifugal Tension. Maximum Tension in the Belt. Initial Tension in the Belt.

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.

MODULE-IV	GEARS AND GEAR TRAINS	Classes: 09

Gears And Gear Trains: friction wheels and toothed gears, types, law of gearing, condition for constant velocity ratio for transmission of motion, velocity of sliding, form of teeth, cycloidal and involute profiles, phenomena of interferences.

Gear trains: Introduction, types, simple and reverted gear trains, epicyclic gear train; Methods of finding train value or velocity ratio of epicyclic gear trains

MODULE-V	GYROSCOPIC COUPLE AND PRECESSION MOTION AND BALANCING OF ROTATING MASSES	Classes: 08

Angular Motion: Gyroscopes - Processional Angular Motion; Gyroscopic Couple; effect of precession motion on the stability of moving vehicles such as motorcycle - motorcar - aero planes and ships.

Balancing of Rotating Masses;. Balancing of a Single Rotating Mass By a Single Mass Rotating in the same plane; Balancing of a Single rotating mass by two masses rotating in different planes; Balancing of several masses rotating in the same plane; Balancing of several masses rotating in different planes.

Text Books :

1. Amithab Ghosh, Asok Kumar Malik, "Theory of Mechanisms and Machines", East West Press Pvt Ltd, 2001.
2. S.S Ratan, "Theory of Machines", Tata McGraw-Hill, 4th Edition, 2014.
3. J. S. Rao, R.V. Dukkipati "Mechanism and Machine Theory / New Age Publications", 1996.
4. P. L. Ballaney, "Theory of Machines", Khanna Publishers, 3rd Edition, 2003

Reference Books:

1. Dr Jagdish Lal, J. M. Shaw "Theory of Machines", 1st Edition, 1985.
2. Abdulla Sharif, Dhanpat Rai, "Theory of Machines", 5th Edition, 1987,
3. Neil Sclater, P. Nicholas, Chironis "Mechanisms and Mechanical Devices Sourcebook", New York McGraw-Hill, publications, 3rd Edition.1963
4. J. E. Shigley, R. Charles, Mischke,"Mechanical engineering and design", TMH,1st Edition, 2003.

Web References:

1. https://en, wikipedia.org/wiki/Mechanism_(engineering)
2. https://en, wikipedia.org/wiki/Machine_(mechanical)
3. https://en, wikipedia.org/wiki/Crank_(mechanism)

E-Text Books:

1. https://engineeringstudymaterial.net/ebook/mechanisms-and-mechanical-devices-sourcebook/
2. https://accessengineeringlibrary.com/browse/mechanisms-and-mechanical-devices-sourcebook-fifth-edition
3. https://www,amazon,com/Mechanisms-Mechanical-Devices-Sourcebook-Fourth-ebook/dp/B0062Y 79H0#navbar

PRODUCT DESIGN AND DEVELOPMENT

PE- IV

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
AAEB44	Elective	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. 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 opportMODULEies, 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 need, 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:

1. K. T Ulrich, S. D. Eppinger, "Product Design and Development", Tata McGraw-Hill, 5th edition, 2008.
2. K. Otto, K. Wood, "Product Design", Pearson, 1st Edition, 2001.

Reference Books:

1. Steven Eppinger, Karl Ulrich, "Product Design and Development", McGraw-Hill Education, 1st Edition, 2011.
2. Karl T. Ulrich, Steven D. Eppinger, "Product Design and Development", McGraw-Hill, 1st Edition, 2012.
3. Semyon D. Savransky, "Engineering of Creativity: Introduction to TRIZ methodology of Inventive Problem Solving", CRC Press, 1st Edition, 2000.

Web References:
1. https://nptel.ac.in/courses/105106049/# 2. https://www.rqriley.com/pro-dev.htm
E-Text Books:
1. https://faculty1.aucegypt.edu/farag/presentations/Chapter1.pdf 2. https://appinventor.mit.edu/explore/sites/all/files/teachingappcreation/MODULE1/DesignMODULE1.pdf

AVIONICS AND INSTRUMENTATION

PE-V

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB45	Elective	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. 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, ASTRIONICS - 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

Text Books:
1. Moir, I. and Seabridge, A., Civil Avionics Systems, AIAA Education Series, AIAA, 2002. 2. Collinson, R.P.G., Introduction to Avionics Systems, Springer, 2nd Edition, 2003.
Reference Books:
1. Helfrick, A., Principles of Avionics, Avionics Communications Inc. Leesburg, 2000. 2. Henderson, M. F., Aircraft Instruments & Avionics for A &P Technicians, Jeppesen Sanderson Training Products, 1993.
Web References:
1. https://soaneemrana.org/onewebmedia/INTRODUCTION%20TO%20SPACE%20DYNAMICS1 2. https://nptel.ac.in/courses/101105030/
E-Text Books:
1. https://store.doverpublications.com/0486651134.html 2. https://www.worldcat.org/title/introduction-to-space-dynamics/oclc/867680515

AIR TRANSPORTATION SYSTEMS

PE - V

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB46	Elective	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. 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 (CNSS); 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:
1. Hirst, M., The Air Transport System, Woodhead Publishing Ltd, Cambridge, England, 2008.
Reference Books:
1. Wensven, J.G., Air Transportation: A Management Perspective, Ashgate, 2nd Edition 2007. 2. Belobaba, P., Odoni, A. and Barnhart, C., Global Airline Industry, 2nd Edition Wiley, 2009. 3. M. Bazargan, M., Airline Operations and Scheduling, Ashgate, 1st Edition 2004.
Web References:
1. https://pdfs.semanticscholar.org/7f85/e5cffcdd85e25bd495b5762e1ca4facda739.pdf2.pdf.pdfhttp://andromeda.rutgers.edu/~jy380/research/air-schedule/chapter50.pdf
E-Text Books:
1. https://link.springer.com/book/10.1007%2F978-3-7091-1880-

AIRPORT PLANNING AND MANAGEMENT

PE - V

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB47	Elective	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. 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 policie; 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 queueing diagram; The future of airport management: Introduction, restructuring of commercial air carriers, new large aircraft, small aircraft transportation systems.

Text Books:

1. Alexander T Wells, Ed. D Seth Young, "Airport planning and Management", 6nd Edition, 2011.

Reference Books:

1. Norman J. Ashford, H. P. Martin Stanton, Clifton A. Moore, Pierre Coutu, “Airport Operations”, McGraw Hill, 3rd Edition, 2013.

Web References:

1. https://memberfiles.freewebs.com/94/47/55224794/documents/airport%20planning%20and%20management.pdf
2. https://books.google.co.in/books?id=RYR6cu4YSBcC&dq=Planning%20and%20Design%20of%20Airports&source=gbs_similarbooks

E-Text Books:

1. https://accessengineeringlibrary.com/browse/airport-planning-and-management-sixth-edition
2. https://www.only4engineer.com/2014/10/planning-and-design-of-airports-by.html

FLIGHT SCHEDULING AND OPERATIONS

PE - V

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB48	Elective	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. 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	Classes: 08

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	Classes: 10

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	Classes: 10

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	Classes: 09

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.	Classes: 08

Complexity theory, heuristic procedures; Case studies of airline operation and scheduling, study through simulation modeling, use of available software.

Text Books:

1. Bazargan, M.,'Airline Operations and Scheduling', Ashgate Publishing Ltd, 2nd Edition, 2010.

Reference Books:

1. Belobaba, P., Odoni, A., Barnhart, C. 'The Global Airline Industry', Wiley, 2nd Edition 2009.
2. Wu, Cheng-Lu0ng, 'Airline Operations and Delay Management', Ashgate Publishing Ltd, 2010.
3. Wensveen, J.G., 'Air Transportation: A Management Perspective', Ashgate Publishing Ltd, 6th Edition., 2007.
4. Ahuja, R. et al, 'Network Flows-Theory, Algorithms and Applications', Prentice-Hall, 1993.

