# B.E. (Aeronautical Engineering)

## Revised 2018 Regulations, Curriculum & Syllabi

*(Candidates admitted during Academic Year 2021-2022)*

Stay Ahead

**BANNARI AMMAN INSTITUTE OF TECHNOLOGY**

An Autonomous Institution Affiliated to Anna University - Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade

SATHYAMANGALAM - 638401 ERODE DISTRICT TAMILNADU INDIA

Ph : 04295-226000/221289 Fax : 04295-226666 E-mail : stayahead@bitsathy.ac.in Web : www.bitsathy.ac.in

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# BANNARI AMMAN INSTITUTE OF TECHNOLOGY, SATHYAMANGALAM

## REVISED REGULATIONS 2018

### (CHOICE BASED CREDIT SYSTEM)

(Common to all B.E./B.Tech. Degree Programmes)

Regulation 2018 has been prepared in accordance with the guidelines given by the University Grants Commission, All India Council for Technical Education and affiliating University incorporating the features of the Choice Based Credit System (CBCS). The Regulation 2018 is applicable to the candidates admitted to the Bachelor of Engineering (B.E.) / Bachelor of Technology (B.Tech.) Degree Programmes of the Institution in the academic year 2018-2019 for Regular admission (Academic year 2019-2020 for Lateral Entry) and subsequently.

*The regulations hereunder are subjected to amendments as may be decided by the Academic Council of the Institution from time to time. Any or all such amendments will be effective from such date and to such batches of students (including those already in the middle of the programme) as may be decided by the Academic Council.*

## 1. ADMISSION

Candidate, seeking admission to the B.E./B.Tech. Programme, shall satisfy the conditions of admission prescribed by the Directorate of Technical Education and Anna University, Chennai as given below.

### 1.1 Regular Admission

Candidates, for admission to the first semester of the eight semesters B.E./B.Tech. Degree Programmes, shall be required to have passed:

- Higher Secondary Examination (10 +2) of curriculum (Regular Academic Stream) prescribed by the Government of Tamil Nadu with Mathematics, Physics, and Chemistry as three of the four subjects of the study prescribed under Part-III or any other examinations of any Board or University or authority accepted by the Syndicate of the University / Directorate of Technical Education (DoTE), Chennai as equivalent thereto.

(or)

- Should have passed Higher Secondary Examination of Vocational Stream (Engineering/Technology), prescribed by the Government of Tamil Nadu.

### 1.2 Lateral Entry Admission

1.2.1 The candidates who possess Diploma in Engineering / Technology awarded by the State Board of Technical Education and Training, Tamil Nadu or its equivalent are eligible to apply for Lateral Entry admission to the third semester of B.E. / B.Tech. Programmes in the branch of study as per the eligibility criteria prescribed by the Directorate of Technical Education from time to time.

(or)

1.2.2 The candidates who possess the Bachelor Degree in Science (B.Sc.) (10+2+3 stream) with Mathematics as a subject in B.Sc. is eligible to apply for Lateral Entry admission to the third semester of B.E./B.Tech. Programmes, as per the eligibility criteria prescribed by the Directorate of Technical Education from time to time. Such candidates shall undergo two additional Engineering subject(s) one each in third and fourth semesters, as bridge courses.

## 2. PROGRAMMES OFFERED

A candidate may be offered admission to any one of the programmes offered by the Institution for the candidates specified in Clause 1.1 and as per the eligibility criteria of DoTE for the candidates under Clause 1.2 from the list given below:

**B. E. Programmes**

i. Aeronautical Engineering
ii. Agriculture Engineering
iii. Automobile Engineering
iv. Biomedical Engineering
v. Civil Engineering
vi. Computer Science and Engineering
vii. Electronics and Communication Engineering
viii. Electrical and Electronics Engineering
ix. Electronics and Instrumentation Engineering
x. Information Science and Engineering
xi. Mechanical Engineering
xii. Mechatronics

**B. Tech. Programmes**

i. Artificial Intelligence and Data Science
ii. Artificial Intelligence and Machine Learning
iii. Biotechnology
iv. Computer Science and Business Systems
v. Computer Technology

vi. Fashion Technology
vii. Food Technology
viii. Information Technology
ix. Textile Technology

## 3. STRUCTURE OF THE PROGRAMME

3.1 Every programme shall have a distinct curriculum with syllabi consisting of theory, laboratory, project, soft-skills and personality development courses, as prescribed by the respective Boards of Studies, broadly categorized under:

(i) **Basic Science** courses including Mathematics, Physics, Chemistry and further specialization in these subjects

(ii) **Basic Engineering** courses including Engineering Graphics, Engineering Practices, Basics of Electrical, Electronics, Civil, Mechanical Engineering, Engineering Mechanics and Computer Programming.

(iii) **Humanities and Social Science** courses including Language Courses, Management Courses, Soft Skills and Professional Ethics.

(iv) **Professional Courses** include Discipline Core Courses, Professional Electives, and Open Electives.

(v) **Employability Enhancement Courses (EEC)** includes Project Work and /or Internship, Seminar, Industrial /Practical Training, Value Added and Certificate Courses.

The medium of instruction is English for all the Courses, Examinations, Seminar Presentation, Projects and any other courses that a student registers for.

3.2 Each course is normally assigned a certain number of credits based on the following

| Contact period per week | Credits |
|---|---|
| 1 Lecture / 1 Tutorial period | 1 |
| 2 laboratory Periods (Laboratory / Seminar / Project Work / etc.) | 1 |

3.3 All the B.E. / B.Tech. Students will study Communicative English I during the First Semester. In the Second Semester, they will be divided into two streams based on their English language proficiency assessed in the Continuous Assessment during

semester I, in which the upper segment will be provided an option to enroll and study Communicative English II / German / Japanese / French / Chinese / Hindi while the lower segment will study Communicative English II.

3.4 Every student shall be required to opt for **Nine** electives from the list of electives. Students can opt for the electives (Core / Professional) from his / her own discipline courses, during V to VII Semesters, if he/she satisfies the prerequisite for that particular course.

3.5 However, out of nine electives, every student shall be required to opt for, a minimum of one and subject to a maximum of three courses as open elective from the list of electives of the branch / branches other than his / her branch of specialisation, if he/she satisfies the prerequisite for that particular course.

3.6 Students can also opt for **one-credit courses** of 15 to 20 hour duration, which will be offered by the experts from the industry on specialised topics. Students can opt for such **one-credit courses** during the semesters I to VI as and when these courses are offered. A student will also be permitted to register the **one-credit courses** offered by other Departments, provided the student has fulfilled the necessary pre-requisites or the courses that may not require any pre-requisites. Under no circumstances, the same one credit course shall be repeated in subsequent semesters in any Department / Centre for the same batch of the students and a maximum batch size for a given course shall not exceed 40. In case of disciplines with multiple divisions (intake more than 60) different course(s) shall be offered to other batch(es) of students.

On successful completion of one credit courses, Credits will be indicated in the Grade Sheet, but will not be considered for computing the Cumulative Grade Point Average (CGPA). However, if a student wishes to avail the exemption from any one of the Electives (other than open elective) of the Semester VII, he / she can do so by exercising his / her option in writing to the respective Head of the Department during the beginning of the VII Semester, following the equivalence norm, that one **regular elective** (in the **VII Semester**) is equivalent to **three one-credit courses** completed by the student during the previous semesters, III to VI. Details of the one credit courses offered by the department shall be forwarded to the Office of the

Controller of Examinations. However one credit courses completed during I to II semesters shall be maintained in the Grade sheet as "Additional credits earned" (not considered for the computation of SGPA/CGPA).

3.7 A student can register for Self-Study Elective(s) over and above the electives from any branch of Engineering / Technology at the rate of one per semester starting from V semester onwards provided he/she maintains a Cumulative Grade Point Average (CGPA) of 8.50 or above till the previous semesters with no current arrears. Credits will be indicated for such courses in the grade sheets (additional credits) but will not be considered for computing the CGPA.

3.8 A Student may be permitted to credit only one online course with the approval of the Departmental Consultative Committee constituted by the Head of the Department, subject to a maximum of three credits. The student needs to obtain certification or credit to become eligible for writing the End Semester Examination to be conducted by the CoE. A student can get exemption for a maximum of 3 credits during the entire programme (in lieu of Core elective or Open elective). The Head of the Department may identify a faculty member as coordinator for the course, who is responsible for the evaluation process. The course shall be evaluated through the End Semester Examination only. The evaluation methodology may be decided by the course faculty coordinator.

3.9 **Industrial Training / Internship**

The students may undergo Industrial training / Internship optionally for a period as specified in the table during summer / winter vacation and the credits earned will be indicated in the Mark Sheet. If the student earns three credits in Industrial Training / Internship, the student may drop one Professional Elective. In such cases, Industrial Training / Internship need to be undergone continuously from one organization only. However, if the number of credits earned is 1 or 2, these credits shall not be considered for classification of the degree. The students may also undergo Internship at Research organization / University (after due approval from the Department Consultative Committee) during summer / winter vacation, in lieu of Industrial training.

| Duration of Training / Internship | Credits |
|---|---|
| 2 Weeks | 1 |
| 4 Weeks | 2 |
| 6 Weeks | 3 |

3.10 **Socially Relevant Projects**

A Student may be permitted to carry out a socially relevant project during semester II to semester VI in consultation with the Faculty Guide and submit the project report, in the prescribed format, at the end of the Semester for the valuation.

On successful completion of socially relevant project work, one credit will be indicated in the grade sheet (Additional credits), but these credits will not be considered for computing the CGPA.

## 4. VALUE ADDED COURSES

A Student can opt for the Value Added Courses offered by the various Department / Centres from Semester II to VII. Head of the Department / Centre shall submit the list of such courses, duly approved / ratified by the Academic Council, to the Controller of Examinations to administer the examination process. A separate Certificate will be issued on successful completion of the course by the Office of the Controller of Examinations.

## 5. DURATION OF THE PROGRAMME

5.1 A regular student (admitted after 10+2) or equivalent is normally expected to satisfactorily fulfil the requirements for award of the degree B.E. / B.Tech. within four academic years (8 semesters) from the date of admission but in any case not more than 7 years (14 Semesters); lateral entry students shall fulfil such requirements within three academic years (6 semesters) from the date of admission but in any case not more than six years (12 Semesters) leading to the award of Degree of Bachelor of Engineering (B.E.) / Bachelor of Technology (B.Tech.) of Anna University, Chennai.

5.2 The total period for completion of the programme from the commencement of the semester, to which the student was admitted, shall not exceed the maximum period

(Clause 5.1), regardless to the break-of-study (vide Clause 15) or period of prevention in order.

5.3 Each semester shall consist of minimum 90 working days. Head of the Department shall ensure that every faculty member teaches the subject / course as prescribed in the approved curriculum and syllabi.

5.4 Special Theory / Practical Sessions may be conducted for students who require additional inputs over and above the number of periods normally specified (Remedial Classes), as decided by the Head of the Department, within the specified duration of the Semester / Programme.

## 6. COURSE ENROLLMENT AND REGISTRATION

6.1 Each student, on admission shall be assigned to a Faculty Advisor (vide Clause 8) who shall advise / counsel the student about the details of the academic programme and the choice of course(s) considering the student's academic background and career objectives.

6.2 Every student shall enroll for the courses of the succeeding semester, in the current semester. However, the student shall confirm the enrollment by registering for the courses within the first five working days after the commencement of the semester concerned.

6.3 After registering for a course, a student shall attend the classes, satisfy the attendance requirements, earn Continuous Assessment marks and appear for the End Semester Examinations.

6.3.1 Each student, on admission to the programme, shall register for **all the courses prescribed in the curriculum** in the **first Semester of study (III Semester** for students admitted under **lateral entry stream).**

6.3.2 The enrollment for all the courses of the Semester II will commence 10 working days prior to the last working day of Semester I. The student shall confirm the enrollment by registering for the courses within the first five working days after the commencement of the Semester II. In case, if a student fails to register in course(s), he/ she may be permitted to register the same, as specified in the Clause 6.5, in the subsequent semesters or when it is offered.

6.3.3 The enrollment for the courses of the Semesters III to VIII will commence 10 working days prior to the last working day of the preceding semester. The student shall enroll for the courses with the guidance of the student's Faculty Advisor. If a student wishes, the student may drop or add courses (vide Clause 6.4) within **five** working days after the commencement of the semester concerned and complete the registration process duly authorized by the Faculty Advisor.

**6.4 Flexibility to Add or Drop courses**

6.4.1 A student has to earn the total number of credits specified in the Curriculum of the respective Programme of study in order to be eligible to obtain the degree. However, if a student wishes, the student is permitted to earn more than the total number of credits prescribed in the curriculum by opting for one- credit courses, self study electives or additional courses.

6.4.2 From the III to VIII semesters (from IV to VIII Semesters in case of lateral entry students), the student has the option of registering for additional courses or dropping existing courses. The total number of credits that a student can add or drop is limited to 8, subject to a maximum of 2 courses in a given Semester. In such cases, the attendance requirement as stated in Clause 7 is mandatory.

6.4.3 The student shall register Project work I in semester VII and Project work II in semester VIII only.

**6.5 Reappearance Registration**

6.5.1 If a student fails in a theory course, the student shall do reappearance registration (Examination) for that course in the subsequent semesters or when it is offered next.

6.5.2 On registration, a student may attend the classes for the reappearance registration courses, if the student wishes, and the attendance requirement (vide Clause 7) is not compulsory for such courses.

6.5.3 However, if a student wishes to improve his/ her continuous assessment, in the second attempt during reappearance, he/she shall satisfy the Clause 6.5.5 and appear for continuous assessment as given for that particular course.

6.5.4 If the theory course, in which the student has failed, is either a professional elective or an open elective, the student may register for the same or any other professional elective or open elective course, respectively in the subsequent semesters. However, the change of elective courses is permitted only once.

6.5.5 In this case (Clause 6.5.4), the student shall attend the classes, satisfy the attendance requirements (vide Clause 7), earn Continuous Assessment marks and appear for the End Semester Examination.

6.5.6 The student who fails in any continuous assessment courses (Laboratory/ Project work / Seminar or any other HSS/EEC courses) shall register for the same in the subsequent semesters or when offered next, and **repeat** the course as per Clause 6.5.5.

6.5.7 If a student is prevented from writing the end semester examination of a course or several courses due to lack of attendance, the student has to register for that / those course(s) again, when offered next, attend the classes and fulfill the requirements as per Clause 6.5.5 & 6.5.6. If the course, in which the student has 'lack of attendance', is a Core Elective or an Open Elective, the student may register for the same or any other Core Elective or Open Elective course(s) respectively in the subsequent semesters and appear in the examination as per Clause 6.5.5.

6.5.8 If a student fails to secure a pass in any theory courses (including elective) he/she is given a maximum of three arrear attempts to complete the courses. If the student still fails to secure a pass, he/she shall register for the same when offered next and repeat the course.

## 7. REQUIREMENTS FOR APPEARING FOR THE END SEMESTER EXAMINATION OF A COURSE

A student who has fulfilled the following conditions (vide Clause 7.1 and 7.2) shall be deemed to have satisfied the attendance requirements for appearing for End Semester Examination of a particular course.

7.1 Every student is expected to attend all the periods and earn 100% attendance. However, a student shall secure not less than 80% attendance course wise taking

into account the number of periods required for that course as specified in the curriculum.