Web References:

1. https://51.254.215.131/files/airport-operations-book-pdf.pdf
2. https://andromeda.rutgers.edu/~jy380/research/air-schedule/chapter50.pdf

E-Text Books:

1. https://51.254.215.131/files/airport-operations-book-pdf.pdf
2. https://andromeda.rutgers.edu/~jy380/research/air-schedule/chapter50.pdf

AUTOMATIC CONTROL OF AIRCRAFT

PE - VI

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB49	Elective	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. 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:

1. Blake Lock, J.H, "Automatic control of Aircraft and missiles", John Wiley Sons, New York, 1990.
2. Stevens B.L & Lewis F.L, "Aircraft control & simulation", John Wiley Sons, New York, 1992.
3. Collinson R.P.G, "Introduction to Avionics", Chapman and Hall, 1st Edition India, 1996.

Reference Books:

1. Garnel.P. & East. D.J, "Guided Weapon control systems", Pergamon Press, Oxford, 1st Edition 1977.
2. Bernad Etikin, "Dynamic of flight stability and control", John Wiley, 1st Edition 1972.
3. Nelson R.C, "Flight stability & Automatic Control", McGraw Hill, 1st Edition 1989.

Web References:
1. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16...aircraft.../lecture-16 2. www.fsd.mw.tum.de/research/flight-control/ 3. nptel.ac.in/courses/101108056/
E-Text Books:
1. https://books.google.co.in/books?isbn=1118870972 2. https://books.google.co.in/books?isbn=0387007261

FLIGHT SIMULATION

PE-VI

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB50	Elective	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. 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	MODEL VALIDATION AND VISUAL SYSTEMS	Classes: 08

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 wire frame 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:

1. David Allerton, "Principles of Flight simulation" John Wiley & Sons, Ltd Publication, 1st Edition.
2. M. J Rycroft, "Flight simulation", Cambridge university press, 1st Edition, 1999.
3. J. M. Rolfe, K. J. Staples "Flight simulation", Cambridge University press, 1st Edition, 1987.
4. Jeffrey Strickland, "Missile Flight Simulation", Lulu press, Inc, 2nd Edition, 2012.
5. Jonathan M. Stern "Microsoft Flight Simulator Handbook" Brady Publishing, 1st Edition, 1995.

Reference Books:

1. Ranjan Vepa, "Flight Dynamics, Simulation, and Control: For Rigid and Flexible Aircraft",
2. CRC press, 1st Edition, 2014.
3. Duane Mc Ruer, Irving Ashkenas, Dunstan Graham "Aircraft Dynamics and Automatic Control" Princeton University Press, 2nd Edition, 2014.
4. Brian L. Stevens, Frank L. Lewis, "Aircraft Control and Simulation", John Wiley & Sons Ltd Publication, 2nd Edition, 2003.

Web References:

1. https://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol1/kwc2/article1.html
2. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.132.5428&rep=rep1&type=pdf
3. https://research.omicsgroup.org/index.php/Flight_simulator
4. https://as.wiley.com/WileyCDA/WileyTitle/productCd-0471371459.html

E-Text Books:

1. https://www.aeronautics.nasa.gov/pdf/principles_of_flight_in_action_9_12.pdf
2. https://helijah.free.fr/dev/Principles-of-Flight-Simulation.pdf
3. https://leseprobe.buch.de/images-adb/ee/49/ee495ffc-8dc1-4a07-ad7b-b18540b9fb60.pdf
4. https://samples.sainsburysebooks.co.uk/9780470682197_sample_388478.pdf

ORBITAL MECHANICS

PE-VI

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB51	Elective	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. 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 orbitsal 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	PRELIMAMINARY 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.

Orbit determination from angle and range measurements angles only, preliminary orbit determination; Gauss method of preliminary orbit determination.

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

Approximations to Relative motion in orbit Linearization of the equations of relative motion in orbit Clohessy-Wiltshire equations two-impulse rendezvous maneuvers Relative motion in close-proximity circular orbits.

Text Books:

1. Curtis, Howard D., "Orbital Mechanics for Engineering Students", Butterworth Heinemann, Elsevier series, 3rd Edition, 2010.
2. Bate, Roger R.; Mueller, Donald D.; White, Jerry E. "Fundamentals of Astrodynamics". Dover Publications, 1st Edition 1971.

Reference Books:

1. Sellers, Jerry J.; Astore, William J.; Giffen, Robert B.; Larson, Wiley J. Kirkpatrick, Douglas H., ed. "Understanding Space An Introduction to Astronautics", McGraw Hill, 2nd Edition,2004.
2. Bryson, A.E., "Control of Aircraft and Spacecraft." Princeton University Press, 1994.
3. Thomson, William T. "Introduction to Space Dynamics." New York: Wiley. 3rd Edition, 1963.

Web References:

1. https://soaneemrana.org/onewebmedia/INTRODUCTION%20TO%20SPACE%20DYNAMICS1
2. https://projectehermes.upc.edu/Enginyeria_Aeroespacial/4A/Enginyeria%20espacial/Teoria/Extra/Orbital%20Mechanics%20for%20Engineering%20Students.pdf

E-Text Books:

1. https://store.doverpublications.com/0486651134.html
2. https://worldcat.org/title/introduction-to-space-dynamics/oclc/867680515

SPACE DYNAMICS

PE-VI

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB52	Elective	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. 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	Classes: 10

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	Classes: 10

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	Classes: 09

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	Classes: 08

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	Classes: 08

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:

1. Ashish Tewari, "Atmospheric and space flight dynamics" Birkhauser publications, 1st Edition, 2007
2. Vallado, David A., "Fundamentals of Astrodynamics and Applications", Kluwer Academic Publishers, London, 3rd Edition, 2007.

Reference Books:

1. Roy, Archie E., “The Foundation of Astrodynamics”, The Macmillan Company, Collier Macmillan Limited, London, 3rd Edition, 2007.
2. Kaplan, Marshall H., “Modern Spacecraft Dynamics and Control”, John Wiely & Sons, New York, 1st Edition, 1976.

Web References:

1. https://soaneemrana.org/onewebmedia/INTRODUCTION%20TO%20SPACE%20DYNAMICS1
2. https://nptel.ac.in/courses/101105030/

E-Text Books:

1. https://store.doverpublications.com/0486651134.html
2. https://worldcat.org/title/introduction-to-space-dynamics/oclc/867680515

FLIGHT CONTROL THEORY

OE - I

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB53	Core	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 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

Dynamical systems-principal constituents-input, output-process (plant)-block diagram representation. Inputs- control input, noise. Function of controls regulation (hold), tracking (command)-examples. Measure of effectiveness. Sensitivity of output to control input, noise and system parameters- robustness. Deterministic and stochastic control. Control in everyday life. The pervasiveness of control in nature, engineering and societal systems. The importance of study of control system. Need for stable, effective (responsive), robust control system. Modeling of dynamical systems by differential equations-system parameters. Examples from diverse fields. First and second order systems, higher order systems, single input single output systems, and multiple-input multiple-output.

MODULE-II	MATHEMATICAL MODELLING OF DYNAMIC SYSTEMS	Classes: 10

Control system performance- time domain description- output response to control inputs-- impulse and indicial response- characteristic parameters- significance- relation to system parameters- examples- first and second order linear systems, higher order systems. Synthesis of response to arbitrary input functions from impulse and indicial response. Review of Fourier transforms and Laplace transforms- inverse transforms- significance, applications to differential equations. 's' (Laplace) domain description of input-output relations- transfer function representation- system parameters- gain, poles and zeroes. Characteristic equation- significance- examples. Frequency and damping ratio of dominant poles.
Relation of transfer functions to impulse response. Partial fraction decomposition of transfer functions-significance.