7.2 If a student, secures attendance between 70% and 79% in any course(s) in the current semester due to medical reasons (prolonged hospitalization / accident / specific illness) or participation in Institution/ University/ State/ National/ International level extra and co-curricular activities, with prior permission from the Head of the Department, shall be permitted to appear for the current semester examinations subject to the condition that the student shall submit the medical certificate / participation certificate attested by the Head of the Department (along with Condonation form). Such certificates along with the condonation forms shall be forwarded to the Controller of Examinations for verification and permission to attend the examinations. However during the entire programme of study, a student can avail such Condonation in any two semesters only (regardless the number of courses).

7.3 A student shall normally be permitted to appear for End Semester Examination of the course(s) if the student has satisfied the attendance requirements (vide Clause 7.1 – 7.2) and has registered for examination in those courses of that semester by paying the prescribed fee.

7.4 Students who do not satisfy Clause 7.1 and 7.2 and who secure less than 70% attendance in a course will not be permitted to write the End-Semester Examination of that course. The student has to register and repeat this course in the subsequent semesters or when it is offered next (vide Clause 6.5).

7.5 If a student has shortage of attendance in all the registered courses, he/she would not be permitted to move to the higher semester and has to repeat the current semester in the subsequent year.

7.6 In the case of reappearance (Arrear) registration for a course, the attendance requirement as mentioned in Clauses 7.1 - 7.3 is not applicable. However, the student has to register for examination in that course by paying the prescribed fee.

7.7 A student who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of grades.

## 8. FACULTY ADVISOR

To help the students in planning their courses of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a Faculty member of the Department who shall function as Faculty Advisor for those students. The Faculty Advisor shall advise and guide the students in registering of courses, reappearance of courses, monitor their attendance and progress and counsel them periodically. The Faculty Advisor also discusses with or informs the parents about the progress / performance of the students concerned.

The responsibilities of the faculty advisor shall be:

- To inform the students about the various facilities and activities available to enhance the student's curricular and co-curricular activities.
- To guide student enrollment and registration of the courses.
- To authorize the final registration of the courses at the beginning of each semester.
- To monitor the academic and general performance of the students including attendance and to counsel them accordingly.

## 9. COMMITTEES

### 9.1 Common Course Committee

9.1.1 A theory course handled by more than one faculty including the discipline with multiple divisions (greater than or equal to 2 ) shall have a "Common Course Committee" comprising of all members of faculty teaching that course with one of the members as the Course Coordinator, nominated by the Head of the Institution (Head of the Department in the case of multiple divisions of a discipline) and student representatives (one per specialization or division) registered for that course in the current semester.

First meeting of the Common Course Committee shall be held within fifteen days from the date of commencement of the semester. Two subsequent meetings in a semester may be held at suitable intervals. During these

meetings, the student members shall meaningfully interact and express their opinions and suggestions of all the students to improve the effectiveness of the teaching-learning process. It is the responsibility of the student representatives to convey the proceedings of these meetings to all the students.

9.1.2 In addition, Common Course Committee (without the student representatives) shall meet to ensure uniform evaluation through the common question papers during Continuous Assessment and End Semester Examinations.

**9.2 Class Committee Meeting**

For all the courses taught, prescribed in the curriculum, Class Committee meeting shall be convened thrice in a semester (first meeting within 15 days from the commencement of the semester and other two meetings at equal interval after the first meeting) comprising members of the faculty handling all the courses and two student representatives from the class.

One of the members of the faculty (preferably not handling any courses to that class), nominated by the Head of the Department, shall coordinate the activities of the Committee. During these meetings, the student members shall meaningfully interact and express their opinions and suggestions of all the students to improve the effectiveness of the teaching-learning process. It is the responsibility of the student representatives to convey the proceedings of these meetings to all other students.

## 10. SYSTEM OF EXAMINATION

10.1 Performance in each course of study shall be evaluated based on (i) Continuous Assessment throughout the semester and (ii) End Semester examination at the end of the semester for the regular courses or as given in the Clause 17. However, the final examination in the case of certificate / value added courses may be conducted, as and when the course is completed, through the office of the Controller of Examinations.

10.2 Each course, both theory and laboratory including project work, shall be evaluated as per the Scheme of Assessment given in Clause 17.

10.3 The End Semester Examinations shall normally be conducted after satisfying the Clause 5.2.

10.4 For the End Semester examinations, both theory and project work, the internal and external examiners (from Academia or Industry) shall be appointed by the Controller of Examinations as per the guidelines given by the Examination cum Evaluation committee of the Institute.

## 11. PASSING REQUIREMENTS AND PROVISIONS

11.1 The Passing requirement for a student in a course is determined based on the marks obtained both in Continuous Assessment and End Semester Examinations. A student who secures not less than 50% of total marks prescribed for the course [Continuous Assessment + End semester University Examinations] with a minimum of 45% of the marks prescribed for the end-semester University Examination, shall be declared to have passed the course and acquired the relevant number of credits.

11.1.1 If a student fails to secure a pass in a particular course, i.e., failing to obtain minimum marks, as stated above, it is mandatory that he/she shall reappear for the examination in that course in the subsequent semester(s) whenever the examinations are conducted for that course, till he/she secures a 'Pass'.

Continuous Assessment (CA) marks obtained by the student in the first appearance shall be retained and considered valid for one subsequent attempt, except Clause 6.5.4, 6.5.5, 6.5.6 and 6.5.7. However, from the third attempt onwards, the student shall be declared to have passed the course if he/she secures a minimum of 5 Grade Points (C Grade) in the course prescribed during the End Semester Examinations.

11.2 If a candidate fails in the seventh semester examinations of Project work I, he/she has to resubmit the Project Report within 30 days from the date of declaration of the results. If he / she fails in the End semester examination of Project work II, he/she shall resubmit the Project Report within 60 days from the date of declaration of the results. The resubmission of the project report and the subsequent viva-voce examination will be considered as reappearance with payment of exam fee. In case a student fails in the resubmission of a project report

and subsequent viva-voce examination, the student shall register for the course again, when offered next.

11.3 The passing requirement for the courses which are assessed only through continuous assessment (Laboratory and EEC courses except project work), shall be fixed as minimum 50% and the remaining grades are decided as per clause 12.4. If a candidate fails in EEC courses (Except Project work), he/she has to register and repeat the course within 30 days from the date of declaration of the results. In case a student fails to register within 30 days, he/she shall register for the course again, when offered next.

11.4 The minimum number of total credits to be earned by a student to qualify for the award of Degree in the various branches of study as prescribed by the respective Boards of Studies is given below:

| **Branch of Study** | **Minimum Credits** | |
|---|---|---|
| | **Regular Admission** | **Lateral Entry** |
| **B.E. Programmes** | | |
| Aeronautical Engineering | 163 | 126 |
| Agriculture Engineering | 163 | 125 |
| Automobile Engineering | 161 | 124 |
| Biomedical Engineering | 163 | 124 |
| Civil Engineering | 163 | 125 |
| Computer Science and Engineering | 163 | 125 |
| Electronics and Communication Engineering | 163 | 122 |
| Electrical and Electronics Engineering | 162 | 123 |
| Electronics and Instrumentation Engineering | 161 | 122 |
| Information Science and Engineering | 163 | 122 |
| Mechanical Engineering | 161 | 122 |
| Mechatronics | 162 | 124 |
| **B.Tech. Programmes** | | |
| Artificial Intelligence and Data Science | 161 | 123 |
| Artificial Intelligence and Machine Learning | 163 | 126 |
| Biotechnology | 163 | 125 |
| Computer Science and Business Systems | 163 | 119 |
| Computer Technology | 161 | 119 |
| Fashion Technology | 163 | 125 |
| Food Technology | 161 | 123 |

| | | |
|---|---|---|
| Information Technology | 161 | 123 |
| Textile Technology | 162 | 124 |

11.5 Student Migration and Credit Transfer: Normalization of the Credits will be carried out in consultation with the Board of Studies of the programme concerned and approved by the Head of Institution, if a student migrates from other Autonomous institutions to Bannari Amman Institution of Technology or rejoins from previous regulation to this regulation.

11.6 A student shall be declared to have qualified for award of B.E/B.Tech. Degree if he/she successfully completes the course requirements (vide Clause 7, 10 and 11) and passed all the prescribed courses of study of the respective programme (listed in Clause 2), within the duration specified in Clause 5.1.

## 12. ASSESSMENT AND AWARD OF LETTER GRADES

12.1 The assessment shall be based on the performance in the End Semester Examinations and / or Continuous Assessment, carrying marks as specified in Clause 17. Letter Grades (based on Credit Point and Grade Point) are awarded to the students based on the performance in the evaluation process.

12.2 Credit Point is the product of Grade Point and number of credits for a course and Grade Point is a numerical weight allotted to each letter grade on a 10-point scale (as specified in the Clause 12.4), while the Letter Grade is an index of the performance of a student in a said course.

12.3 Condition for Relative Grading

The minimum number of students for applying relative grading system is 30. If the students' strength is less than 30 then absolute grading system shall be followed with the grade range as specified below. The relative grading system shall not be applied for laboratory and continuous assessment courses.

| O | A+ | A | B+ | B | C | U |
|---|---|---|---|---|---|---|
| 91 - 100 | 81 - 90 | 71 - 80 | 61 - 70 | 56 - 60 | 50 - 55 | < 50 |

12.4 The performance of a student will be reported using Letter Grades, each carrying certain points as detailed below: A student who earns a minimum of 5 grade points in a course is declared to have successfully passed the course.

| **Letter Grade** | **Grade Points** |
|---|---|
| O (Outstanding) | 10 |
| A + (Excellent) | 9 |
| A (Very Good) | 8 |
| B + (Good) | 7 |
| B (Average) | 6 |
| C (Satisfactory) | 5 |
| U (Reappearance) | 0 |
| W (Withdrawal) | 0 |
| AB (Absent) | 0 |
| SA (Shortage of Attendance) | 0 |

'U' ---Reappearance is required for that particular course

'SA' --- shortage of attendance (Clause 7) and hence prevented from writing end semester examination.

12.5 After completion of the evaluation process, Semester Grade Point Average (SGPA), and the Cumulative Grade Point Average (CGPA) is calculated using the formula:

$$SGPA/CGPA = \frac{\sum_1^n C_i * g_i}{\sum_1^n C_i}$$

Where

$C_i$ : Credit allotted to the course.

$g_i$ : Grade Point secured corresponding to the course.

n : number of courses successfully cleared during the particular semester in the case of SGPA and all the semesters, under consideration, in the case CGPA.

12.6 A student who does not appear for the End Semester Examinations in a course, after registering for the same, shall be deemed to have appeared for that examination for the purpose of classification (Subject to Clause 14 and 15).

12.7 For the non credit courses grades shall be indicated as given in the Clause 17 and shall not be counted for the computation of SGPA/CGPA.

For the Co-curricular activities such as NCC / NSS / NSO / YRC, a satisfactory / not satisfactory grading will appear in the mark sheet. Every student shall put in a minimum of 75% attendance in the training and attend the camp compulsorily. The training and camp shall be completed during the first year of the programme. However, for valid reasons, the Head of the Institution may permit a student to complete this requirement in the second year. A satisfactory grade in the above co-curricular activities is compulsory for the award of degree.

12.8 **Revaluation:** A student, who seeks the re-valuation of the answer script, is directed to apply through proper application to the Controller of Examinations in the prescribed format through the Head of the Department. The Controller of Examinations shall arrange for the revaluation and declare the results. Revaluation is not permitted to the courses other than theory courses. In the case of theory courses with laboratory component, a student can seek revaluation for the theory component only, following the procedure stated above.

12.9 **Eligibility for the Award of Degree**

A student shall be declared to be eligible for the award of the B.E. / B.Tech. Degree provided the student has

i. Successfully gained the required number of total credits as specified in the curriculum corresponding to the student's programme within the stipulated time.
ii. Successfully completed the course requirements, appeared for the End-Semester examinations and passed all the courses prescribed in all the 8 semesters within a maximum period of 7 years reckoned from the commencement of the first semester to which the candidate was admitted.
iii. Successfully completed the NCC / NSS / NSO / YRC / Extra-curricular/ Co-curricular requirements.

iv. No disciplinary action is pending against the student.

v. The award of Degree must have been approved by the Syndicate of the University.

12.10 **Conduct of Special Examination**

The special or make-up exams may be conducted for the students who missed the regular examination due to participation / representing the institute in various activities and the schedule may be included in the academic calendar. The special or make-up exams may be conducted after the completion of end-semester examinations and prior to starting of the next semester.

## 13. CLASSIFICATION OF THE DEGREE AWARDED

For the purpose of the 'Award of Degree', the duration of completion of the programme shall be the total duration taken by a student for completing first time registration of all the required courses and satisfying Clause 11, regardless to the period of Break-of-study as per Clause 15 and satisfy any one of the conditions required as given below.

13.1 **First Class with Distinction**: A student who satisfies the following conditions shall be declared to have passed the examination in **First class with Distinction**:

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry students) in the student's First Appearance within five years, which includes authorized break of study of one year. Withdrawal from examination (vide Clause 15) will not be considered as an appearance.
- Should have secured a CGPA of **not less than 8.50**
- Should **NOT** have been prevented from writing end semester examination due to lack of attendance in any of the courses.

13.2 **First Class**: A student who satisfies the following conditions shall be declared to have passed the examination in **First class**:

- Should have passed the examination in all the courses of all eight semesters (six semesters for lateral entry students) within five years, which includes one year of authorized break of study (if availed) or prevention from writing the End Semester Examination due to lack of attendance (if applicable).

- Should have secured a CGPA of **not less than 6.50**

13.3 **Second Class**: All other students (not covered in clauses 13.1 and 13.2) who qualify for the award of the degree shall be declared to have passed the examination in **Second Class.**

## 14. WITHDRAWAL FROM THE EXAMINATION

14.1 A student may, for valid reasons, be granted permission by the Head of the Department to withdraw from appearing in the examination in any course(s) only once during the entire duration of the degree programme.

14.2 Withdrawal application shall be valid only, if the student is eligible to write the examination as per Clause 7 and, if it is made within TEN working days before the commencement of the end semester examination in that course or courses and also recommended by the Head of the Department.

14.3 Notwithstanding the requirement of mandatory TEN working days' notice, applications for withdrawal for special cases under extraordinary conditions will be considered on the merit of the case.

14.4 If a student withdraws a course or courses from writing end semester examinations, he/she shall register the same in the subsequent semester and write the end semester examination(s).

14.5 Withdrawal shall not be considered as an appearance in the examination for the eligibility of a student for First Class with Distinction or First Class.

14.6 Withdrawal is permitted for the end semester examinations in the final semester, only if the period of study of the student concerned does not exceed 5 years as per clause 13.1 & 13.2.

## 15. AUTHORIZED BREAK OF STUDY FROM A PROGRAMME

15.1 A student is permitted to go on break of study for a fixed period of one year as a single break in the entire course of study.

15.2 A student is normally not permitted to break the period of study temporarily. However, if a student happens to discontinue the programme temporarily during the middle of programme of study, for reasons such as personal accident or hospitalization due to ill health or in need of health care, he/she shall apply to the

Head of the Institution in advance, in any case, not later than the last date for registering for the semester examination, through the Head of the Department stating the reasons for the break-of-study (for one academic semester or 6 months, whichever is earlier). However, a student detained for want of minimum attendance requirement as per Clause 7 shall not be considered as permitted 'Break of Study' and Clause 15.3 is not applicable for such case.

15.3 The student is permitted to rejoin the programme after the break / prevention due to lack of attendance, shall be governed by the Curriculum and Regulations in force at the time of rejoining. The students rejoining in new Regulations shall apply to the Dean Academics in the prescribed format through the Head of the Department at the beginning of the readmitted semester itself for prescribing additional/equivalent courses, if any, from any semester of the regulations in-force, so as to bridge the curriculum in-force and the old curriculum.

15.4 Authorized break of study will be counted towards the duration specified for passing all the courses (vide Clause 5.1 and 5.2) and for the purpose of classification of Degree (vide Clause 13).

15.5 The total period for completion of the programme reckoned from the commencement of the first semester to which the student is admitted shall not exceed the maximum period specified in Clause 5.1, irrespective of the period of break of study in order that he / she may be eligible, for the award of the degree (vide Clause 13).

15.6 In case of valid reasons (as stated in Clause 15.2) extended break-of-study may be granted by the Head of the Institution for a period not more than one year in addition to the earlier authorized break of study.

15.7 If a student does not report back to the Institute, even after the extended Break of Study, the name of the student shall be deleted permanently from the college enrollment. Such students are not entitled to seek readmission under any circumstances.

## 16. IMPLEMENTATION OF MINOR DEGREE/ HONOURS

The following guidelines shall be implemented for the B.E. / B. Tech. students who have been admitted from the academic year 2021-2022.

16.1 B.E. / B.Tech. Honours (specialization in the same discipline):

- The student should have earned additionally a minimum of 18 credits from a vertical of the same programme.
- Should have passed all the courses in the first attempt.
- Should have earned a minimum CGPA of 7.50.

16.2 B.E. / B.Tech. Honours

- The students should have earned additionally a minimum of 18 credits from more than one vertical of the same programme.
- Should have passed all the courses in the first attempt.
- Should have earned a minimum CGPA of 7.50.

16.3 B.E. / B.Tech. (minor in other specialisation)

The student should have earned additionally a minimum of 18 credits in any one of the verticals of other B.E/B.Tech. programmes or from any one of the following verticals

Vertical I: Fintech and Block Chain

Vertical II: Entrepreneurship

Vertical III: Public Administration

Vertical IV: Business Data Analytics

Vertical V: Environment and Sustainability

16.4 Students can earn maximum of 6 credits in online mode (SWAYAM platform), out of these 18 credits with the approval of the Departmental Consultative Committee constituted by the Head of the Department.

16.5 B.E./ B. Tech. (Hons) Specialization in the same discipline, B.E. / B.Tech. Honors and B.E. / B.Tech. Minor in other specialization degrees will be optional for students.

16.6 For categories 16.1 and 16.2, the students will be permitted to register for the courses from V Semester onwards provided the marks earned by the students until III semester should be of CGPA 7.50 and above and cleared all the courses in the first attempt.

16.7 For category 16.3, the students will be permitted to register the courses from Semester V onwards provided the marks earned by the students until Semester III is CGPA 7.50 and above.

16.8 If a student decides not to opt for Honours, after completing a certain number of additional courses, the additional courses studied shall be considered instead of the Professional Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of Professional Elective courses required as per the curriculum, the courses with higher grades shall be considered for the calculation of CGPA. Remaining courses shall be printed in the grade sheet, however, they will not be considered for the calculation of CGPA.

16.9 If a student decides not to opt for Minor degree, after completing a certain number of courses, the additional courses studied shall be considered instead of Open Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of open electives required as per the curriculum, the courses with higher grades shall be considered for calculation of CGPA. Remaining courses shall be printed in the grade sheet, however, they will not be considered for calculation of CGPA.

16.10 Classification of the Degree Awarded

The conditions for First Class with Distinction, First Class, and Second Class are same as Clause except the following classification.

**First Class:** A student who satisfies the following conditions shall be declared to have passed the examination in First class for the purpose of the 'Award of Degree', of B.E. / B.Tech. Honors (specialization in the same discipline) and B.E. / B.Tech. Honors

- Should have secured a CGPA of not less than 7.50.

## 17. SCHEME OF ASSESSMENT

Courses offered under B.E. / B.Tech. Programmes are assessed as given below:

| I | **THEORY COURSES** | **Marks** |
|---|---|---|
| | **Continuous Assessment** | **40** |
| | **Distribution of marks for Continuous Assessment:** | |
| | *Periodical Test I (12)* | |
| | *Periodical Test II (12)* | |
| | *Innovative Practices (16)* | |
| | **End Semester Examination** | **60** |
| | **Total Marks** | **100** |

| II | **THEORY COURSES WITH LAB COMPONENT** | **Marks** |
|---|---|---|
| | **Continuous Assessment** | **50** |
| | **Distribution of marks for Continuous Assessment:** | |
| | *Periodical Test I (15)* | |
| | *Periodical Test II (15)* | |
| | *Innovative Practices (20)* | |
| | *(Laboratory Assessment & Report)* | |
| | **End Semester Examination** (QP pattern as per (I)) | **50** |
| | **Total Marks** | **100** |

| III | **LABORATORY COURSES** | **Marks** |
|---|---|---|
| | **Continuous Assessment** | **100** |
| | **Distribution of marks for Continuous Assessment:** | |
| | *Conduct of Experiment* | |
| | *i. Preparation (20)* | |
| | *ii. Experiment and Analysis of Results (20)* | |
| | *iii. Record (10)* | |
| | *Test – Cycle I (25)* | |
| | *Test – Cycle II (25)* | |
| | **Total Marks** | **100** |

| IV | **PROJECT WORK I** | **Marks** |
|---|---|---|
| | **Continuous Assessment** | **50** |
| | **Distribution of marks for Continuous Assessment:** | |
| | *Review I* | |
| | *Literature Survey (5)* | |
| | *Identification of topic and Justification (5)* | |
| | *Work plan (10)* | |
| | *Review II* | |
| | *Approach & Results (15)* | |
| | *Conclusion (15)* | |

| | | |
|---|---|---|
| | **End Semester Examination** | |
| | *Report[#] (20)* | **50** |
| | *Presentation (20)* | |
| | *Viva voce (10)* | |
| | **Total Marks** | **100** |

| | | |
|---|---|---|
| **V** | **PROJECT WORK II** | **Marks** |
| | **Continuous Assessment** | **50** |
| | **Distribution of marks for Continuous Assessment:** | |
| | *Review I* | |
| | *Progress (10)* | |
| | *Review II* | |
| | *Approach & Results (10)* | |
| | *Review III* | |
| | *Conclusion & Final Presentation (10)* | |
| | *Report (15)* | |
| | *Publication of Paper in Conferences / Journals (5)* | |
| | **End Semester Examination** | |
| | *Presentation (30)* | **50** |
| | *Viva voce (20)* | |
| | **Total Marks** | **100** |

| | | |
|---|---|---|
| **VI** | **LANGUAGE ELECTIVE** | **Marks** |
| | **(CONTINUOUS ASSESSMENT ONLY)** | |
| | Test 1 | |
| | *Listening (5)* | |
| | *Speaking (10)* | **25** |
| | *Reading (5)* | |
| | *Writing (5)* | |
| | Test 2 | |
| | *Listening (5)* | |
| | *Speaking (10)* | **25** |
| | *Reading (5)* | |
| | *Writing (5)* | |
| | Oral Exam | **50** |
| | **Total Marks** | **100** |
| **VII** | **ONE-CREDIT COURSE** | **Marks** |
| | **(CONTINUOUS ASSESSMENT ONLY)** | |
| | Test I | **50** |
| | Quiz/ Assignment | **50** |
| | **Total Marks** | **100** |

[#] *Reports / Record Note / Integrated Lab Manual to be retained for 1 year for Academic Audit, by respective Department*

| VIII | **INDUSTRIAL TRAINING/ INTERNSHIP (CONTINUOUS ASSESSMENT ONLY)** | **Marks** |
|---|---|---|
| | Assessment by Industry | **30** |
| | Viva-voce | **20** |
| | *Presentation* | **30** |
| | Case Study / Report | **20** |
| | **Total Marks** | **100** |

| IX | **SOFT SKILLS (CONTINUOUS ASSESSMENT ONLY)** | **Marks** |
|---|---|---|
| | Test I | **25** |
| | Test II | **25** |
| | Final Examination | **50** |
| | **Total Marks** | **100** |
| | Grades (Excellent / Good / Satisfactory) | |

| X | **VALUE ADDED / CERTIFICATE COURSES (CONTINUOUS ASSESSMENT ONLY)** | **Marks** |
|---|---|---|
| | Test I | **25** |
| | Test II | **25** |
| | Final Evaluation / Test | **50** |
| | **Total Marks** | **100** |
| | Grades (Excellent / Good / Satisfactory) | |

| XI | **ENGINEERING GRAPHICS** | **Marks** |
|---|---|---|
| | **Continuous Assessment** | **100** |
| | **Distribution of marks for Continuous Assessment:** | |
| | *Exercise (Minimum 10 Exercises/Modelling)* | **60** |
| | *Model Examination* | **40** |
| | **Total Marks** | **100** |

***Optional Test:*** *A student becomes eligible to appear for an optional test conducted after the Periodical Test II, only under the following circumstances: (i) absent for Test I or Test II or both on account of medical reasons (hospitalization / accident / specific illness), or (ii) participation in the College / University / State / National / International level Sports events with prior permission from the Head of the Institution and (iii) on satisfying the conditions (i) or (ii), the student should have registered for the Optional Test, through the concerned member of faculty who handles the course or through the respective Head of the Department, submitted to the Controller of Examinations. Such Optional Tests are not conducted for the courses under the categories III, IV, V, VI, VII, VIII, IX, X and XI listed above.*

## 18. FIELD / INDUSTRIAL VISIT / INTERNSHIP

In order to provide the experiential learning to the students, Head of the Department shall take efforts to arrange at least two industrial visits / field visits. The students may also undergo in-plant training / internship during summer / winter vacation between III and VII semesters.

## 19. PERSONALITY AND CHARACTER DEVELOPMENT

Every student shall be required to undergo a minimum of 40 hours of Personality Development Programmes viz, NSS / NCC / YRC / YOGA / Sports and Games / Technical and Non-technical Club activities during the first year. The attendance of the personality and character development courses / events shall be maintained on the regular basis by the concerned First Year Co-ordinators and made available in the Office of the Controller of Examinations before the commencement of Semester examinations of Semester I or Semester II.

## 20. DISCIPLINE

A student is expected to follow the rules and regulations laid down by the Institute and the affiliating University, as published from time to time. Any violations, if any, shall be treated as per the procedures stated thereof.

If a student indulges in malpractice in any of the End Semester / Continuous Assessments, he / she shall be liable for punitive action as prescribed by the Institution / University from time to time.

## 21. REVISION OF REGULATIONS, CURRICULUM AND SYLLABI

The Institution reserves the right to revise/amend/change the Regulations, Curriculum, Syllabi, Scheme of Examinations and date of implementation and to introduce Additional Electives, Open Electives, One Credit Courses and Value Added Courses through the Academic Council.

## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

- PEO-I. Excel in professional career and/or higher education by acquiring knowledge in Engineering principles through analytical, computational and experimental methods
- PEO-II. Design and analysis of components, systems appropriate to Aeronautical/Aerospace engineering and solutions that are technically sound, economically feasible and socially acceptable, including real life problems.
- PEO-III. Exhibit professionalism, ethical attitude, communication skills, team work in their professional carrier and adapt to state of art through continuous improvement.

## PROGRAMME OUTCOMES (POs)

The students of Aeronautical Engineering will come out with:

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

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

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

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

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

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

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

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

i. **Individual and Team Work**: Function effectively as an individual, and as a member or

leader in diverse teams, and in multidisciplinary settings.

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

k. **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.

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

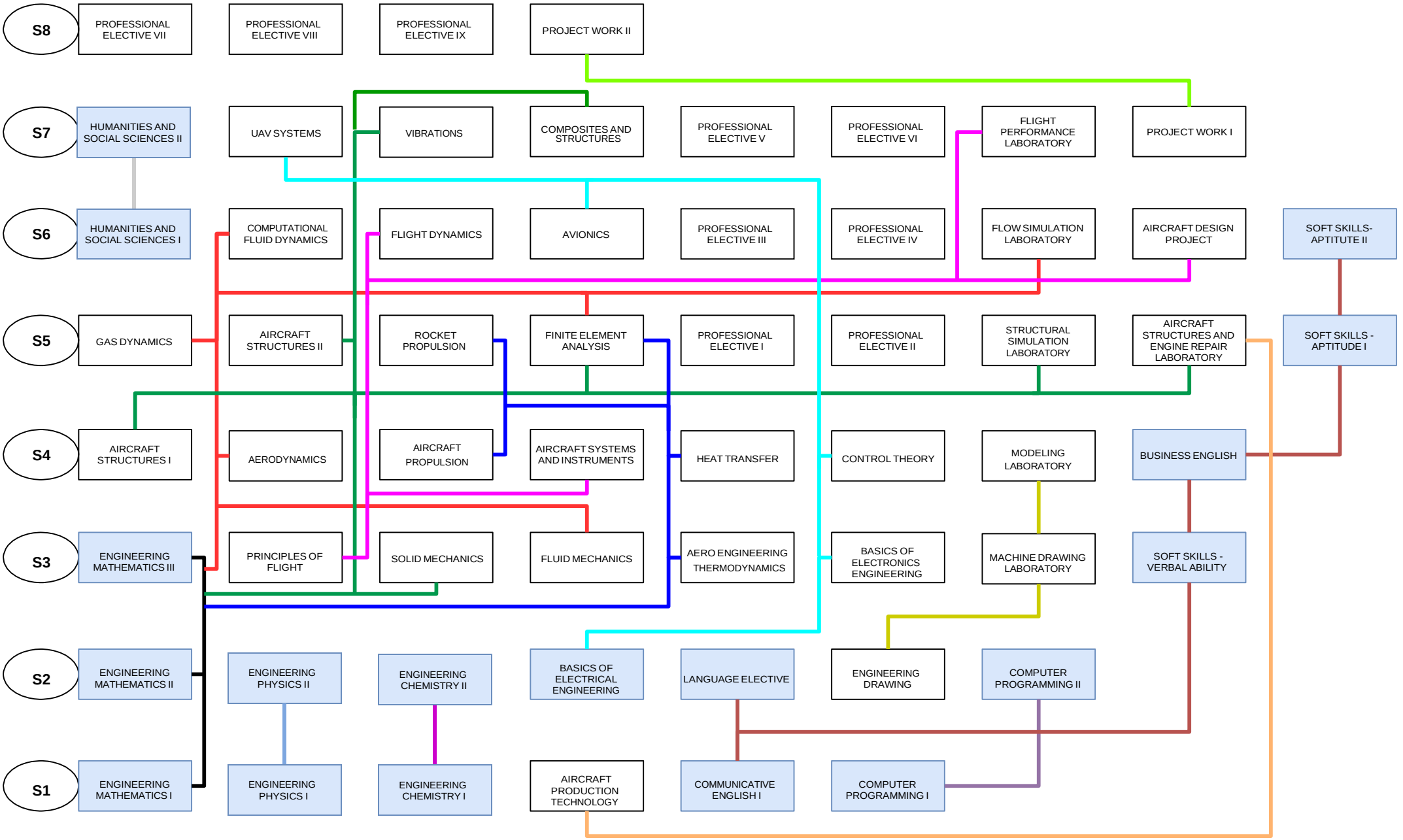
## PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Utilize the knowledge of Aeronautical engineering in innovative, dynamic and challenging environment for design and development of new products.
2. Impart professional skills through simulation, language skills and general purpose CAE packages to solve practical problems of components in design and analysis to meet the airworthiness requirements for flight vehicles.
3. Fabricate, test and develop the products with more innovative technologies.