MODULE -III	STEADY STATE RESPONSE ANALYSIS	Classes: 10

System type, steady state error, error constants- overall system stability. Application of feedback in stability augmentation, control augmentation, automatic control-examples. Composition, reduction of block diagrams of complex systems-rules and conventions. Control system components - sensors, transducers, servomotors, actuators, filters-modeling, transfer functions. Single-input single-output systems. Multiple input-multiple output systems, matrix transfer functions-examples. Types of control problems- the problem of analysis, control synthesis, system synthesis- examples- static control of aircraft. Extension to dynamic control. System identification from input output measurements importance.

Experimental determination of system transfer functions by frequency response measurements. Example. Frequency domain description- frequency response- gain and phase shift- significance- representation asymptotic (Bode) plots, polar (Nyquist) plots, frequency transfer functions. Characteristic parameters

corner frequencies, resonant frequencies, peak gain, and bandwidth- significance. First and second order systems- extension to higher order systems.

MODULE-IV	A IRCRAFT RESPONSE TO CONTROLS	Classes:07

Approximations to aircraft transfer functions, control surface actuators-review. Response of aircraft to elevator input, Response of aircraft to rudder input and Response of aircraft to aileron input to atmosphere. Need for automatic control. Auto pilots Stability augmentation systems-pitch damper and yaw damper.

MODULE -V	FLYING QUALITIES OF AIRCRAFT	Classes: 08

Reversible and irreversible flight control systems. Flying qualities of aircraft-relation to airframe transfer function. Pilot's opinion ratings. Flying quality requirements- pole-zero, frequency response and time-response specifications. Displacement and rate feedback determination of gains conflict with pilot input s resolution-control augmentation systems- Full authority fly-by-wire. Auto Pilot-Normal acceleration, Turn rate, Pitch rate Commands-Applications.

Text Books:

1. Kuo, B.C., “Automatic Control Systems”, Prentice Hall India, 1992.
2. Stevens, B.L. and Lewis, F.L., “Aircraft Control and Simulation”, John Wiley, 1992.

Reference Books:

1. Mc Lean, D., “Automatic Flight Control Systems”, Prentice Hall, 1990 J.
2. Bryson, A.E., “Control of Aircraft and Spacecraft”, Princeton University Press, 1994.
3. E H J Pallett, Shawn Coyle, “Automatic Flight Control”, 4th Edition, 2002.

E-Text Books:

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

AIRFRAME STRUCTURAL DESIGN

OE - I

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEB54	Elective	3	0	-	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. Understand the historical evolution of airplane and types of aircrafts along with exploration of space environment.
II. Discuss various aerodynamic forces acting on aircraft components and related principles.
III. Explain the performance and stability of aircraft for different mission segments of flight.
IV. Study the various types of satellite systems and subsystems with human exploration into space.

MODULE - I	HISTORY OF FLIGHT AND SPACE ENVIRONMENT	Classes: 10

Balloons and dirigibles, heavier than air aircraft, commercial air transport; Introduction of jet aircraft, helicopters, missiles; Conquest of space, commercial use of space; Different types of flight vehicles, classifications exploring solar system and beyond, a permanent presence of humans in space; Earth's atmosphere, the standard atmosphere; The temperature extremes of space, laws of gravitation, low earth orbit, microgravity, benefits of microgravity; Environmental impact on spacecraft, space debris; Planetary environments.

MODULE-II	INTRODUCTION TO AERODYNAMICS	Classes: 09

Anatomy of the airplane, helicopter; Understanding engineering models; Aerodynamic forces on a wing, force coefficients; Generating lift, moment coefficients; Aerodynamic forces on aircraft – classification of NACA airfoils, aspect ratio, wing loading, mach number, centre of pressure and aerodynamic centre-aerofoil characteristics-lift, drag curves; Different types of drag.

MODULE -III	FLIGHT VEHICLE PERFORMANCE AND STABILITY	Classes: 09

Performance parameters, performance in steady flight, cruise, climb, range, endurance, accelerated flight symmetric maneuvers, turns, sideslips, takeoff and landing.

Flight vehicle Stability, static stability, dynamic stability; Longitudinal and lateral stability; Handling qualities of the airplanes.

MODULE-IV	INTRODUCTION TO AIRPLANE STRUCTURES AND MATERIALS, POWER PLANTS	Classes:08

General types of construction, monocoque, semi-monocoque; Typical wing and fuselage structure; Metallic & non-metallic materials, use of aluminum alloy, titanium, stainless steel and composite materials; Basic ideas about engines, use of propeller and jets for thrust production; Principles of operation of rocket, types of rockets.

MODULE -V	SATELLITE SYSTEMS ENGINEERING HUMAN SPACE EXPLORATION	Classes: 09
Satellite missions, an operational satellite system, elements of satellite, satellite bus subsystems; Satellite structures, mechanisms and materials; Power systems; Communication and telemetry; Propulsion and station keeping; Space missions, mission objectives. Goals of human space flight missions, historical background, the Soviet and US missions; The mercury, Gemini, Apollo (manned flight to the moon), Skylab, apollo-soyuz, space Shuttle; International space station, extravehicular activity; The space suit; The US and Russian designs; Life support systems, flight safety; Indian effort in aviation, missile and space technology.		

Text Books:

1. Anderson J. D, "Introduction to Flight", McGraw-Hill, 5th Edition, 1989.
2. Newman D, "Interactive Aerospace Engineering and Design", McGraw-Hill, 1st Edition, 2002.

Reference Books:

1. Kermode, A. C, "Flight without Formulae", McGraw Hill, 4th Edition, 1997.
2. Barnard R.H and Philpot. D.R, "Aircraft Flight", Pearson, 3rd Edition, 2004.
3. Swatton P. J, "Flight Planning", Blackwell Publisher, 6th Edition, 2002.

Web References:

1. https://www.aerospaceengineering.es/book/
2. https://www.ne.nasa.gov/education/
3. https://nptel.ac.in

E-Text Books:

1. https://www.e-booksdirectory.com/
2. https://www.adl.gatech.edu/extrovert/Ebooks/ebook_Intro.pdf
3. https://www.academia.edu/7950378/Introduction_to_Flight_-_Anderson_5th_Ed.

MECHANICAL PROPERTIES OF MATERIALS

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AMEB54	Open	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. 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	Classes : 09

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	Classes : 09

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	Classes: 09

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	Classes: 09

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	Classes : 09

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:
1. M. F. Ashby, “Material Selection in Mechanical Design”, Elsevier, 4th Edition, 2015. 2. M.Ashby,K.Johnson, “Materials and Design”, Lakshmi Publications, Elsevier, 3rd Edition, 2014.
Reference Books:
1. Kenneth G. Budinski, “Engineering Materials: Properties and Selection”, PHI, 1st Edition, 2013. 2. J. G. Gerdeen, H. W. Lord, R. A. L., “Engineering Design with Polymers and Composites”, CRC Press, 2nd Edition, 2011.
Web References:
1. http://nptel.ac.in/courses/112106138/
E-Text Book:
1. https://accessengineeringlibrary.com/browse/precision-engineering

AUTOMATION IN MANUFACTURING

OE – I

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AMEB55	Elective	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. 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**

Production System Facilities, Manufacturing Support systems, Automation in Production systems, Automation principles and Strategies Manufacturing Operations, Product/Production Relationship, Production concepts and Mathematical Models & Costs of Manufacturing Operations

MODULE-II	**INDUSTRIAL CONTROL SYSTEM**	**Classes: 09**

Basic Elements of an Automated System, Advanced Automation Functions and Levels of Automation, Continuous versus Discrete control, Computer Process control, Forms of Computer Process Control.

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**

Part Families, Parts Classification and coding, Production Flow Analysis, Cellular Manufacturing, and Flexible Manufacturing Systems: What is an FMS, FMS Components, FMS Applications, benefits, FMS Planning and Implementation issues.

MODULE-V	**Manufacturing Support System**	**Classes: 09**

Process Planning, Computer Aided Process Planning, Concurrent Engineering and Design for Manufacturing, Advanced Manufacturing Planning, Just-in Time Production System, basic concepts of lean and Agile manufacturing.

Text Books:

1. R. Thomas Wright and Michael Berkeihiser, "Manufacturing and Automation Technology", 3rd Edition,2012
2. M.P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing" / PE/PHI.

Reference Books:

1. Tien-Chien Chang, Richard A. Wysk, Hsu-Pin Wang, “Computer Aided Manufacturing”‖, Pearson 1st Edition, 2009.
2. R Thomas Wright, Michael Berkeihiser, “Manufacturing and Automation Technology”, Good Heart/Willcox Publishers, 1st Edition, 2013.

Web References:

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

E-Text Book:

1. https://docs.google.com/file/d/0B7uir_9DoCLFaGduckFqQmcwUnc/edit?usp=drive
2.https://lehrerfortbilduw.de/faecher/nwt/fb/atechnik/grundlagen/en/kapitel/563060_Fundamentals_of_automation_technology.pdf

REMOTE SENSING AND GIS

OE – I

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
ACEB50	Elective	3	0	0	3	30	70	100
Contact Classes: 45	Tutorial Classes:	Practical Classes: Nil				Total Classes: 45		

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	Classes: 09

Principles& types of aerial photograph, geometry of vertical aerial photograph, Scale & Height measurement on single vertical aerial photograph, Height measurement based on relief displacement, Fundamentals of stereoscopy, fiducially points, parallax measurement using fiducially line.

MODULE -II	REMOTE SENSING	Classes: 09

Basic concepts and foundation of remote sensing – elements involved in remote sensing, electromagnetic spectrum, remote sensing terminology and units. Energy resources, energy interactions with earth surface features and atmosphere, resolution, sensors and satellite visual interpretation techniques, basic elements, converging evidence, interpretation for terrain evaluation, spectral properties of water bodies, introduction to digital data analysis.

MODULE - III	GEOGRAPHIC INFORMATION SYSTEM AND TYPES OF DATA REPRESENTATION	Classes: 09

Introduction, GIS definition and terminology, GIS categories, components of GIS, fundamental operations of GIS, A theoretical framework for GIS.

Data collection and input overview, data input and output. Keyboard entry and coordinate geometry procedure, manual digitizing and scanning, Raster GIS, Vector GIS – File management, Spatial data – Layer based GIS, Feature based GIS mapping.

MODULE - IV	GIS SPATIAL ANALYSIS	Classes: 09

Computational Analysis Methods(CAM), Visual Analysis Methods (VAM), Data storagevector 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	Classes: 09

Land use/Land cover in water resources, Surface water mapping and inventory, Rainfall – Runoff relations and runoff potential indices of watersheds, Flood and Drought impact assessment and monitoring, Watershed management for sustainable development and Watershed characteristics.

Text Books:
1. Remote Sensing and GIS by B.Bhatta, Oxford University Press,New Delhi. 2. Fundamentals of remote sensing by Gorge Joseph , Universities press, Hyderabad.
Reference Books:
1. LRA Narayana, “Remote Sensing and its applications”, University Press 1999. 2. S.Kumar, “Basics of Remote Sensing & GIS”, Laxmi Publications. 3. M.Anji Reddy, “Remote Sensing and GIS”, B.S. Pubiliications, New Delhi. 4. Tsung Chang, “GIS”, TMH Publications & Co.,
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:
1.https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/105107160/lec20.pdf

PROJECT SAFETY MANAGEMENT

OE – I

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
ACEB51	Elective	3	-	-	3	30	70	100
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**

Accidents and their Causes – Human Factors in Construction Safety – Costs of Construction Injuries – Occupational and Safety Hazard Assessment – Legal Implications -The introduction of OH&S management system.

MODULE -II	**SAFETY PROGRAMMES**	**Classes: 09**

Problem Areas in Construction Safety – Elements of an Effective Safety Programme – Job-Site Safety Assessment – Safety Meetings – Safety Incentives.

MODULE - III	**CONTRACTUAL OBLIGATIONS**	**Classes: 09**

Safety in Construction Contracts – Substance Abuse – Safety Record Keeping

Comparison of Actions and Laws – Agreements, Subject Matter, Violation, Appointment of Arbitrators, Conditions of Arbitration – Powers and Duties of Arbitrator.

MODULE - IV	**DESIGNING FOR SAFETY**	**Classes: 09**

Safety Culture – Safe Workers – Safety and First Line Supervisors – Safety and Middle Managers – Top Management Practices, Company Activities and Safety – Safety Personnel – Sub contractual Obligation – Project Coordination and Safety Procedures – Workers Compensation.

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:

1. Raymond Elliot Levitt and Nancy Morsesamelson "Construction Safety Management" copyright materials, Wiley; 2nd Edition, 1993.
2. Charles D. Reese, "occupational health and safety", CRC Press, 2003.

Reference Books:
1. Jimmy W. Hinze, "Construction Safety", Prentice Hall Inc., 1997. 2. Richard J. Coble, Jimmie Hinze and Theo C. Haupt, Construction Safety and Tamilnadu Factory Act, Department of Inspectorate of factories, Tamilnadu. Health Management, Prentice Hall Inc., 2001.
Web References:
1. https://nptel.ac.in/content/storage2/courses/114106039/Tutorial%2012%20key.pdf 2. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/114106039/lec36.pdf
E-Text Books:
1. https://safetyrisk.net/free-safety-ebooks/ 2. https://boilersinfo.com/fire-safety-management-handbook-3rd-edition/

COMPUTER ARCHITECTURE

OE – II

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
ACSB32	Elective	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. 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:

1. M. Morris Mano, "Computer Systems Architecture", Pearson, 3rd Edition, 2015.
2. Patterson, Hennessy, "Computer Organization and Design: The Hardware/Software Interface", Morgan Kaufmann, 5th Edition, 2013.

Reference Books:

1. John. P. Hayes, “Computer System Architecture”, McGraw-Hill, 3rd Edition, 1998.
2. Carl Hamacher, Zvonko G Vranesic, Safwat G Zaky, “Computer Organization”, McGraw-Hill, 5th Edition, 2002.
3. William Stallings, “Computer Organization and Architecture”, Pearson Edition, 8th Edition, 2010.

Web References:

1. https://www.tutorialspoint.com/computer_logical_organization/
2. https://www.courseera.org/learn/comparch
3. https://www.cssimplified.com/.../computer-organization-and-assembly-language-programming

E-Text Books:

1. https://www.groupes.polymtl.ca/inf2610/.../ComputerSystemBook.pdf
2. https://www.cse.hcmut.edu.vn/~vtphuong/KTMT/Slides/TextBookFull.pdf

ANALYSIS OF ALGORITHMS AND DESIGN

OE - II

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
ACSB33	Elective	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. 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:

1. Ellis Horowitz, Satraj Sahni, Sanguthevar Rajasekharan, “Fundamentals of Computer Algorithms, Universities Press, 2nd Edition, 2015.
2. Alfred V. Aho, John E. Hopcroft, Jeffrey D, “The Design And Analysis Of Computer Algorithms, Pearson India, 1st Edition, 2013.

Reference Books:

1. Levitin A, "Introduction to the Design and Analysis of Algorithms", Pearson Education, 3rd Edition, 2012.
2. Goodrich, M. T. R Tamassia, "Algorithm Design Foundations Analysis and Internet Examples", John Wiley and Sons, 1st Edition, 2001.
3. Base Sara Allen Vangelder, "Computer Algorithms Introduction to Design and Analysis", Pearson, 3rd Edition, 1999.