## MAPPING OF PEOs WITH POs & PSOs

| | POs | | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **a** | **b** | **c** | **d** | **e** | **f** | **g** | **h** | **i** | **j** | **k** | **l** | **1** | **2** | **3** |
| **PEO-1** | X | X | X | X | X | | | | | | | | X | X | |
| **PEO-2** | | | | | X | X | X | | X | | | | | X | |
| **PEO-3** | | | | | | | | X | X | X | X | X | | | X |

# DEPARTMENT OF AERONAUTICAL ENGINEERING
# CONNECTIVITY CHART



**DEPARTMENT OF AERONAUTICAL ENGINEERING**
**Minimum Credits to be Earned: 163**

**I SEMESTER**

| Code No. | Course | L | T | P | C | Hours / Week | Maximum Marks | | | Category |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | CA | ES | Total | |
| 18AE101 | ENGINEERING MATHEMATICS I | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | BS |
| 18AE102 | ENGINEERING PHYSICS I | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | BS |
| 18AE103 | ENGINEERING CHEMISTRY I | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | BS |
| 18AE104 | AIRCRAFT PRODUCTION TECHNOLOGY | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | ES |
| 18HS101 | COMMUNICATIVE ENGLISH I | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| 18AE106 | COMPUTER PROGRAMMING I | 0 | 0 | 4 | 2 | 4 | 100 | 0 | 100 | ES |
| **Total** | | **10** | **1** | **12** | **17** | **23** | | | | **-** |

**II SEMESTER**

| Code No. | Course | L | T | P | C | Hours / Week | Maximum Marks | | | Category |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | CA | ES | Total | |
| 18AE201 | ENGINEERING MATHEMATICS II | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | BS |
| 18AE202 | ENGINEERING PHYSICS II | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | BS |
| 18AE203 | ENGINEERING CHEMISTRY II | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | BS |
| 18AE204 | BASICS OF ELECTRICAL ENGINEERING | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | ES |
| | LANGUAGE ELECTIVE | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| 18AE206 | ENGINEERING DRAWING | 1 | 0 | 4 | 3 | 5 | 100 | 0 | 100 | ES |
| 18AE207 | COMPUTER PROGRAMMING II | 0 | 0 | 4 | 2 | 4 | 100 | 0 | 100 | ES |
| **Total** | | **11** | **1** | **16** | **20** | **28** | | | | **-** |

| **III SEMESTER** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours / Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CA** | **ES** | **Total** | |
| 18AE301 | ENGINEERING MATHEMATICS III | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | BS |
| 18AE302 | PRINCIPLES OF FLIGHT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | ES |
| 18AE303 | SOLID MECHANICS | 2 | 1 | 2 | 4 | 5 | 50 | 50 | 100 | ES |
| 18AE304 | FLUID MECHANICS | 2 | 1 | 2 | 4 | 5 | 50 | 50 | 100 | ES |
| 18AE305 | AERO ENGINEERING THERMODYNAMICS | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | ES |
| 18AE306 | BASICS OF ELECTRONICS ENGINEERING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | ES |
| 18AE307 | MACHINE DRAWING LABORATORY | 0 | 0 | 4 | 2 | 4 | 100 | 0 | 100 | ES |
| 18GE301 | SOFT SKILLS - VERBAL ABILITY | 0 | 0 | 2 | - | 2 | 100 | 0 | 100 | EEC |
| **Total** | | **16** | **4** | **10** | **24** | **30** | | | | **-** |
| **IV SEMESTER** | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours / Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CA** | **ES** | **Total** | |
| 18AE401 | AIRCRAFT STRUCTURES I | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC |
| 18AE402 | AERODYNAMICS | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 18AE403 | AIRCRAFT PROPULSION | 2 | 1 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 18AE404 | AIRCRAFT SYSTEMS AND INSTRUMENTS | 2 | 0 | 2 | 3 | 4 | 50 | 50 | 100 | PC |
| 18AE405 | HEAT TRANSFER | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 18AE406 | CONTROL THEORY | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PC |
| 18AE407 | MODELING LABORATORY | 0 | 0 | 2 | 1 | 2 | 100 | 0 | 100 | PC |
| 18HS001 | ENVIRONMENTAL SCIENCE | 2 | 0 | 0 | 0 | 2 | 100 | 0 | 100 | HSS |
| 18GE401 | SOFT SKILLS – BUSINESS ENGLISH | 0 | 0 | 2 | - | 2 | 100 | 0 | 100 | EEC |
| **Total** | | **16** | **2** | **12** | **23** | **32** | | | | **-** |

| **V SEMESTER** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours / Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CA** | **ES** | **Total** | |
| 21AE501 | GAS DYNAMICS | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC |
| 21AE502 | AIRCRAFT STRUCTURES II | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| 21AE503 | ROCKET PROPULSION | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC |
| 21AE504 | FINITE ELEMENT ANALYSIS | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC |
| | PROFESSIONAL ELECTIVE I | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | PROFESSIONAL ELECTIVE II | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE507 | STRUCTURAL SIMULATION LABORATORY | 0 | 0 | 2 | 1 | 2 | 100 | 0 | 100 | PC |
| 21AE508 | AIRCRAFT STRUCTURES AND ENGINE REPAIR LABORATORY | 0 | 0 | 2 | 1 | 2 | 100 | 0 | 100 | PC |
| 18GE501 | SOFT SKILLS - APTITUDE I | 0 | 0 | 2 | - | 2 | 100 | 0 | 100 | EEC |
| **Total** | | **18** | **3** | **8** | **24** | **29** | | | | **-** |
| **VI SEMESTER** | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours /Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CA** | **ES** | **Total** | |
| 21HS002 | HUMAN VALUES AND ETHICS | 2 | 0 | 0 | 2 | 2 | 40 | 60 | 100 | HS |
| 21AE602 | FLIGHT DYNAMICS | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC |
| 21AE603 | AVIONICS | 3 | 0 | 2 | 4 | 5 | 50 | 50 | 100 | PC |
| | PROFESSIONAL ELECTIVE III | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | PROFESSIONAL ELECTIVE IV | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | PROFESSIONAL ELECTIVE V | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE607 | FLOW SIMULATION LABORATORY | 0 | 0 | 2 | 1 | 2 | 100 | 0 | 100 | PC |
| 21AE608 | AIRCRAFT DESIGN PROJECT | 0 | 0 | 4 | 2 | 4 | 100 | 0 | 100 | PC |
| 18GE601 | SOFT SKILLS - APTITUDE II | 0 | 0 | 2 | - | 2 | 100 | 0 | 100 | EEC |
| **Total** | | **17** | **1** | **10** | **22** | **28** | | | | **-** |

| **VII SEMESTER** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours /Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CA** | **ES** | **Total** | |
| 21AE701 | VIBRATIONS | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC |
| 21AE702 | COMPOSITES AND STRUCTURES | 3 | 1 | 0 | 4 | 4 | 40 | 60 | 100 | PC |
| | PROFESSIONAL ELECTIVE VI | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | PROFESSIONAL ELECTIVE VII | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | PROFESSIONAL ELECTIVE VIII | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| | PROFESSIONAL ELECTIVE IX | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE707 | FLIGHT PERFORMANCE LABORATORY | 0 | 0 | 2 | 1 | 2 | 100 | 0 | 100 | PC |
| 21AE708 | PROJECT WORK I | 0 | 0 | 6 | 3 | 6 | 50 | 50 | 100 | EEC |
| **Total** | | **18** | **2** | **8** | **24** | **28** | | | | **-** |
| **VIII SEMESTER** | | | | | | | | | | |
| **Code No.** | **Course** | **L** | **T** | **P** | **C** | **Hours /Week** | **Maximum Marks** | | | **Category** |
| | | | | | | | **CA** | **ES** | **Total** | |
| 21AE801 | PROJECT WORK II | 0 | 0 | 18 | 9 | 18 | 50 | 50 | 100 | EEC |
| **Total** | | **9** | **0** | **18** | **9** | **18** | | | | **-** |

## ELECTIVES

## LANGUAGE ELECTIVES

| Code No. | Course | L | T | P | C | Hours/ Week | Maximum Marks | | | Category |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | CA | ES | Total | |
| 18HS201 | COMMUNICANITIVE ENGLISH II | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| 18HSH01 | HINDI | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| 18HSG01 | GERMAN | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| 18HSJ01 | JAPANESE | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| 18HSC01 | CHINESE | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| 18HSF01 | FRENCH | 1 | 0 | 2 | 2 | 3 | 100 | 0 | 100 | HSS |
| **PROFESSIONAL ELECTIVES** | | | | | | | | | | |
| **VERTICAL I: AERODYNAMICS** | | | | | | | | | | |
| 21AE001 | WIND TUNNEL TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE002 | INDUSTRIAL AERODYNAMICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE003 | HELICOPTER AERODYNAMICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE004 | WIND POWER ENGINEERING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE005 | WIND TUNNEL INSTRUMENTATION AND MEASUREMENTS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE006 | HIGH-SPEED AERODYNAMICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL II: PROPULSION** | | | | | | | | | | |
| 21AE007 | CRYOGENICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE008 | SPACE MECHANICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE009 | HIGH TEMPERATURE GAS DYNAMICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE010 | COMBUSTION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE011 | ADVANCED PROPULSION SYSTEMS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE012 | ROCKETRY AND MISSILES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL III: AEROSPACE STRUCTURES** | | | | | | | | | | |
| 21AE013 | THEORY OF ELASTICITY | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE014 | EXPERIMENTAL STRESS ANALYSIS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE015 | FATIGUE AND FRACTURE MECHANICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |

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|---|---|---|---|---|---|---|---|---|---|---|
| 21AE016 | STRUCTURAL DYNAMICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE017 | AEROSPACE MATERIALS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE018 | AERO ELASTICITY | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL IV: AVIONICS AND DRONE TECHNOLOGY** | | | | | | | | | | |
| 21AE019 | PRINCIPLES OF NAVIGATION | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE020 | GUIDANCE OF MISSILES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE021 | AIR TRAFFIC CONTROL AND AERODROME DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE022 | UAV SYSTEMS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE023 | AERODYNAMICS OF UAVS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE024 | SATELLITE TECHNOLOGY | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL V: AIRCRAFT MAINTENANCE** | | | | | | | | | | |
| 21AE025 | NDT FOR AERONAUTICAL APPLICATIONS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE026 | HELICOPTER MAINTENANCE | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE027 | AERO ENGINE REPAIR AND MAINTENANCE | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE028 | AIRFRAME MAINTENANCE AND REPAIR | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE029 | AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE030 | AIRLINE AND AIRPORT MANAGEMENT | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **VERTICAL VI: COMPUTATIONAL ENGINEERING** | | | | | | | | | | |
| 21AE031 | PYTHON FOR AEROSPACE ENGINEERING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE032 | AIRCRAFT DESIGN | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE033 | COMPUTATIONAL FLUID DYNAMICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE034 | GRID GENERATION TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE035 | COMPUTER AIDED DESIGN AND ANALYSIS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE036 | AI & ML IN AEROSPACE ENGINEERING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |

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|---|---|---|---|---|---|---|---|---|---|---|
| **VERTICAL VII: DIVERSIFIED COURSES** | | | | | | | | | | |
| 21AE037 | CIVIL AVIATION REQUIREMENTS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE038 | CORROSION OF AEROSPACE MATERIALS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE039 | CRISIS MANAGEMENT IN AIRCRAFT INDUSTRY | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE040 | BOUNDARY LAYER THEORY | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE041 | VEHICLE AERODYNAMICS | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| 21AE042 | ADVANCED VEHICLE ENGINEERING | 3 | 0 | 0 | 3 | 3 | 40 | 60 | 100 | PE |
| **ONE CREDIT COURSES** | | | | | | | | | | |
| 18AE0XA | WIND TURBINE DESIGN AND TESTING | 0 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18AE0XB | REAL TIME INDUSTRIAL APPLICATIONS IN CFD | 0 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18AE0XC | FAILURE ANALYSIS OF ADVANCED COMPOSITES | 0 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18AE0XD | TECHNICAL DOCUMENTATION FOR AEROSPACE ENGINEERING SERVICES | 0 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18AE0XE | INTRODUCTION TO AEROSPACE NAVIGATION | 0 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18AE0XF | SUPERSONIC/HYPERSONIC INLET DESIGN | 0 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18AE0XG | FATIGUE AND DAMAGE TOLERANCE | 0 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18AE0XH | INTRODUCTION TO SPACE TECHNOLOGY | 0 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18AE0XI | ADVANCED COMPOSITE IN AEROSPACE ENGINEERING APPLICATIONS | 0 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18AE0XJ | WIND AND OCEAN ENERGY | 0 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| **ADDITIONAL ONE CREDIT COURSES** | | | | | | | | | | |
| 18GE0XA | ETYMOLOGY | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18GE0XB | GENERAL PSYCHOLOGY | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18GE0XC | NEURO BEHAVIORAL SCIENCE | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18GE0XD | VISUAL MEDIA AND FILM MAKING | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18GE0XE | YOGA FOR HUMAN EXCELLENCE | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |

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|---|---|---|---|---|---|---|---|---|---|---|
| 18GE0XF | VEDIC MATHEMATICS | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18GE0XG | HEALTH AND FITNESS | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18GE0XH | CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18GE0XI | BLOG WRITING | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18GE0XJ | INTERPERSONAL SKILLS | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18GE0XK | COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18GE0XL | NATIONAL CADET CORPS | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18GE0XM | NEW AGE INNOVATION AND ENTREPRENEURSHIP | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18GE0XN | DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |
| 18GE0XO | SOCIAL PSYCHOLOGY | 1 | 0 | 0 | 1 | | 100 | 0 | 100 | EEC |

**MINOR DEGREE:**

| **VERTICAL I: AERODYNAMICS** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 21AEM01 | WIND TUNNEL TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 | PE |
| 21AEM02 | INDUSTRIAL AERODYNAMICS | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 | PE |
| 21AEM03 | HELICOPTER AERODYNAMICS | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 | PE |
| 21AEM04 | WIND POWER ENGINEERING | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 | PE |
| 21AEM05 | WIND TUNNEL INSTRUMENTATION AND MEASUREMENTS | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 | PE |
| 21AEM06 | HIGH-SPEED AERODYNAMICS | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 | PE |

**HONOURS DEGREE:**

| **VERTICAL I: AERODYNAMICS** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 21AEH01 | WIND TUNNEL TECHNIQUES | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 | PE |
| 21AEH02 | INDUSTRIAL AERODYNAMICS | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 | PE |
| 21AEH03 | HELICOPTER AERODYNAMICS | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 | PE |
| 21AEH04 | WIND POWER ENGINEERING | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 | PE |
| 21AEH05 | WIND TUNNEL INSTRUMENTATION AND MEASUREMENTS | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 | PE |
| 21AEH06 | HIGH-SPEED AERODYNAMICS | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 | PE |

# SUMMARY OF CREDIT DISTRIBUTION

| No | CATEGORY | CREDITS PER SEMESTER | | | | | | | | TOTAL CREDIT | CREDITS in % | Range of Total Credits | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI | VII | VIII | | | Min | Max |
| 1 | BS | 10 | 10 | 4 | | | | | | 24 | 14.72 | 15% | 20% |
| 2 | ES | 5 | 8 | 20 | | | | | | 33 | 20.25 | 15% | 20% |
| 3 | HSS | 2 | 2 | | | | 2 | 2 | | 6 | 3.68 | 5% | 10% |
| 4 | PC | | | | 23 | 18 | 11 | 9 | | 61 | 37.42 | 30% | 40% |
| 5 | PE | | | | | 6 | 9 | 12 | | 27 | 16.5 | 10% | 15% |
| 6 | EEC | | | | | | | 3 | 9 | 12 | 7.36 | 7% | 10% |
| Total | | 17 | 20 | 24 | 23 | 24 | 22 | 24 | 9 | 163 | 100 | - | - |

BS - Basic Sciences
ES - Engineering Sciences
HSS - Humanities and Social Sciences
PC - Professional Core
PE - Professional Elective
EEC - Employability Enhancement Course
CA - Continuous Assessment
ES - End Semester Examination

## 18AE101 ENGINEERING MATHEMATICS I 3 1 0 4

**Course Objectives**

- Understand the concepts of vectors and Eigenvectors for different matrices to describe the stability of the linear systems in engineering fields.
- Exemplify the concepts of differentiation and integration to identify the area of 2D and 3D surfaces in engineering problems.
- Explain the concepts of analytic functions in complex domain to predict the nature of different engineering systems.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Represent the different forms of coordinate system in complex plane and characteristics of linear systems by Eigenvalues and Eigenvectors.
2. Analyse various types of functions and their differentiation techniques involved in engineering fields.
3. Implement different methods of integration used in engineering problems.
4. Execute the suitable integration technique to calculate the area and volume of different surfaces.
5. Apply the concept of analytic function to estimate the integral in complex plane.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 3 | | | | | | | | | | | | | |
| 2 | 3 | 1 | | | | | | | | | | | | | |
| 3 | 1 | - | | | | | | | | | | | | | |
| 4 | 2 | - | | | | | | | | | | | | | |
| 5 | - | 3 | | | | | | | | | | | | | |

**UNIT I** **9 Hours**

**COMPLEX NUMBERS, VECTORS AND MATRICES**

Complex plane, polar coordinates and polar form of complex numbers, powers and roots, fundamental theorem of algebra. Vector algebra in 2-D and 3-D space, dot product and cross product. Matrices : Eigen values and Eigen vectors, Properties of eigen values and eigen vectors.