Web References:

1. http://www.personal.kent.edu/~rmuhamma/Algorithms/algorithm.html
2. http://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=IntroToAlgorithms
3. http://www.facweb.iitkgp.ernet.in/~sourav/daa.html

E-Text Books:

1.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
3. http://www.amazon.com/Computer-Algorithms-Introduction-Design-Analysis/dp/0201612445

RELATIONAL DATABASE MANAGEMENT SYSTEMS

OE – II

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
ACSB34	Elective	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. 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

Database Design and ER diagrams – Attributes and Entity Sets – Relationships and Relationship Sets – Constraints - Keys - Design Issues - Entity-Relationship Diagram- Weak Entity Sets - Extended E-R Features- Database Design with ER model - Database Design for Banking Enterprise.

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

Functional Dependencies– Introduction , Basic Definitions, Trivial and Non trivial dependencies, closure of a set of dependencies, closure of attributes, irreducible set of dependencies- Schema Refinement in Database Design- Problems Caused by Redundancy Decompositions – Problem Related to Decomposition –- Lossless Join Decomposition – Dependency Preserving Decomposition - FIRST, SECOND, THIRD Normal Forms – BCNF –Multi valued Dependencies – Fourth Normal Form.

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:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw-Hill, 6th Edition, 2017.

Reference Books:

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamental Database Systems", Pearson Education, 6th Edition, 2014.
2. Raghu Ramakrishnan, "Database Management System", Tata McGraw-Hill Publishing Company, 3rd Edition, 2007.
3. Hector Garcia Molina, Jeffrey D. Ullman, Jennifer Widom, "Database System Implementation", Pearson Education, United States, 1st Edition, 2000.
4. Peter Rob, Corlos Coronel, "Database System, Design, Implementation and Management", Thompson Learning Course Technology, 5th Edition, 2003.

Web References:

1. https://www.youtube.com/results?search_query=DBMS+onluine+classes
2. http://www.w3schools.in/dbms/
3. http://beginnersbook.com/2015/04/dbms-tutorial/

E-Text Books:

1. http://www.e-booksdirectory.com/details.php?ebook=10166
2. http://www.e-booksdirectory.com/details.php?ebook=7400re
3. https://docs.google.com/file/d/0B9aJA_iV4kHYM2dieHZhMHhyRVE/edit

MOOC Course

1. https://onlinecourses.nptel.ac.in/noc18_cs15/preview
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-830-database-systems-fall-2010/

ADVANCED DATA STRUCTURES

OE - II

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AITB30	Elective	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. 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

Binary Search Trees - Definition, ADT, Operations - Searching, Insertion, Deletion, AVL Trees - Definition, ADT, Balance factor, Operations – Insertion, Deletion, Searching, Introduction to Red – Black and Splay Trees, B-Trees, B-Tree operations - insertion, deletion, searching, Comparison of Search Trees.

MODULE -V	PATTERN MATCHING AND TRIES	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:

1. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", Universities Press Private Limited, India, 2nd Edition, 2008.
2. G.A. V.Pai, "Data Structures and Algorithms", Tata McGraw Hill, New Delhi, 1st Edition, 2008.
3. Richard F Gilberg, Behrouz A Forouzan, "Data Structures - A Pseudocode Approach with C", Cengage Learning, Thomson Press (India) Ltd, 2nd Edition, 2006.

Reference Books:

1. D. Samanta, "Classic Data Structures", Prentice Hall of India Private Limited, 2nd Edition, 2003.
2. Aho, Hop craft, Ullman, "Design and Analysis of Computer Algorithms", Pearson Education India, 1st Edition, 1998.
3. Goodman, Hedetniemi, "Introduction to Design and Analysis of Algorithms", Tata McGraw Hill, New Delhi, India, 1st Edition, 2002.
4. Adam Drozdek, "Data Structures and Algorithms in C++", Thomson Course Technology, 3rd Edition, 2005.
5. M. T. Goodrich, R. Tomassia, "Data structures and Algorithms in Java", Wiley India, 3rd Edition, 2011.

Web References:

1. https://www.tutorialspoint.com/data_structures_algorithms/data_structures_basics.htm
2. https://www.geeksforgeeks.org/data-structures/
3. http://www.nptelvideos.in/2012/11/data-structures-and-algorithms.html

E-Text Books:

1. https://pdfs.semanticscholar.org/19ec/55ed703eb24e1d98a4abd1a15387281cc0f8.pdf
2. https://www.academia.edu/35961658/Data.Structures.A.Pseudocode.Approach.with.C.2nd.edition_1_.pdf
3. https://sonucgn.files.wordpress.com/2018/01/data-structures-by-d-samantha.pdf

MOOC Course

1. https://nptel.ac.in/courses/106103069/
2. https://www.coursera.org/learn/data-structures
3. https://www.edureka.co/blog/data-structures-algorithms-in-java/
4. https://www.edx.org/micromasters/ucsandiegox-algorithms-and-data-structures

DATA COMMUNICATIONS AND NETWORKS

OE - II

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AITB31	Elective	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. 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**

Introduction, Framing, and Error – Detection and Correction – Parity – LRC – CRC Hamming code, Flow and Error Control, Noiseless Channels, Noisy Channels, HDLC, Point to Point Protocols.

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**

Introduction, client server programming, WWW (World Wide Web) and HTTP (Hyper Text Transfer Protocol), FTP (File Transfer Protocol), E-MAIL, TELNET, SECURE SHELL, DNS(Domain Naming System), SNMP (Simple Network Management Protocol). Introduction to Application Layer: HTTP (Hyper Text Transfer Protocol), DNS(Domain Naming System).

Text Books:

1. Behrouz A. Forouzan, "Data Communications and Networking", Tata McGraw Hill, 5th Edition, 2012.
2. Andrew S. Tanenbaum, David.j.Wetherall, "Computer Networks", Prentice-Hall, 5th Edition, 2010.

Reference Books:

1. Douglas E. Comer "Internetworking with TCP/IP ", Prentice-Hall, 5th Edition, 2011.
2. Peterson, Davie, Elsevier "Computer Networks", 5th Edition, 2011
3. Comer, "Computer Networks and Internets with Internet Applications", 4th Edition, 2004.
4. Chawan- Hwa Wu, Irwin, "Introduction to Computer Networks and Cyber Security", CRC publications, 2014.

Web References:

1. http://computer.howstuffworks.com/computer-networking-channel.htm
2. http://www.ietf.org
3. http://www.rfc-editor.org/
4. https://technet.microsoft.com/en-us/network/default.aspx

E-Text Books:

1. http://www.freebookcentre.net/networking-books-download/Lecture-Notes-on-Computer-Networks.html
2. http://www.freebookcentre.net/networking-books-download/Introduction-to-Computer-Networks.html

MOOC Course

1. https://www.mooc-list.com/course/networking-introduction-computer-networking-stanford-university
2. https://lagunita.stanford.edu/courses/Engineering/Networking/Winter2014/about.

NETWORK SECURITY

OE - II

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AITB32	Elective	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. 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.

Hash functions: Hash functions, secure hash algorithm, digital signatures. Authentication application: Kerberos, X.509 authentication service.

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

1. William Stallings, "Cryptography and Network Security", Pearson Education, 4th Edition, 2005.
2. Atul Kahate, "Cryptography and Network Security", McGraw-Hill, 2nd Edition, 2009.

Reference Books
1. C K Shymala, N Harini, Dr. T R Padmanabhan, “Cryptography and Network Security”, Wiley India, 1st Edition, 2016. 2. Behrouz A. Forouzan Debdeep Mukhopadhyay, “Cryptography and Network Security”, McGraw- Hill, 2nd Edition, 2010.
Web References
1. http://bookboon.com/en/search?q=INFORMATION+SECURITY 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 2. http://www.amazon.in/Cryptography-Network-Security-Behrouz-Forouzan/dp/007070208X

SOFT SKILLS AND INTERPERSONAL COMMUNICATION

OE - III

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB18	Elective	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. 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 Writng skills; Barriers to Listening, Speaking, Reading and Writing; Essential formal writing skills; Public Speaking: Skills, Methods, Strategies and Essential tips for effective public speaking.