**UNIT II** **9 Hours**

**CALCULUS**

Limits and Continuity of Functions: Limits of functions, types of limits, evaluation of limits, continuity of functions, properties of continuous functions. Derivatives: Derivatives, differentiability, rules and properties, differentiation of transcendental functions, higher order derivatives, implicit

differentiation, and differentiation of hyperbolic functions. Integration: Anti-derivatives, Riemann Sum, indefinite and definite integration, Mean Value Theorem for definite integral, Fundamental Theorem of Calculus.

**UNIT III** **9 Hours**

**INTEGRATION METHODS**

Basic integration formulae for algebraic and transcendental functions. Integration by special devices: integration by parts, rationalizing substitution or trigonometric substitution, partial fractions, reduction formulas, improper integrals, convergence tests.

**UNIT IV** **9 Hours**

**APPLICATIONS OF DERIVATIVES AND INTEGRATIONS**

Extreme values, points of inflection and curve sketching, Rolles Theorem, Mean Value Theorem, optimization, indeterminate forms, L Hopitals Rule.
Area between curves, volume of a general solid by slicing and cylindrical shell methods, volume of a solid of revolution, length of plane curves, area of a surface of revolution.

**UNIT V** **9 Hours**

**COMPLEX ANALYSIS**

Analytic Functions- Properties of Analytic function - Determination of Analytic Function using Milne Thompson method. Cauchys Integral Formula - Classification of Singularities - Cauchys Residue Theorem.

**Total: 60 Hours**

**Reference(s)**

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley, 2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.
3. Kreysgiz E, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons, 1999.
4. Anton H, Calculus with Analytic Geometry, 5th edition, John Wiley & Sons, 1995.
5. Ayres F Jr and Mendelson E, Schaum s Outline of Theory and Problems of Calculus, 4th edition, McGraw Hill, 1999.
6. S.C. Gupta, Fundamentals of Statistics, 7th Edition, Himalaya Publishing House Pvt. Ltd. 2018.

## 18AE102 ENGINEERING PHYSICS I 2 0 2 3

**Course Objectives**

- Familiarise basic concepts and force systems in a real world environment.
- Provide knowledge on statics of particles in space with moment.
- Impart knowledge on equilibrium of rigid bodies.
- Study the moment of surfaces and solids.
- Learn the concepts of static friction.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

**Course Outcomes (COs)**

1. Draw a free body diagram for given real world systems to compose and resolve forces involved.
2. Compute the moment created by the applied forces with reference to any centre/axis in 2D & 3D space.
3. Estimate the appropriate support system for the given force system by considering the force generated by various reactions.
4. Identify the location of the centroid, centre of gravity for a geometrical body and calculate the moment of inertia for 2D sections.
5. Compute the effect and resultant forces generated by the frictional forces involved in given systems.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | | | | | | | 2 | | | | | | |
| 2 | 2 | 3 | | | | | | | 2 | | | | | | |
| 3 | 3 | 2 | | | | | | | 2 | | | | | | |
| 4 | 1 | 3 | | | | | | | 2 | | | | | | |
| 5 | 2 | 3 | | | | | | | 2 | | | | | | |

**UNIT I** **5 Hours**

**BASIC CONCEPTS AND FORCE SYSTEM**

Introduction to mechanics - idealization of mechanics - laws of mechanics - principle of transmissibility. Vector - addition, subtraction and product. Force- types - system of forces - resultant forces - composition of forces - resolution of force - free body diagram for real world systems

**UNIT II** **6 Hours**

**STATICS OF PARTICLES AND FORCE SYSTEM**

Equilibrium of particles. Moment of force, moment of couple - equilibrant moment about point and specific axis - simplification of force and couple systems

**UNIT III** **7 Hours**

**STATICS OF RIGID BODIES**

Equilibrium of rigid bodies in two and three dimensions. Trusses - method of joints and method of sections. Beams - types of loads, supports and their reactions. Two and three force members - static determinacy.

**UNIT IV** **6 Hours**

**PROPERTIES OF SURFACES AND SOLIDS**

Centroid - determination of area, volume and mass - Pappus and Guldinus theorems - moment of inertia of plane and area - radius of gyration, parallel axis and perpendicular axis theorems. Product of inertia, mass moment of inertia.

**UNIT V** **6 Hours**

**FRICTION**

Introduction - mechanism and microscopic origin of friction - types - laws of friction - friction on horizontal and inclined planes, ladder and wedge friction - rolling resistance.

**1** **3 Hours**

**EXPERIMENT 1**

Experimental verification of parallelogram law.

**2** **3 Hours**

**EXPERIMENT 2**

Experimental verification of Lamis theorem.

**3** **3 Hours**

**EXPERIMENT 3**

Experimental demonstration of principles of moments using bell crank lever apparatus.

**4** **3 Hours**

**EXPERIMENT 4**

Experimental study of equilibrium of forces in three concurrent co-planer systems.

**5** **3 Hours**

**EXPERIMENT 5**

Experimental analysis of the reaction forces of a simply supported beam and compare with analytical results.

**6** **3 Hours**

**EXPERIMENT 6**

Determination of centroid of laminas.

**7** **3 Hours**

**EXPERIMENT 7**

Determination of moment of inertia of plane area.

**8** **3 Hours**

**EXPERIMENT 8**

Determination of mass moment of inertia of a disc - torsion pendulum apparatus.

**9** **3 Hours**

**EXPERIMENT 9**

Determination of coefficient of friction between two surfaces.

**10** **3 Hours**

**EXPERIMENT 10**

Demonstration of tipping and sliding

**Total: 60 Hours**

**Reference(s)**

1. F.P. Beer, and Jr. E.R Johnston, Vector Mechanics for Engineers - Statics and Dynamics, Tata McGraw-Hill Publishing Company, New Delhi, 2007

2. N.H.Dubey, Engineering Mechanics- Statics and Dynamics, Tata McGraw-Hill Publishing Company, New Delhi, 2013
3. Irving H. Shames, Engineering Mechanics - Statics and Dynamics, Pearson Education Asia Pvt. Ltd., 2006
4. R.C.Hibbeller, Engineering Mechanics: Combined Statics & Dynamics, Prentice Hall, 2009
5. D. P. Sharma, Engineering Mechanics, Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2010.
6. S. Rajasekaran and G. Sankara subramanian, Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt. Ltd., New Delhi, 2005

## 18AE103 ENGINEERING CHEMISTRY I 2 0 2 3

**Course Objectives**

- Recall the terminologies of electrochemistry and explain the function of electrode with its electrochemical reactions
- Infer the fundamentals of corrosion, types and its prevention
- Analyze the three types of fuels based on calorific value for selected applications
- Interpret the properties and applications of lubricants and adhesives

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Identify the electrodes, electrolyte and cell reactions to measure the single electrode potential and pH by using calomel electrode and glass electrode
2. Analyze the type of corrosion, factors influencing rate of corrosion on metals and identify suitable corrosion control method
3. Distinguish the three types of fuels based on calorific value for selected applications
4. Identify the properties and application of lubricants used in aircraft
5. Analyze the type of adhesive, properties and application of adhesive in aircraft

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | | | | | | | | | | | | | |
| 2 | 3 | 2 | | | | | | | | | | | | | |
| 3 | 3 | 2 | | | | | | | | | | | | | |
| 4 | 2 | | | | | | | | | | | | | | |
| 5 | 3 | | | | | | | | | | | | | | |

**UNIT I** **6 Hours**

**ELECTROCHEMISTRY**

Introduction - Electrode potential : Standard electrode potential - Electrochemical series and its importance -Types of electrodes - Calomel electrode - Determination of single electrode potential - Glass electrode (Measurement of pH using glass electrode)- Li Battery: Advanced Materials (anode and cathode) for Li Batteries.

**UNIT II** **7 Hours**

**CORROSION SCIENCE**

Corrosion - Chemical: Types of oxide layer - Pilling-Bedworth rule - Electrochemical corrosion: Mechanism (oxygen absorption and hydrogen evolution) - Types of electrochemical corrosion: Galvanic corrosion - Differential aeration corrosion (pitting). Corrosion control: Sacrificial anode - Impressed current method. Protective coatings - Electroplating and Electroless plating

**UNIT III** **5 Hours**

**HYDROCARBON FUELS**

Classification of fuels - Manufacturing of synthetic petrol - Calorific value - Measurement of calorific value - Octane number - Calculation of air qualities. Biofuel: Composition and Applications. Aviation Fuels

**UNIT IV** **5 Hours**

**LUBRICANTS**

Lubricant: Classification : Solid and semisolid lubricants - Liquid lubricants - Lubricant Additives - Functions - Properties - Greases (calcium based, sodium based and lithium based). Grading of lubricants

**UNIT V** **7 Hours**

**ADHESIVES**

Introduction - Physical and chemical factors influencing adhesive action - Adhesive Selection - Types of adhesion: Hot-melt adhesives, contact adhesives, solvent type adhesives, dispersed adhesives and pressure-sensitive adhesives - Resin based adhesive (Epoxy and phenolic) - Application in aircraft

**FOR FURTHER READING**

Gaseous Fuels : Types - Properties - Applications

**1** **2 Hours**

**EXPERIMENT 1**

Preparation of N/10 oxalic acid and M/10 sodium carbonate solution

**2** **4 Hours**

**EXPERIMENT 2**

Determination of strength of hydrochloric acid in a given solution using glass electrode

**3** **4 Hours**

**EXPERIMENT 3**

Measurement of rate of corrosion on zinc/mild steel in aerated/neutral/alkaline solution by weight loss method

**4** **4 Hours**

**EXPERIMENT 4**

Estimate the amount of ferrous iron present in the given sample solution using potentiometer.

**5** **2 Hours**

**EXPERIMENT 5**
Determination of flash point, fire point for petrol and diesel

**6** **4 Hours**

**EXPERIMENT 6**
Preparation of biofuel from castor oil

**7** **2 Hours**

**EXPERIMENT 7**
Determination of viscosity in given lubricant by using redwood viscometer

**8** **4 Hours**

**EXPERIMENT 8**
Preparation of epoxy resin using epichlorohydrin and bisphenol-A

**9** **2 Hours**

**EXPERIMENT 9**
Corrosion protection: Quantitative estimation of electroplated Cu on iron metal.

**10** **2 Hours**

**EXPERIMENT 10**
Construction of an electrochemical cell (Battery)

**Total: 60 Hours**

**Reference(s)**

1. P. C. Jain and Monica Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publisher, New Delhi, 2013.
2. O. G. Palanna, Engineering Chemistry, 15th Edition, McGraw Hill publication, 2017.
3. B.R. Puri, L. R. Sharma, M.S. Pathania, "Principles of Physical Chemistry", 41st Edition, Vishal Publishing Co., (2004)
4. R. Mukhopadhy and S. Datta, Engineering Chemistry, New Age International Pvt. Ltd, New Delhi, 2010.
5. McCafferty, E., Introduction to Corrosion Science, Springer, New York, 2010
6. https://www.sciencedirect.com/science/article/pii/S2589299118300533?via%3Dihub

## 18AE104 AIRCRAFT PRODUCTION TECHNOLOGY 2 0 2 3

**Course Objectives**

- To impart knowledge about manufacturing processes used for aircraft production.
- To provide knowledge on quality control of manufactured aircraft parts.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**Course Outcomes (COs)**

1. Apply the basic principle of various manufacturing methods.
2. Apply the principles and appropriateness of conventional machining processes
3. Apply the suitable metal joining process for the given materials and its applications
4. Apply the basic principle for various forming process
5. Apply the principles and appropriateness of non-conventional machining process

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | - | 1 | 1 | | | | | | | | | | |
| 2 | 3 | 2 | 2 | 1 | 3 | 2 | | | | | | | | | |
| 3 | 1 | 3 | 2 | 3 | | | | | | | | | | | |
| 4 | 2 | 3 | 1 | | 2 | | | | | | | | | | |
| 5 | 2 | 2 | - | 3 | 1 | 2 | | | | | | | | | |

**UNIT I** **6 Hours**

**INTRODUCTION**

Introduction to manufacturing - Classification of manufacturing processes - Selection of manufacturing
processes Mechanical Properties of Materials (Ductility, brittleness, hardness, toughness, malleability, etc.

**UNIT II** **5 Hours**

**CONVENTIONAL MACHINING**

Introduction to metal cutting - Cutting tools (materials, properties) - Center lathe - Radial drilling machine
- Universal milling machine - Shaping machine.

**UNIT III** **7 Hours**

**METAL JOINING TECHNIQUES**

Introduction to welding process - Resistance welding - Spot/butt, seam, stud welding - Submerged arc -Tungsten Inert Gas (TIG) welding - Metal Inert Gas (MIG) welding - Plasma arc welding - Riveting- Brazing.

**UNIT IV** **7 Hours**

**FORMING PROCESS**

Introduction to cold and hot working - Principles and types of forging, rolling, extrusion- Tube drawing - Sheet metal operations - Metal spinning - Magnetic pulse forming.

**UNIT V** **5 Hours**

**UNCONVENTIONAL MACHINING**

Abrasive jet machining - Electric Discharge Machining (EDM) - Electro-Chemical machining - Ultrasonic machining - Laser beam/electron beam/plasma arc machining - Additive manufacturing.

**1** **3 Hours**

**EXPERIMENT 1**

Developing a various types of Rivet joint.

**2** **3 Hours**

**EXPERIMENT 2**

Developing various types weld joint using Plasma Arc Welding.

**3** **3 Hours**

**EXPERIMENT 3**

Developing various types weld joint using MIG.

**4** **3 Hours**

**EXPERIMENT 4**

Make a simple component using 3D printing.

**5** **3 Hours**

**EXPERIMENT 5**

Lathe Operation- Tapper turning and step turning and threading.

**6** **3 Hours**

**EXPERIMENT 6**

Milling Operation- Gear component.

**7** **3 Hours**

**EXPERIMENT 7**

Drilling Operation Hole, boring and tapping.

**8** **3 Hours**

**EXPERIMENT 8**

Shaper operations-Key hole

**9** **3 Hours**

**EXPERIMENT 9**

Machining process using non conventional machining- EDM

**10** **3 Hours**

**EXPERIMENT 10**

Sheet metal operations.