MODULE-III	ORAL AND AURAL SKILLS	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:

1. Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2. Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3. Klaus, Peggy, Jane Rohman & Molly Hamaker. "The Hard Truth about Soft Skills", London: HarperCollins E-books, 2007.
4. Stein, Steven J. & Howard E. Book. "The EQ Edge: Emotional Intelligence and Your Success" Canada: Wiley & Sons, 2006
5. Suresh Kumar. English for Success. Cambridge University Press IndiaPvt.Ltd.2010.
6. Dorling Kindersley. Communication Skills & Soft Skills - An Integrated Approach. India Pvt. Ltd. 2013.

Web References:

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

E-Text Books:

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

CYBER LAW AND ETHICS

OE - III

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB19	Elective	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. 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

Definitions, Specificities of the Cyberspace, Dimensions of Cyber Ethics in Cyber Society, Fourth Industrial Revolution, Users' Motivations in Cyber-Space, Core Values and Virtues, Old Values or Eschatological Vision?, Cyber Ethics by Norms, Laws and Relations Artificial Intelligence Ethics: "AI for Good", Cyber-Capitalism: Cyber-Ethics as Business Ethics.

MODULE-II	CYBER LAW AND CYBER ETHICS	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

Principles: Ethical Values, Participation: Access to Knowledge for All, People: Community, Identity, Gender, Generation, Education, Profession: Ethics of Information Professions, Privacy: Dignity, Data Mining, Security.

Piracy: Intellectual Property, Cybercrime, Protection: Children and Young People,
Power: Economic Power of Technology, Media and Consumers, Policy: Ethics of Regulation and Freedom.

MODULE-IV	DISRUPTIVE CYBER TECHNOLOGIES AND AI ETHICS	Classes: 09

Disruptive Cyber Technologies and Ethics -I

Artificial: Negative Moral Judgment?, Artificial: Ethically Positive Innovation?, Intelligence: Action-oriented Ability, Creation Story: Human Beings Responsibility, The Commandment to Love and Artificial Intelligence; **Artificial Intelligence Ethics:**Top Nine Ethical Issues in Artificial Intelligence, Five Core Principles to Keep AI Ethical, Ethics Should Inform AI – But Which Ethics?

MODULE-V	DISRUPTIVE CYBER TECHNOLOGIES AND ETHICS -II	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.

Text Books:
1. Christoph Stuckelberger, Pavan Duggal, “Cyber Ethics 4.0 Serving humanity with values”, Globethics.net Global Series, 2018.
Reference Books:
1. Dr. Farooq Ahmad, Cyber Law in India, Allahbad Law Agency- Faridabad. 2. J.P. Sharma, SunainaKanojia, Cyber Laws 3. Harish Chander , Cyber Laws and IT Protection
E-Reference:
1. https://www.globethics.net/documents/4289936/13403236/Ge_Global_17_web_isbn9782889312641.pdf/

ECONOMIC POILICIES IN INDIA

OE - III

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB20	Elective	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. 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 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:

1. The Wealth of Nations-Adam Smith, introduction by Alan B Krueger.
2. The Strength of Economic Development by Albert Hirschman.
3. Money, Banking and Public Finance by Dr. V.C.Sinha
4. Government of India, Economic Survey (Annual), Ministry of Finance, New Delhi.
5. Jain, a. K. (1986), Economic Planning in India, Ashish Publishing House, New Delhi.

Reference Books:

1. Ahluwalia, I. J. and I. M. D Little (Eds.) (1999), India's Economic Reforms and Development (Essays in honour of Manmohan Singh), Oxford University Press, New Delhi.
2. Bardhan, P. K. (9th Edition) (1999), The Political Economy of Development in India, Oxford University Press, New Delhi.
3. Bawa, R. s. and P. S. Raikhy (Ed.) (1997), Structural Changes in Indian Economy, Guru Nanak Dev University Press, Amritsar.
4. Brahmananda, P. R. and V. R. Panchmukhi (Eds.) (2001), Development Experience in the Indian Economy: Inter-State Perspectives, Book well, Delhi.
5. Chakravarty, S. (1987), Development Planning: The Indian Experience, Oxford University Press, New Delhi.
6. Dantwala, M. L. (1996), Dilemmas of Growth: The Indian Experience, Sage Publications, New Delhi.
7. Datt, R. (Ed.) (2001), Second Generation Economic Reforms in India, Deep & Deep Publications, New Delhi.

Web References:

1. Parikh, K. S. (1999), India Development Report – 1999-2000, Oxford University Press, New Delhi8.
2. Reserve Bank of India, Report on Currency and Finance, (Annual).
3. Sandesara, J. c. (1992), Industrial Policy and Planning, 1947-19919 : Tendencies, Interpretations and Issues, Sage Publications, New Delhi.

GLOBAL WARMING AND CLIMATE CHANGE

OE - III

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB21	Elective	3	0	0	3	30	70	100
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

Role of ozone in environment, Ozone layer – Ozone depleting gases, Green House Effect – Radioactive effects of Greenhouse gases, The Hydrological cycle, Green House Gases and Global Warming, Carbon Cycle.

MODULE -II	ATMOSPHERE AND ITS COMPONENTS	Classes: 09

Importance of Atmosphere – Physical and chemical characteristics of Atmosphere, Vertical structure of the atmosphere, Composition of the atmosphere, Atmospheric stability, Temperature profile of the atmosphere, Lapse rates, Temperature inversion, Effects of inversion on pollution dispersion.

MODULE - III	IMPACTS OF CLIMATE CHANGE	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

Climate change and Carbon credits, CDM – Initiatives in India-Kyoto Protocol, Paris Convention - Intergovernmental Panel on Climate change, Climate Sensitivity and Feedbacks. The Montreal Protocol – UNFCCC – IPCC – Global Climate Models (GCM) - Evidences of Changes in Climate and Environment- on a Global scale and in India.

MODULE - V	CLIMATE CHANGE AND MITIGATION MEASURES	Classes: 09

Clean Development Mechanism, Carbon Trading – Examples of future clean technology, Biodiesel – Natural Compost, Eco-friendly plastic, Alternate Energy –Hydrogen, Bio-fules, Solar Energy, Wind and Hydroelectric Power. Mitigation Efforts in India and Adaptation funding. Key Mitigation Technologies and Practices – Energy Supply, Transport, Buildings, Industry, Agriculture, Forestry – Carbon sequestration, Carbon capture and storage (CCS), Waste (MSW & Bio-waste, Biomedical, Industrial waste) – International and Regional cooperation.

Text Books:

1. Dr. Sushil Kumar Dash, "Climate Change: An Indian Perspective (Environment and Development)", Cambridge University Press India Pvt Ltd, 2007.
2. Adaptation and mitigation of climate change – Scientific Technical Analysis, Cambridge University Press, Cambridge, 2006.

Reference Books:
1. Atmospheric Science, J.M. Wallace and P.V Hobbs, Elsevier/ Academic Press, 2006. 2. "Climate Change and Climate Variability on Hydrological Regimes", Jan C. Van Dam, Cambridge University Press, 2003.
E-Text Books:
1. https://www.worldcat.org/title/encyclopedia-of-global-warming-climate-change/oclc/805580328 2. https://libguides.nus.edu.sg/c.php?g=433566&p=2955835

INTELLECTUAL PROPERTY RIGHTS

OE: III

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB22	Elective	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. 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 INTELLECTUAL 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:

1. P. K. Vasudeva,World Trade Organization: Implications on Indian Economy, Pearson Education,2015.
2. P.KrishnaRao, WTO, Text and cases, Excel Books, 2015.
3. Carlos M.Correa- Intellectual property rights, The WTO and Developing countries-Zed books.

Reference Books:

1. Caves, Frankel, Jones, World Trade and Payments-An Introduction, Pearson4. Education, 2015.
2. Carlos M.Correa- Intellectual property rights, The WTO and Developing countries-Zed books.
3. Peter-Tobias stoll, Jan busche, Katrianarend- WTO- Trade –related aspects of IPR- Library of Congress.

Web References:

1. http://www.ebooks directory.com
2. http://Campus guides.lib.utah.edu

E-Text Books:

1. http://www.bookboon.com
2. http://www.freemagagement.com
3. http://www.emeraldinsight.com

ENTREPRENEURSHIP

OE - III

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB23	Elective	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. 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**

The revolution impact of entrepreneurship- The evolution of entrepreneurship - Functions of Entrepreneurs – types of entrepreneurs -Approaches to entrepreneurship- Process approach- Role of entrepreneurship in economic development- Twenty first century trends in entrepreneurship.

MODULE-II	**INDIVIDUAL ENTREPRENEURIAL MIND-SET AND PERSONALITY**	**Classes: 09**

The entrepreneurial journeyStress and the entrepreneur - the entrepreneurial ego - Entrepreneurial motivations- Motivational cycle – Entrepreneurial motivational behavior – Entrepreneurial competencies. Corporate Entrepreneurial Mindset, the nature of corporate entrepreneur- conceptualization of corporate entrepreneurship Strategy-sustaining corporate entrepreneurship.

MODULE-III	**LAUNCHING ENTREPRENEURIAL VENTURES**	**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:

1. D F Kuratko and T V Rao, "Entrepreneurship- A South-Asian Perspective", Cengage Learning, 2012.
2. Bruce R. Barringer/ R.Duane Ireland, "Entrepreneurship Successfully Launching New Ventures", Pearson, 4th Edition, 2015.
3. S.S.Khanka, Entrepreneurship Development, S. Chand Publications, 2015.

Reference Books:

1. Stuart Read, Effectual Entrepreneurship, Routledge, 2013.
2. Rajeev Roy, Entrepreneurship, Oxford publications, 2nd Edition, 2012.
3. Nandan .H, Fundamentals of Entrepreneurship, PHI, 2013.

MICRO PROCESSORS AND INTERFACING

OE - IV

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AECB55	Elective	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. 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.**	**Classes: 08**

An over view of 8085, Architecture of 8086 Microprocessor, register organization of 8086, 8086 flag register. Addressing modes of 8086, Instruction set of 8086. Assembler directives, procedures, and macros. Assembly language programs involving logical, Branch & Call instructions, sorting, evaluation of arithmetic expressions, string manipulation.

MODULE -II	**Operation of 8086 and Interrupts.**	**Classes: 09**

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.**	**Classes: 09**

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**	**Classes: 09**

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**	**Classes: 10**

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:

1. A.K.Ray and K.M.Bhurchandi, "Advanced Microprocessor and Peripherals", TMH, 2000.
2. Deshmukh, "Micro Controllers", Tata McGraw Hill Edition, TMH, 2000

Reference Books:

1. Douglas U, "Micro Processors & Interfacing", Hall, 2007.
2. By Liu, GA Gibson, "Micro Computer System 8086/8088 Family Architecture, Programming and Design", PHI, 2nd Edition, 2007.

Web References:
1. http://www.nptel.ac.in/downloads/106108100/ 2. http://www.the8051microcontroller.com/web-references 3. http://www.iare.ac.in
E-Text Books:
1. https://books.google.co.in/books 2. http://www.www.jntubook.com 3. http://www.ebooklibrary.org/articles/mpmc

PRINCIPLES OF COMMUNICATION

OE - IV

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AECB56	Elective	3	0	0	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. 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**	**Classes: 08**

Introduction, Amplitude Modulation: Time & Frequency – Domain description, Switching modulator, Envelop detector.

MODULE -II	**DOUBLE SIDE BAND-SUPPRESSED CARRIER MODULATION**	**Classes: 09**

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**	**Classes: 09**

SSB Modulation, VSB Modulation, Frequency Translation, Frequency- Division Multiplexing, Theme Example: VSB Transmission of Analog and Digital Television.

MODULE -IV	**ANGLE MODULATION**	**Classes: 09**

Basic definitions, Frequency Modulation: Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals, FM Stereo Multiplexing, Phase–Locked Loop: Nonlinear model of PLL, Linear model of PLL, Nonlinear Effects in FM Systems. The Super heterodyne Receiver

MODULE -V	**DIGITAL REPRESENTATION OF ANALOG SIGNALS**	**Classes: 10**

Introduction, Why Digitize Analog Sources?, The Sampling process, Pulse Amplitude Modulation, Time Division Multiplexing, Pulse-Position Modulation, Generation of PPM Waves, Detection of PPM Waves, The Quantization Process, Quantization Noise, Pulse–Code Modulation: Sampling, Quantization, Encoding, Regeneration, Decoding, Filtering, Multiplexing

Text Books:

1. Communication Systems, Simon Haykins & Moher, 5th Edition, John Willey, India Pvt. Ltd, 2010, ISBN 978 – 81 – 265 – 2151 – 7.

Reference Books:

1. Modern Digital and Analog Communication Systems, B. P. Lathi, Oxford University Press., 4th edition.
2. An Introduction to Analog and Digital Communication, Simon Haykins, John Wiley India Pvt. Ltd., 2008, ISBN 978–81–265–3653–5.

3. Principles of Communication Systems, H.Taub & D.L.Schilling, TMH, 2011.
4. Communication Systems, Harold P.E, Stern Samy and A.Mahmond, Pearson Edition, 2004.
5. Communication Systems: Analog and Digital, R.P.Singh and S.Sapre: TMH 2nd edition, 200

Web References:

1. http://www.web.eecs.utk.edu
2. https://everythingvtu.wordpress.com
3. http://nptel.ac.in/
4. http://www.iare.ac.in

E-Text Books:

1. http://www.bookboon.com/
2. http://www.jntubook.com
3. http://www.smartzworld.com
4. http://www.archive.org

IMAGE PROCESSING

OE - IV

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AECB57	Elective	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. 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**

Digital Image through scanner, digital camera. Concept of gray levels. Gray level to binary image conversion. Sampling and quantization. Relationship between pixels. Imaging Geometry.

MODULE -II	**IMAGE TRANSFORMS**	**Classes: 09**

2-D FFT , Properties. Walsh transform, Hadamard Transform, Discrete cosine Transform, Haar transform, Slant transform, Hotelling transform.

MODULE -III	**IMAGE ENHANCEMENT**	**Classes: 08**

Point processing. Histogram processing. Spatial filtering. Enhancement in frequency domain, Image smoothing, Image sharpening.

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:

1. R.C. Gonzalez & R.E. Woods, "Digital Image Processing", Addison Wesley/ Pearson education, 2nd Education, 2002.

Reference Books:

1. A.K.Jain, "Fundamentals of Digital Image Processing, PHI. 3RD Edition, 2003.
2. Rafael C. Gonzalez, Richard E Woods and Steven, "Digital Image Processing using MAT LAB" L. Edition, PEA, 2004.
3. William K. Pratt, John, "Digital Image Processing", Wilely , 3rd Edition, 2004.