**Total: 60 Hours**

**Reference(s)**

1. Hajra Choudhury,Elements of Workshop Technology, Vol. I and II, Media Promoters and Publishers Pvt., Ltd., Mumbai, 2005.

2. Nagendra Parashar B.S. and Mittal R.K.,Elements of Manufacturing Processes, Prentice-Hall of India Private Limited, 2007
3. S.C. Keshu, K.K. Ganapathy, "Aircraft Production Techniques", Interline Publishing House,Bangalore, 1993.
4. SeropeKalpakajian, "Manufacturing Engineering and Technology", Addison Wesley Publication Company, 3rd Edition, USA, 1995.
5. R.K. Jain, "Production Technology", Khanna Publishers, New Delhi, 15th Edition, 1995.
6. O.P. Khanna, "Production Technology", Dhanpat Rai Publications, New Delhi, Reprint Edition, 2005.

**18HS101 COMMUNICATIVE ENGLISH I 1 0 2 2**

**Course Objectives**

- Read and understand the main points on familiar matters regularly encountered in work, school, or leisure
- Listen and respond in most common situations where English is spoken
- Write simple connected texts on topics which are familiar or of personal interest
- Describe experiences and events, hopes and ambitions and briefly give reasons and explanations for opinions and plans

**Programme Outcomes (POs)**

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

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

**Course Outcomes (COs)**

1. Use appropriate grammar and vocabulary that is expected at the BEC Preliminary exam level
2. Understand the general meaning of non-routine letters within own work area, and short reports of a predictable nature
3. Write formal, routine letters of factual nature, and make notes on routine matters, such as taking/placing orders
4. Follow simple presentations/demonstrations
5. Deal with predictable requests from a visitor, state routine requirements, and offer advice within own job area on simple matters

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 5 | | | | | | | | | | 2 | | | | | |

**UNIT I** **9 Hours**

**GRAMMAR**

Tenses Future continuous, Past continuous, Past perfect, Past simple, Past tense responses, Present perfect continuous, Present perfect/past simple Reported speech Adverbs intensifiers Comparatives and superlatives Conditionals 2nd and 3rd Connecting words expressing cause and effect, contrast Phrasal verbs Prepositions of place Simple passive - Wh-questions in the past Question tags Will and going to, for prediction.

**UNIT II** **9 Hours**

**READING**

Understanding short real-world notices, messages Detailed comprehension of factual material; skimming and scanning skills - Interpreting visual information Reading for detailed factual information Reading for gist and specific information - Grammatical accuracy and understanding of text structure - Reading and information transfer.

**UNIT III** **9 Hours**

**WRITING**

Internal communication including note, message, memo or email - arranging / rearranging appointments, asking for permission, giving instructions - Business correspondence including letter, fax, email apologising and offering compensation, making or altering reservations, dealing with requests, giving information about a product.

**UNIT IV** **9 Hours**

**LISTENING**

Listening for specific information Listening for numbers and letters Note completion Listening for gist listening to monologues (presentations, lectures, announcements and briefings) listening to interacting speakers (telephone conversations, face-to-face conversations, interviews and discussions).

**UNIT V** **9 Hours**

**SPEAKING**

Exchanging personal and factual information expressing and finding out about attitudes and opinions organise a larger unit of discourse Turn-taking, negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing and/or disagreeing, suggesting, speculating, comparing and contrasting, and decision-making. 1.Goodbye party for Miss Pushpa T S - Nissim Ezekiel 2.Our Casuarina Tree - Toru Dutt 3.Palanquin Bearers - Sarojini Naidu 4.The Tyger - William Blake 5.Ode on a Grecian Urn - John Keats

**Total: 45 Hours**

**Reference(s)**

1. Alexander Garrett, Cambridge BEC Preliminary Students Book with Answers, Cambridge University Press, 2016.
2. Lan Wood, Anne Williams and Anna Cowper. Pass Cambridge BEC Preliminary, Second Edition, New Delhi, 2014.
3. Norman Whitby. Cambridge Business Benchmark. Pre-Intermediate to Intermediate, Students Book. South Asian Edition, 2018.

## 18AE106 COMPUTER PROGRAMMING I 0 0 4 2

**Course Objectives**

- Understand the basics of C primitives, operators and expressions.
- Gain knowledge about the different primitive and user defined data types.
- Impart knowledge about the structural programming concepts.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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

**Course Outcomes (COs)**

1. Implement C programs using operators, type conversion and input-output functions.
2. Apply decision making and looping statements in writing C programs.
3. Develop C programs using the concepts of Arrays and Strings.
4. Design applications using structures in C.
5. Apply the concepts of functions in writing C programs.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 2 | 3 | - | | 3 | | | | | | | | | | |
| 3 | 2 | 3 | - | | 3 | | | | | | | | | | |
| 4 | 1 | 3 | - | | 3 | | | | | | | | | | |
| 5 | 1 | 3 | - | | 3 | | | | | | | | | | |

**1** **3 Hours**

**EXPERIMENT 1**

Implement a C program which include a Fundamental Data types-Integer, Float, double and Character.

**2** **3 Hours**

**EXPERIMENT 2**

Implement a C program to perform the Arithmetic Operations using primitive data types.

**3** **6 Hours**

**EXPERIMENT 3**

Implementation of logical, relational, bitwise, increment/decrement and conditional Operators in C.

**4** **3 Hours**

**EXPERIMENT 4**

Implementation of Simple if else Conditional Statement.

**5** **3 Hours**

**EXPERIMENT 5**

Implementation of nested if else Conditional Statement.

**6** **3 Hours**

**EXPERIMENT 6**

Implementation of Switch Case Statement.

**7** **3 Hours**

**EXPERIMENT 7**
Implement a C program using for Looping Statement.

**8** **3 Hours**

**EXPERIMENT 8**
Implement a C program using Do-While Looping Statement.

**9** **3 Hours**

**EXPERIMENT 9**
Implement a C program using While Looping Statement.

**10** **3 Hours**

**EXPERIMENT 10**
Implementation of Jumping Statements.

**11** **3 Hours**

**EXPERIMENT 11**
Implementation of One Dimensional Array.

**12** **6 Hours**

**EXPERIMENT 12**
Implementation of Two Dimensional Array.

**13** **6 Hours**

**EXPERIMENT 13**
Implement a C program to perform String Manipulation Functions.

**14** **6 Hours**

**EXPERIMENT 14**
Implement a C program using structures.

**15** **6 Hours**

**EXPERIMENT 15**
Implement a C program which includes four categories of functions and recursive functions.

**Total: 60 Hours**

**Reference(s)**

1. Herbert Schildt, C -The complete Reference, Tata McGraw-Hill, 2017
2. Byron Gottfried , Programming with C, Schaum's Outlines, Tata Mcgraw-Hill, 2013
3. E.Balagurusamy, Programming in ANSI C, Tata McGraw-Hill, 2012
4. Kernighan B W and Ritchie O M, The C programming Language. Prentice-Hall of India, 2009
5. Kelley A and I. Pohl, A Book on C : Programming in C, Pearson Education, 1998
6. Ashok.N.Kamthane,Programming in C,Pearson education,2013

**18AE201 ENGINEERING MATHEMATICS II** **3 1 0 4**

**Course Objectives**

- Understand the concepts of partial derivatives and multiple integrals to define the area, volume and extreme values of various surfaces in engineering fields.
- Classify the sequences and series in linear systems is convergent or divergent.
- Formulate the real time engineering problem into mathematical model using ordinary differential equation and solve it by appropriate method.

**Programme Outcomes (POs)**

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

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

**Course Outcomes (COs)**

1. Illustrate the various parameters in partial differentiation and characterize the maxima and minima functions for signals and systems.
2. Apply multiple integral concepts to calculate the area and volume by appropriate vector integral theorems.
3. Analyse the convergence and divergence of sequences and series by various tests.
4. Construct first order differential equations from real time phenomena and solve it by suitable method.
5. Execute the appropriate method to solve the second order differential equations.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 5 | - | 3 | | | | | | | | | | | | | |

**UNIT I** **9 Hours**

**PARTIAL DIFFERENTIATION**

Functions of several variables, plotting of 2-variable functions, introduction to cylindrical and spherical coordinates, chain rule, total differential, gradient, directional derivatives, normal lines and tangent planes, extreme of functions of two variables, applications.

**UNIT II** **9 Hours**

**MULTIPLE INTEGRALS**

Double integrals, regions of integrations, triple integrals, applications (Cartesian coordinates only- Greens theorem and Gauss Divergence theorem).

**UNIT III** **9 Hours**

**SEQUENCES AND SERIES**

Sequences and series, convergence and divergence of series, absolute convergence, conditional convergence, test for convergence and divergence. Power series for functions, interval of convergence, Taylor and Maclaurin series, Taylors Theorem with remainder.

**UNIT IV** **9 Hours**

**FIRST ORDER DIFFERENTIAL EQUATIONS**

Separable differential equations, homogeneous differential equations, exact differential equations, integrating factor, Bernoullis equation, applications.

**UNIT V** **9 Hours**

**SECOND ORDER DIFFERENTIAL EQUATIONS**

Second order homogeneous and non-homogeneous equations with constant coefficients, variation of parameters, method of undetermined coefficients, series solutions of differential equations, applications.

**FOR FURTHER READING**

Applications of mass spring system in ordinary differential equations of higher order

**Total: 60 Hours**

**Reference(s)**

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley, 2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.Kreysgiz E, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons, 1999.
3. Ray Wylie and C Louis Barrett, Advanced Engineering Mathematics, Sixth Edition, Tata McGraw-Hill Publishing Company Ltd, 2003.
4. Peter V. O Neil , Advanced Engineering Mathematics, Seventh Edition , Cengage Learning India Private Limited, 2012.
5. Glyn James, Advanced Engineering Mathematics, Third Edition,Wiley India, 2014.

## 18AE202 ENGINEERING PHYSICS II 2 1 0 3

**Course Objectives**

- Impart knowledge in kinematics of particles
- Familiarize the basic concepts of force, mass and acceleration
- Determine the nature of force associated with work and energy
- Summarize the motion of rigid bodies
- Solve the realistic problems related to rigid body kinetics

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Determine the solution for the problems related to kinematics of particles.
2. Evaluate the relation existing among force, mass and acceleration of particles.
3. Calculate forces associated with work, energy, impulse and momentum.
4. Analyze the geometric motion of rigid bodies.
5. Apply the concepts of rigid body kinetics to solve engineering problems.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 2 | 3 | | | | | | | | | | | | | |
| 3 | 2 | 2 | | | | | | | | | | | | | |
| 4 | 3 | 2 | | | | | | | | | | | | | |
| 5 | 3 | 2 | | | | | | | | | | | | | |

**UNIT I** **6 Hours**

**KINEMATICS OF PARTICLES**

Introduction to dynamics - rectilinear motion displacement, velocity and acceleration - equations of motion - curvilinear motion angular displacement, velocity and acceleration - types of coordinates system - rectangular, tangential and normal.

**UNIT II** **6 Hours**

**KINETICS OF PARTICLES I: FORCE, MASS AND ACCELERATION**

Introduction to kinetics - Newton second law of motion - equations of motion problems on rectangular coordinates, normal and tangential components - dynamic equilibrium Alembert principle.

**UNIT III** **6 Hours**

**KINETICS OF PARTICLES II: WORK ENERGY AND IMPULSE MOMENTUM**

Principle of work - conservative and non-conservative forces - principle of energy - potential energy, kinetic energy, conservation of energy - principles of impulse and momentum principle of conservation of linear momentum - impact direct, central, non-central, oblique coefficient of restitution.

**UNIT IV** **6 Hours**

**PLANE KINEMATICS OF RIGID BODIES**

Introduction to planar kinematics - types of motion - rectilinear and curvilinear translation motion, rotational motion about a fixed axis, general plane motion - absolute and relative velocity - instantaneous centre of rotation and acceleration.

**UNIT V** **6 Hours**

**PLANAR KINETICS OF RIGID BODIES**

Introduction to 2-D kinetics force and acceleration - general equations of motion - principle of work and energy work done by a couple, spring principle of conservation of energy - principle of impulse and momentum linear momentum.

**Total: 45 Hours**

**Reference(s)**

1. Beer, Johnston, Mazurek, Cornwells and Sanghi, Vector Mechanics for Engineers: Statics, Dynamics, 10th Edition, Tata McGraw Hill Noida, Uttar Pradesh, 2013.
2. N.H. Dubey, Engineering Mechanics Statics and Dynamics, First Edition, McGraw-Hill Education India Private Ltd., New Delhi, 2012.
3. R.C. Hibbeler, Engineering Mechanics: Dynamics, 13th Edition, Prentice Hall, 2012.
4. J.L. Meriam and L.G. Kraige, Engineering Mechanics: Dynamics, 7th Edition, Wiley India Private Limited, 2013.
5. Irving H. Shames, Engineering Mechanics Statics and Dynamics, 4th Edition, Pearson India, 2011.

6. www.nptel.iitm.ac.in/video.php?subjectId=122104015.

## 18AE203 ENGINEERING CHEMISTRY II 2 0 2 3

**Course Objectives**

- Indicate the properties and applications of ferrous and non-ferrous alloys used in engineering industries
- Compare polymer and composite material properties and application of engineering area
- Interpret the behavior of nanomaterials through structural property and application

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Compare the properties of engineering metals and ferrous alloys and select a suitable metal and alloy for various engineering applications
2. Analyze the composition, properties of nonferrous alloy and select a suitable non- ferrous metal to alloy for aircraft applications
3. Select the suitable polymers and engineering materials for engineering applications and compare the properties
4. Summarize the various processing of composite materials for aircraft industries
5. Outline the nanotechnology and preparation, properties and application of carbon nanotubes

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
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| 5 | 3 | 2 | | | | | | | | | | | | | |

**UNIT I** **7 Hours**

**FERROUS AND SUPER ALLOYS**

Types of steels - SAE and MIL specifications - Effect of alloying elements on properties of steels - Heat treatment of aircraft steels, super alloys - Nickel, Iron and cobalt based alloys - Composition and applications

**UNIT II** **6 Hours**

**NON - FERROUS ALLOYS**

Aluminium alloys - Heat treatment - Strengthening mechanisms - Precipitation hardening - Dispersion strengthening - Applications of cast and wrought aluminium alloys - Magnesium and titanium alloys - Properties and applications

**UNIT III** **5 Hours**

**INTRODUCTION TO POLYMERS**

Polymers - Classification of polymers based on source and applications. Preparation, properties and applications of thermosetting (PMMA and Nylon 66) and thermoplastics (Polyethylene, polypropylene, polystyrene, polyvinylchloride, polytetrafluoroethylene and acrylonitrile butadiene styrene (ABS)

**UNIT IV** **7 Hours**

**COMPOSITE MATERIALS**

Composite material - Definition, Classification based on matrix and fiber, Polymer matrix composite: Hand layup - Spray layup - Filament winding - Resin transfer moulding - Sheet moulding - Bulk moulding compound. Metal matrix composites: Stir casting - Squeeze casting - Aerospace Application

**UNIT V** **5 Hours**

**NANOTECHNOLOGY**

Nano Materials: Classification - Properties - Applications. Carbon nanotubes: Types (single and multiwall) - Synthesis - Top down and bottom up method (definition only) - Arc method - laser ablation method - Chemical vapour deposition. Properties and Applications of carbon nanotubes

**FOR FURTHER READING**

Bio-polymer: Preparation - Properties - Applications

**1** **4 Hours**

**EXPERIMENT 1**

Estimate the amount of ferrous iron present in the given solution using spectrophotometer

**2** **4 Hours**

**EXPERIMENT 2**

Estimation of copper content in brass by complexometric method

**3** **4 Hours**

**EXPERIMENT 3**

Estimation of magnesium ions in given solution by EDTA method

**4** **4 Hours**

**EXPERIMENT 4**

Determination of molecular weight of polyvinyl chloride using Ostwald viscometer

**5** **6 Hours**

**EXPERIMENT 5**

Preparation of polymer matrix composite by hand layup method

**6** **4 Hours**

**EXPERIMENT 6**

Synthesis of CdS nanomaterials by bottom up method

**7** **4 Hours**

**EXPERIMENT 7**

Fabrication of sandwich composite

**Total: 60 Hours**

**Reference(s)**

1. R. Gowariker, N.V. Viswanathan, J. Sreedhar, Polymer Science,1st Edition, New age International Publishers, New Delhi, 2014.
2. R. Mukhopadhy and S. Datta, Engineering Chemistry, New Age International Pvt. Ltd, New Delhi, 2010.
3. William D Callister Jr., Materials Science and Engineering: An Introduction, John Wiley & Sons Inc., New York, 7th Edition, 2007.
4. V. Raghavan, Materials Science and Engineering, Prentice Hall of India, Delhi, 2009.
5. William Smith and JavedHashemi, Foundations of Materials Science and Engineering, 5th Edition, McGraw Hill, New York, 2009.
6. G. Murray, C. White and W. Weise, Introduction to Engineering Materials, 2nd Edition, Chemical Rubber Company (CRC) Press, Taylor & Francis Group, Florida, 2007.

## 18AE204 BASICS OF ELECTRICAL ENGINEERING 2 0 2 3

**Course Objectives**

- To understand the concepts of power supply units and electrical machines.
- To understand the wiring system used in aircraft.
- To organize the lighting system and earthing techniques.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Explain the ground power uint, battery and its connections of an aircraft.
2. Exemplify the operation of electrical drives used in aircraft.
3. Explain the wiring connection and wiring layout of an aircraft.
4. Interpret the lighting systems used in aircraft.
5. Attribute the different types of earthing and electrical safety.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 4 | 3 | 2 | | | | | | | | | | | | | |
| 5 | 3 | 2 | | | | | | | | | | | | | |

**UNIT I** **5 Hours**

**POWER SUPPLY**

Types of battery, Backup system, Ground power unit, Electrical power connection from ground power unit, Schematic wiring layout of alternator, Battery and accessories.

**UNIT II** **8 Hours**

**ELECTRIC MOTORS AND DRIVES**

Construction and working of permanent magnet synchronous generator, DC servo motor and Brushless DC motor - Selection of motors for drives based on torque speed characteristics, Types of actuators.

**UNIT III** **6 Hours**

**AIRCRAFT WIRING**

Types of wires, cables, Schematic of aircraft wiring interconnection, wiring layout between generator - battery, Wiring layout between battery - lighting system, Wiring protection.

**UNIT IV** **5 Hours**

**LIGHTING SYSTEM**

Basic units-illuminance, lumence, luminance intensity, Types of lamps - LED, Sodium vapour lamp, Lamps in compartment, Exterior lighting, Emergency lighting

**UNIT V** **6 Hours**

**SAFETY AND PROTECTION**

Lightning, Earthing: Necessity- Types of Earthing, Ground eletrifician-ypes of fuses, MCB, ELCB, Types of switches, Plugs and Sockets.

**1** **6 Hours**

**EXPERIMENT 1**

Develop a wiring diagram for connecting battery with alternator with charging circuit.

**2** **6 Hours**

**EXPERIMENT 2**

Develop a prototype driving mechanism for Actuator control using servo motor.

**3** **6 Hours**

**EXPERIMENT 3**

Develop a wiring diagram between battery and lamps with necessary protection circuits.

**4** **6 Hours**

**EXPERIMENT 4**

Develop a speed control methods for prototype 12V DC motor.

**5** **6 Hours**

**EXPERIMENT 5**

Fuse replacement and earthing methods.

**Total: 60 Hours**

**Reference(s)**

1. EH J Pallet, Aircraft Electrical Systems, Third Edition, Pearson Education Publication, 2007.
2. Mike Tooley and David Wyatt, Aircraft Electrical and Electronics Systems, First Edition, Elsevier Publications Ltd, 2007.
3. T. K. Nagsarkar and M. S. Sukhija, Basic of Electrical Engineering, Oxford University Press, 2011.

4. Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, Prentice Hall (India) Pvt. Ltd., 2010.
5. A. Sudhakar, Shyammohan S Palli, Circuits and Networks Analysis and Synthesis, Tata McGraw Hill, 2010.
6. R. S. Sedha, A Textbook of Applied Electronics, S.Chand& Company Ltd, 2013.

## 18AE206 ENGINEERING DRAWING 1 0 4 3

**Course Objectives**

- To provide knowledge on fundamentals of engineering drawings and conic sections.
- To impart skill on orthographic projections of points and lines.
- To familiarize on projection of planes and simple solids.
- To provide knowledge on section of solids and development of surfaces of simple solids.
- To impart skill on conversion of isometric view to orthographic projection and vice versa.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**Course Outcomes (COs)**

1. Apply the engineering drawing concepts as per industrial standards
2. Apply the methodology to Construct orthographic projections of points and lines
3. Apply the methodology to construct to draw the projection of planes and simple solids
4. Apply the methodology to Construct the section of solids and development of surfaces
5. Apply the methodology to Construct the orthographic projection from isometric view and vice versa.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | | | | | | | | - | 1 | | | | | |
| 2 | 2 | | | | | | | | - | 1 | | | | | |
| 3 | 2 | | | | | | | | - | 1 | | | | | |
| 4 | 2 | | | | | | | | - | 1 | | | | | |
| 5 | 3 | | | | | | | | - | 1 | | | | | |

**UNIT I** **15 Hours**

**FUNDAMENTALS OF ENGINEERING DRAWINGS**

Definition, standards, drawing tools, drawing sheets, scales, line and its types. Practices on lettering, numbering, dimensioning of drawings. Construction of conic sections-ellipse, parabola and hyperbola using eccentricity method. Involutes, Cycloids-Epicycloids, Hypocycloids.

**UNIT II** **15 Hours**

**PROJECTION OF POINTS**

Principles of projection, projection of points in four quadrants, first angle projection of straight lines - perpendicular to one plane, parallel and inclined to both planes.

**UNIT III** **15 Hours**

**PROJECTION OF PLANES AND SOLIDS**

Projection of simple planes and projection of simple solids parallel, perpendicular and inclined to one plane using change of position method.

**UNIT IV** **15 Hours**

**SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES**

Section of Solids - simple position with cutting plane parallel, perpendicular and inclined to one plane. Development of surfaces - simple and truncated solids.

**UNIT V** **15 Hours**

**ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW**

Orthographic projections and isometric view of components used in engineering applications.

**Total: 75 Hours**

**Reference(s)**

1. K Venugpoal, Engineering Drawing and Graphics, Sixth edition, New Age International, 2011.
2. Basant Agrawal, Mechanical drawing, Tata McGraw-Hill Education, 2008.
3. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian Standards-Sp46, 2008.
4. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2008.
5. K.V. Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.

## 18AE207 COMPUTER PROGRAMMING II 0 0 4 2

**Course Objectives**

- Understand the basics of C++ and Java primitives, operators and expressions.
- Gain knowledge about the different primitive and user defined data types.
- Impart knowledge about the structural programming concepts.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Implement C++ and Java programs using operators, type conversion and input-output functions.
2. Apply decision making and looping statements in writing C++ programs.
3. Develop C++ and Java programs using the concepts of Arrays and Strings.

4. Design applications using structures in C++ and Java.
5. Apply the concepts of functions in writing C++ and Java programs.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 3 | | | 3 | | | | | | | | | | |
| 2 | 2 | 3 | | | 3 | | | | | | | | | | |
| 3 | 2 | 3 | | | 3 | | | | | | | | | | |
| 4 | 1 | 3 | | | 3 | | | | | | | | | | |
| 5 | 1 | 3 | | | 3 | | | | | | | | | | |

**1** **4 Hours**

**EXPERIMENT 1**
Working with basic data types and arrays.

**2** **4 Hours**

**EXPERIMENT 2**
Implementation of control statements.

**3** **4 Hours**

**EXPERIMENT 3**
Implementation of looping statements.

**4** **4 Hours**

**EXPERIMENT 4**
Implementation of class and objects.

**5** **4 Hours**

**EXPERIMENT 5**
Working with constructor and destructor.

**6** **4 Hours**

**EXPERIMENT 6**
Implementation of types of Inheritance.

**7** **4 Hours**

**EXPERIMENT 7**
Working with call by value and call by reference.

**8** **4 Hours**

**EXPERIMENT 8**
Implementation of friend function.

**9** **4 Hours**

**EXPERIMENT 9**
Working with basic data types, static variables and arrays.

**10** **4 Hours**

**EXPERIMENT 10**
Program on Classes and objects.

**11** **4 Hours**

**EXPERIMENT 11**
Working with Methods related aircraft industry specific problem.

**12** **4 Hours**

**EXPERIMENT 12**
Implementation of Inheritance related aircraft industry specific problem.

**13** **4 Hours**

**EXPERIMENT 13**
Implementation of overloading and overriding related aircraft industry specific problem

**14** **4 Hours**

**EXPERIMENT 14**
Implementation of Packages related aircraft industry

**15** **4 Hours**

**EXPERIMENT 15**
Implementation of Interfaces related aircraft industry specific problem

**Total: 60 Hours**

**Reference(s)**

1. E Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing, New Delhi, 2011.
2. Robert Lafore, Object Oriented Programming in C++, Galgotia Publication, 2010.
3. Herbert Schildt, Java: The Complete Reference, Eleventh Edition, McGraw-Hill Education,2018.
4. D.T. Editorial Services ,Java 8 Programming Black Book , second edition, Dreamtech Press,2015.

## 18AE301 ENGINEERING MATHEMATICS III 3 1 0 4

**Course Objectives**

- Understand the concepts of Fourier series, Transforms and Boundary Conditions, which will enable them to model and analyze the physical phenomena.
- Understand the methods to solve polynomial equations and Implement the mathematical ideas for interpolation numerically.
- Apply the methodologies involved in solving problems related to ordinary and partial differential equations.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Apply the periodicity of a function and formulate the same as a combination of sine and cosine using Fourier series and formulate a function in frequency domain whenever the function is defined in time domain.
2. Analyse the equations into algebraic, transcendental or simultaneous and apply the techniques to solve them numerically.
3. Apply the numerical differentiation and integration in engineering problems.
4. Analyse the numerical solutions of ordinary differential equations.
5. Apply basic statistical inference techniques, including confidence intervals, hypothesis testing to science/engineering problems.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 5 | 3 | 2 | | | | | | | | | | | | | |

**UNIT I** **9 Hours**

**FOURIER ANALYSIS**

Review of Fourier series for periodic functions. Orthogonal functions. The Euler coefficients. Fourier transforms. Properties of Fourier transform. Applications of Fourier series and transform analysis.

**UNIT II** **9 Hours**

**NUMERICAL SOLUTION OF ALGEBRAIC AND TRANSCENDENTAL EQUATION EIGEN VALUE PROBLEMS**

Single and multi-variable nonlinear equations, convergence of fixed point iterations. Least squares approximation, Normal equations. Polynomial interpolation and cubic spline interpolation. Solution of system of equations: Gauss elimination method, Gauss Jordan method, Gauss Jordan method of inverse of the matrix, power method to find the dominant eigen value of the matrix.

**UNIT III** **9 Hours**

**NUMERICAL DIFFERENTIATION AND INTEGRATION**

Numerical differentiation: Newtons forward and backward interpolation formulae - Numerical integration: Trapezoidal and Simpsons 1/3 rules - Two point Gaussian quadrature formula- Double integrals: Simpsons rules.

**UNIT IV** **9 Hours**

**NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS**

Single step method: Taylors method, Eulers method, Runge-Kutta methods. Multi-step method: Milnes method and Adams method, Finite Difference Methods.

**UNIT V** **9 Hours**

**MATHEMATICAL STATISTICS**

Sample mean and variance. Sampling distributions. Statistical estimation of parameters, confidence intervals. Testing of hypotheses, one-sample and two-sample inferences. Applications to statistical quality control and reliability analysis

**Total: 60 Hours**

**Reference(s)**

1. Kreyszig Erwin, Advanced Engineering Mathematics, 7th Edition, John Wiley, 1993.
2. Johnson Richard A. and Bhaltacharyya Gouri K., Statistics, Principles and Methods, 3rd Edition, John Wiley, 1996.
3. ONeil Peter V., Advanced Engineering Mathematics, 4th Edition, PWS-Kent, 1995.
4. James Glyn, Advanced Modern Engineering Mathematics, Addison-Wesley, 1993.
5. Milton J. S. and Arnold Jesse C., Introduction to Probability and Statistics: Principles and Applications for Engineering and The Computing Sciences, McGraw Hill Inc, 3rd Edition, 1995

## 18AE302 PRINCIPLES OF FLIGHT 3 0 0 3

**Course Objectives**

- To introduce the concepts of flying, International standard atmosphere, structural aspects of airplanes, brief description of systems, instruments and power plants used in airplanes.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**Course Outcomes (COs)**

1. Describe the classification and working principles of different types of flight vehicles and its components.
2. the basic principles of aerodynamics, characteristics of airfoils and NACA numbering system for airfoil.
3. Apply the methods of aircraft construction and characteristics of aircraft materials.
4. Analyze the characteristics of aircraft and rocket propulsion systems with its merits, demerits and applications
5. Analyse the working of Air data, Navigation and engine instruments of an aircraft.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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| 4 | 2 | 2 | | | | | | | | | | | | | |
| 5 | 3 | 2 | | | | | | | | | | | | | |

**UNIT I** **9 Hours**

**AIRCRAFT CONFIGURATIONS**

Classification of flight vehicles, airplanes and Helicopters-working principles - aircraft axis-Components of an airplane and their functions-Primary and Secondary Control Surfaces- control actuation.

**UNIT II** **9 Hours**

**INTRODUCTION TO AERODYNAMICS**

International Standard Atmosphere, Temperature, pressure and altitude relationships- lift, drag and moment-Basic characteristics of airfoils-NACA classification- Mach number-introduction to compressible flows-aircraft maneuvers.

**UNIT III** **9 Hours**

**AIRCRAFT STRUCTURES AND MATERIALS**

General types of construction, Monocoque, semi-monocoque and geodesic construction, typical wing and fuselage structure.Loads on aircraft-classification

**UNIT IV** **9 Hours**

**AIRCRAFT AND ROCKET PROPULSION**

Working principles of piston, turboprop and jet engines, use of propeller and jets for thrust production. Comparative merits, principles of operation of rocket, types of rockets and typical applications, Introduction to space mechanics - Keplers laws of planetary motion-Introduction to satellites.

**UNIT V** **9 Hours**

**AIRCRAFTS INSTRUMENTS AND ADVANCED FLIGHT VEHICLES**

Pitot based instruments-Navigation instruments-communication instruments - Engine Instruments. Introduction to UAVs and MAVs-Types and applications.

**FOR FURTHER READING**

Historical developments in aviation - Staging of rockets, space mission, re-entry vehicles, life support systems for manned space missions, Fuel cells. Indian space programmes-NASA space programmes-aircraft certifying agencies and their function.