Web References:
1. https://imagingbook.com/ 2. https://en.wikipedia.org/wiki/Digital_image_processing 3. http://www.tutorialspoint.com/dip/ 4. http://www.imageprocessingplace.com/
E-Text Books:
1. http://www.sci.utah.edu/~gerig/CS6640-F2010/dip3e_chapter_02.pdf 2. http://www.faadooengineers.com/threads/350-Digital-Image-Processing 3. http://newwayofengineering.blogspot.in/2013/08/anil-k-jain-fundamentals-of-digital.html

ELECTRICAL ENGINEERING MATERIALS

OC – IV

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AEEB55	Elective	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. 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:

1. J Dekker, "Electrical Engineering Materials Adrianus", Phi Learning Publishers, 2nd Edition, 1996.
2. Solymar, L, "Electrical Properties of Materials", Oxford University Press-New Delhi 8th Edition, 2009.

Reference Books:
1. Indulkar C, “Introduction to Electrical Engineering Materials”, S Chand &Company Ltd-New Delhi 4th Edition, 2004. 2. SK Bhattacharya, “Electrical and Electronic Engineering Materials”, Khanna Publishers, New Delhi, 2nd Edition, 1998.
Web References:
1. https://www.electrical4u.com/electrical-engineering-materials/ 2. https://lecturenotes.in/subject/219/electrical-engineering-materials-eem
E-Text Books:
1. https://www.books.google.co.in/books/about/A_Textbook_of_Electrical_Engineering_Mat.html?id=Ee8ruUXkJeMC. 2. https://www.amazon.in/Introduction-Electrical-Engineering-Materials-ebook/dp/B00QUYKXTI

NON CONVENTIONAL ENERGY SOURCES

OE - IV

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AEEB56	Elective	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. 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.

Bio-Mass: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C. Engine operation and economic aspects

MODULE - IV	GEOTHERMAL ENERGY AND OCEAN ENERGY	Classes: 10

Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India
Ocean Energy: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

MODULE - V	DIRECT ENERGY CONVERSION	Classes: 08

Need for DEC, Carnot cycle, limitations, principles of DEC.

Text Books:

1.G.D. Rai, "Non-Conventional Energy Sources", TMH, 3rd Edition 2009.
2.Twidell & Weir, "Renewable Energy Sources", CRC Press, 1st Edition, 2008.

Reference Books:

1. Renewable Energy resources /Tiwari and Ghosal/Narosa
2. Renewable Energy Technologies /Ramesh & Kumar /Narosa
3. Non-Conventional Energy Systems / K Mittal /Wheeler
4. Renewable Energy sources and emerging technologies by D.P. Kothari, K.C. Singhal, P.H.I

NANO TECHNOLOGY

OE - IV

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AEEB57	Elective	3	-	-	3	30	70	100
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

X-Ray Diffraction (XRD), small angle X-ray scattering (SAXS), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscope (STM), Field Ion Microscope (FEM), Three-dimensional Atom Probe (3DAP), Nanoindentation.

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:

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

Reference Books

1. T. Pradeep, "Nano: The Essentials", McGraw- Hill Education.
2. David Ferry, "Transport in Nano structures", Cambridge University Press, 2000.
3. Challa S., S. R. Kumar, J. H. Carola, "Nanofabrication towards Biomedical Application: Techniques, tools", Application and impact Edition.
4. Michael J. O'Connell. "Carbon Nanotubes: Properties and Applications", Cambridge University Press.
5. S. Dutta, "Electron Transport in Mesoscopic Systems", Cambridge University Press.

Web References:

1.https://www.dummies.com/education/.../useful-nanotechnology-information-websites/
2.https://www.ncbi.nlm.nih.gov/books/NBK21031/
3.https://libguides.northwestern.edu › LibGuides

E-Text Book:

1. https://www.accessengineeringlibrary.com/.../textbook-of-nanoscience-and-nanotechn
2. https://www.azonano.com/book-reviews-index.aspx
3. https://en.wikibooks.org/wiki/Nanotechnology/Print_version

ENVIRONMENTAL SCIENCES

IV Semester: AE / CSE / IT / ECE / EEE / ME / CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB07	Mandatory	-	-	-	-	30	70	100
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

Text Books:

1. Benny Joseph, "Environmental Studies", Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2005.
2. Erach Bharucha, "Textbook of Environmental Studies for Undergraduate Courses", Universities Press 2005.

Reference Books:

1. Anji Reddy .M, "Textbook of Environmental Sciences and Technology", BS Publications, 2007.
2. Anjaneyulu, "Introduction to Environmental Sciences", BS Publications, 2004.
3. Anubha Kaushik, Perspectives in Environmental Science, New age international. 3rd Edition, 2006.
4. Tyler Miller, Scott Spoolman, "Environmental Science", Cengage Learning, 14th Edition, 2012.

Web References:

1. https://www.tndte.com
2. https://www.nptel.ac.in/downloads
3. https://www.scribd.com
4. https://www.cuiet.info
5. https://www.sbtebihar.gov.in
6. https://www.ritchennai.org

ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

VII Semester: AE / CSE / IT / ECE / EEE / ME / CE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AHSB17	Mandatory	-	-	-	-	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: Nil		

COURSE OBJECTIVES:

The course should enable the students to:

I. Understand the concept of Traditional knowledge and its importance
II. Know the need and importance of protecting traditional knowledge.
III. Know the various enactments related to the protection of traditional knowledge.
IV. Understand the concepts of Intellectual property to protect the traditional knowledge

MODULE-I	INTRODUCTION TO TRADITIONAL KNOWLEDGE

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge

MODULE-II	PROTECTION OF TRADITIONAL KNOWLEDGE

Protection of traditional knowledge: The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

MODULE-III	LEGAL FRAMEWORK AND TK

A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act);

B: The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indicators act 2003.

MODULE-IV	TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

MODULE-V	TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS:

Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK. 139.

Text Books:

1. Traditional Knowledge System in India, by Amit Jha, 2009.
2. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, Pratibha Prakashan 2012.

Reference Books:
1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002. 2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2

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 stake – holders know that we are an Autonomous College?

Autonomous status, once declared, shall be accepted by all the stake holders. The Govt. of Telangana mentions autonomous status during the First Year admission procedure. Foreign Universities and Indian Industries will know our status through our website.

5 What is the change of Status for Students and Teachers if we become Autonomous?

An autonomous college carries a prestigious image. Autonomy is actually earned out of our continued past efforts on academic performances, our capability of self- governance and the kind of quality education we offer.

6 Who will check whether the academic standard is maintained / improved after Autonomy? How will it be checked?

There is a built in mechanism in the autonomous working for this purpose. An Internal Committee called Academic Program Evaluation Committee, which will keep a watch on the academics and keep its reports and recommendations every year. In addition the highest academic council also supervises the academic matters. The standards of our question papers, the regularity of academic calendar, attendance of students, speed and transparency of result declaration and such other parameters are involved in this process.

7 Will the students of IARE as an Autonomous College qualify for University Medals and Prizes for academic excellence?

No. IARE has instituted its own awards, medals, etc. for the academic performance of the students. However for all other events like sports, cultural on co-curricular organized by the University the students shall qualify.

8 Can IARE have its own Convocation?

No. Since the University awards the Degree the Convocation will be that of the University, but there will be Graduation Day at IARE.

9 Can IARE give a provisional degree certificate?

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

10 Will Academic Autonomy make a positive impact on the Placements or Employability?

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

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

Presently, it is 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.

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

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

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

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

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

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

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

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

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

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

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

No. There will double valuation of answer scripts. There will be a 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 Boared of Studies level are to be ratified at the Academic Council and Governing Body.

25 What is the role of Examination committee?

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

26 Is there any mechanism for Grievance Redressal?

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

27 How many attempts are permitted for obtaining a Degree?

All such matters are defined in Rules & Regulation

28 Who declares the result?

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

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

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

30 What is our relationship with the JNT University?

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

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

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

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

Yes, presently our PG programs also enjoying autonomous status.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

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

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

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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

UNDERTAKING BY STUDENT / PARENT

"To make the students attend the classes regularly from the first day of starting of classes and be aware of the College regulations, the following Undertaking Form is introduced which should be signed by both student and parent. The same should be submitted to the Dean, 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