**Total: 45 Hours**

**Reference(s)**

1. John D. Anderson "Introduction to Flight", McGraw-Hill Higher Education, 8th edition, 2016.
2. Austin R., "Unmanned Aircraft Systems", AIAA Education Series, 2010.
3. John Cutler & Jeremy Liber, "Understanding Aircraft Structures", 4th edition, Sheridan House Inc, 2006.
4. Stephen.A. Brandt, "Introduction to aeronautics: A design perspective", 2nd edition, AIAA Education Series, 2004.
5. Kermode, A.C. "Mechanics of Fligh", Prentice Hall; 11 edition, 2006.
6. http://nptel.ac.in/courses/101101002/

## 18AE303 SOLID MECHANICS 2 1 2 4

**Course Objectives**

- Apply materials and their elastic constants for composite bar subjected to various loads including thermal load.
- Draw shear force and bending moment diagram for beams with different kinds loads and end conditions
- Find the deflections of beam using different methods
- Impart the knowledge of torsion, spring, twist, spring deflection and spring constants
- Impart the Knowledge of bi-axial loading, stresses in cylinder and Mohr circle

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Apply materials and their elastic constants for composite bar subjected to various loads including thermal load.
2. Analyse shear force and bending moment diagram for beams with different loads and end conditions
3. Analyse deflection of beams using different methods
4. Apply the knowledge of torsion, spring, twist, spring to estimate deflection and spring constants
5. Apply the knowledge of bi-axial loading cylinder burst pressure and Mohr circle to aircraft structural components

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 3 | 2 | 3 | | | | | | | | | | | | | |
| 4 | 2 | 3 | | | | | | | | | | | | | |
| 5 | 3 | 2 | | | | | | | | | | | | | |

**UNIT I** **6 Hours**

**STRESS, STRAIN AND DEFORMATION OF SOLIDS**

Rigid bodies and deformable solids - Tension, Compression and Shear Stresses - Deformation of simple and compound bars - Elastic constants - Volumetric strain - Thermal stress

**UNIT II** **6 Hours**

**TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM**

Types of beams - Shear force and bending moment diagrams - Cantilevers - Simply supported and overhanging beams - bending and shear stress distribution - principal stresses and principal planes - Mohrs circle.

**UNIT III** **6 Hours**

**DEFLECTION OF BEAMS**

Double Integration method - Macaulay method - Area moment method Conjugate beam method for computation of slopes and deflections in beams

**UNIT IV** **6 Hours**

**TORSION**

Torsion - formulation of stresses and twists in circular and hollows shafts - Stresses and deflection of helical springs

**UNIT V** **6 Hours**

**THIN CYLINDERS**

Stresses in thin cylindrical shell due to internal pressure - circumferential and longitudinal stresses - deformation - spherical shells subjected to internal pressure - Deformation in spherical shells

**FURTHER READING**

Properties of ductile and brittle materials - Load carrying capacity of beams and their free body diagrams - Application of torsional effects.

**1** **5 Hours**

**EXPERIMENT 1**

Determination of different hardness of a material

**2** **5 Hours**

**EXPERIMENT 2**

Determination of a tensile strength of steel and aluminium rod using Universal Testing machine

**3** **5 Hours**

**EXPERIMENT 3**

Determination of impact strength of a given material by Izod and Charpy test

**4** **5 Hours**

**EXPERIMENT 4**

Determination of deflection of beam for different loading conditions

**5** **5 Hours**

**EXPERIMENT 5**

Compression test of a helical spring

**6** **5 Hours**

**EXPERIMENT 6**

Test of a thin cylinder subjected to an internal pressure

**Total: 75 Hours**

**Reference(s)**

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2007
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2007
3. Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2002
4. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials",Tata McGraw Hill Publishing co. Ltd., New Delhi, 2005.
5. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013
6. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education series, 2010.

## 18AE304 FLUID MECHANICS 2 1 2 4

**Course Objectives**

- To understand the control volume analysis to develop basic equations and to solve problem.
- To understand the concept of viscosity and where viscosity is important in real flows.
- To learn to use dimensional analysis to design physical or numerical experiments and to apply dynamic similarity.
- To understand the boundary layer concept and boundary layer separation over the airfoil.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**Course Outcomes (COs)**

1. Understand the fluid mechanics fundamentals, including concepts of mass and momentum conservation.
2. Analyse the types of flow and apply the Bernoulli equation to solve problems in fluid flow
3. Analyse the relationship between shear stress and pressure gradient for different conditions
4. Apply the dimension of physical quantities using different methods
5. Apply and analyse the boundary layer concept for aeronautical application

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 1 | 3 | 1 | | | | | | | | | | | | |
| 3 | 1 | 2 | 1 | | | | | | | | | | | | |
| 4 | | 2 | 3 | | | | | | | | | | | | |
| 5 | 1 | 1 | | 2 | | | | | | | | | | | |

**UNIT I** **6 Hours**

**BASIC CONCEPTS IN FLUID MECHANICS**

Continuum - Units and Dimensions - Fluids - Properties of fluids - Newton-s Law of Viscosity - Classification of fluids - Fluid statics: Hydrostatic Law, Absolute Pressure, Gauge Pressure, and Vaccum Pressure - Pressure measurement by Manometers and Pressure Gauges - Numerical Problems

**UNIT II** **6 Hours**

**POTENTIAL FLOW**

Review of Vector calculus - Kinematics of Fluid Elements -Stream line, Streak line, and Path line- Angular Velocity and Vorticity - Rotational and irrotational flows - Laplace equation - Velocity Potential and Stream Function - Equation of streamline - equations of motion - Eulers equation along a streamline - Bernoullis equation - applications - Venturi meter, Orifice meter, Pitot tube - Numerical Problems

**UNIT III** **6 Hours**

**INCOMPRESSIBLE FLOW**

Viscous flow - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes (Hagen poiseulle) - flow through pipes - Darcy -Weisback equation - pipe roughness -friction factor- Moodys diagram-minor losses.

**UNIT IV** **6 Hours**

**DIMENSIONAL ANALYSIS AND VISCOUS FLOW**

Need for dimensional analysis - methods of dimensional analysis - Similitude-types of similitude - Dimensionless parameters- application of dimensionless parameters - Model analysis - model laws.

**UNIT V** **6 Hours**

**BOUNDARY LAYER**

Introduction to boundary layer concepts - boundary layer thickness - Displacement thickness, momentum thickness and energy thickness - boundary layer separation - drag and lift coefficients - method of preventing the separations.

**1** **3 Hours**

## EXPERIMENT 1

Select a simple flow measuring device and find its coefficient of discharge to make it applicable to any closed pipe flow

**2** **3 Hours**

## EXPERIMENT 2

Select an efficient flow measuring device to measure the flow of water in a closed pipe and find its coefficient of discharge.

**3** **3 Hours**

## EXPERIMENT 3

Use of a vertically oriented flow measuring device to measure the discharge of a pipe flow and find its significant parameters.

**4** **3 Hours**

## EXPERIMENT 4

Measure and show the major loss of given pipe with water flowing inside then compare any two pipes.

**5** **3 Hours**

**EXPERIMENT 5**

Use of a Bernoulli's apparatus device to measure the pressure and velocity at given sections.

**6** **3 Hours**

**EXPERIMENT 6**

Use of the wind tunnel to measure the velocity of wind at the test section by manometer.

**7** **3 Hours**

**EXPERIMENT 7**

Select a non-rotary positive displacement pump and find its optimum performance parameters.

**8** **3 Hours**

**EXPERIMENT 8**

Perform experiments on a rotary type positive displacement pump to pumping high viscous fluids and finds its optimum parameters.

**9** **3 Hours**

**EXPERIMENT 9**

Operate an available impulse turbine with various water heads and conclude its best performance parameters.

**10** **3 Hours**

**EXPERIMENT 10**

Operate an axial flow turbine suitable for high discharge applications, with various water heads and conclude its best performance parameters.

**Total: 75 Hours**

**Reference(s)**

1. F. M. White, "Fluid Mechanics", 6th Edition, Tata McGraw-Hill, New Delhi, 2008.
2. E. John Finnemore and Joseph B. Franzini, "Fluid Mechanics with Engineering, Applications", McGraw-Hill International Edition, 2001.
3. V. L. Streeter and E. B. Wylie, "Fluid Mechanics", McGraw-Hill, 2005.
4. R. K. Bansal, "Fluid Mechanics and Hydraulics Machines", 5th Edition, Laxmi Publications (P) Ltd., New Delhi, 2005.
5. S. K. Som and G. Biswas, "Introduction to fluid mechanics and fluid machines", 2nd Edition, Tata McGraw-Hill, 2008.
6. K. L. Kumar, "Engineering Fluid Mechanics", 7th Edition, Eurasia Publishing House (P) Ltd., New Delhi, 2004.

## 18AE305 AERO ENGINEERING THERMODYNAMICS

**3 1 0 4**

**Course Objectives**

- To familiarize the students with the application of various law of thermodynamics
- To study the application in work transfer, refrigeration and airconditioning system.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Apply thermodynamic laws to estimate heat and work transfer in flow and non flow processes
2. Apply second law of thermodynamics, Carnot theorem to estimate the entropy change for various processes
3. Analyse air standard cycles to measure efficiency, mean effective pressure of two stroke, four stroke and gas turbine engines
4. Apply vapour power cycles to calculate work done and heat transfer in non-flow and flow processes
5. Analyse simple vapour compression refrigeration system and simple vapour absorption refrigeration system based on reversed Carnot cycle

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 2 | 3 | | | | | | | | | | | | | |
| 3 | 2 | 3 | | | | | | | | | | | | | |
| 4 | 3 | 2 | | | | | | | | | | | | | |
| 5 | 2 | 3 | | | | | | | | | | | | | |

**UNIT I** **9 Hours**

**FUNDAMENTAL CONCEPT AND FIRST LAW**

Concept of continuum, macroscopic approach, thermodynamic systems - closed, open and isolated. Property, state, path and process, quasi-static process, work, internal energy, enthalpy, specific heat capacities and heat transfer, Zeroth law of thermodynamics, First law of thermodynamics, relation between pressure, volume and temperature for various processes.

**UNIT II** **9 Hours**

**SECOND LAW AND ENTROPY**

Second law of thermodynamics - Kelvin Planck and Clausius statements of second law.Reversibility and irreversibility, thermal reservoir, Carnot theorem. Carnot cycle, Reversed Carnot cycle, efficiency, COP, Thermodynamic temperature scale - Clausius inequality, Concept of entropy, Entropy change for various processes.

**UNIT III** **9 Hours**

**AIR STANDARD CYCLES**

Otto, Diesel, Dual and Brayton cycles - air standard efficiency - mean effective pressure.

**UNIT IV** **9 Hours**

**FUNDAMENTALS OF VAPOUR POWER CYCLES**

Properties of pure substances - solid, liquid and vapour phases, phase rule, p-v, p-T, T-v, T-s, h-s diagrams, p-v-T surfaces, thermodynamic properties of steam - calculations of work done and heat

transfer in non-flow and flow processes - standard Rankine cycle, Reheat and Regeneration cycle. Heat rate, Specific steam consumption, Tonne of refrigeration.

**UNIT V** **9 Hours**

**REFRIGERATION SYSTEM**

Fundamentals of refrigeration, C.O.P., reversed Carnot cycle, simple vapour compression refrigeration system, T-S, P-H diagrams, simple vapour absorption refrigeration system, desirable properties of an ideal refrigerant.

**FOR FURTHER READING**

Isentropic flow of ideal gases through nozzles - Rankine Cycle, Classifications of jet engines Simple jet propulsion system - Thrust of rocket motor - Specific impulse.

**Total: 60 Hours**

**Reference(s)**

1. E.Radhakrishnan, "Fundamentals of Engineering Thermodynamics", Prentice, Hall, India, 2006
2. Yunus A. Cengal., "Thermodynamics an Engineering Approach", Tata McGraw- Hill Co. Ltd., 8th Edition, 2015.
3. P. K. Nag, "Engineering Thermodynamics", Tata McGraw-Hills Co., Ltd., Fifth Edn., 2013.
4. Rajput, "Introduction to Thermodynamics", Lakshmi Publications, Mumbai, 2009.
5. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
6. Holman.J.P., "Thermodynamics", 3rd Edition, McGraw-Hill, 2007.

## 18AE306 BASICS OF ELECTRONICS ENGINEERING

**3 0 0 3**

**Course Objectives**

- To understand the conceptual design of integrated circuits
- To understand the communication modules and processing of an aircraft
- To extrat the influences and functioning of electronics drives in an aircraft

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
m. Utilize the knowledge of aeronautical engineering in innovative, dynamic and challenging environment for design and development of new products.
n. Impart professional skills through simulation, language skills and general purpose CAE packages to solve practical problems of components in design and analysis to meet the airworthiness requirements for flight vehicles.

**Course Outcomes (COs)**

1. Explain the components and the operation of Integrated circuits used in aircraft.
2. Exemplify the operation of digital computer and data storage devices used in aircraft.
3. Explain the functional components of aircraft communication system.
4. Interpret the major electronic drives mounted in an aircraft for digital control process.
5. Analyze the various sensors used for guiding aircraft during onboard.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 3 | 2 | | | | | | | | | | | 2 | 2 | |
| 3 | 3 | 2 | | | | | | | | | | | 2 | 2 | |
| 4 | 3 | 2 | | | | | | | | | | | 2 | 2 | |
| 5 | 3 | 2 | | | | | | | | | | | 2 | 2 | |

**UNIT I** **9 Hours**

**ELECTRONIC CIRCUITS AND COMPONENTS**

Basics on Integrated circuits - History, Types of ICs and components- Integrated Logic Circuits - Pin diargrams - Specific Radio frequency ICs - operation of an Aircraft landing gear warning logic circuit.

**UNIT II** **9 Hours**

**DIGITAL COMPUTER AND MEMORY DEVICES**

Digital Computer - Functions and Hardware components - Data Buses and protocols - Types of memories - working of Aircraft Digital Computer system.

**UNIT III** **9 Hours**

**AIRCRAFT COMMUNICATION DRIVES**

HF, VHF and UHF systems - Radio Frequency Transmitter and Receiver - Antennas - aircraft audio electronics control panel - Microphones- Location of antennas in a commercial aircraft - block diagram of simple aircraft communication system.

**UNIT IV** **9 Hours**

**ELECTRONIC CONVERTERS AND DRIVES**

Analog and Digital Converters - Modulator and Demodulator - Amplifiers - Encoder and Decoder circuts - Multipler and Demultiplexers - Aircraf Flight Recorder.

**UNIT V** **9 Hours**

**AIRCRAFT SENSORS**

Basic terminologies of sensors and Transduces - Radar sensor - Ultrasonic sensor - Light Detection and Ranging Sensor - Infrared Sensor - Acoustic Sensor - Air pressure sensor - Attitude sensors

**FOR FURTHER READING**

Aircraft Cockpit and Engine electronics control panels

**Total: 45 Hours**

**Reference(s)**

1. B.P Singh and Rekha Singh, "Electronic Devices and Integrated Circuits", Third Edition, Dorling Kindersley Publications, 2009.
2. Mike Tooley and David Wyatt, "Aircraft Electrical and Electronics System", First Edition, Elsevier Publications Ltd, 2007.
3. Thomas K Eismin,"Aicraft Electricity and Electronics", Six Edition, McGraw Hill, 2014.
4. Smarjith Ghosh, "Fundamentals of Electrical and Electronics Engineering", Prentice Hall (India) Pvt. Ltd., 2010.
5. Anil K Maini,"Digital Electronics Ã¢?? Principles and Integrated Circuit", First Edition, Wiley India, 2008.

6. Mike Tooley,"Aircraft Digital Electronics and Computer Syste", Second Edition, Routledge Publishers, 2013.

**18AE307 MACHINE DRAWING LABORATORY 0 0 4 2**

**Course Objectives**

- To familiarize the students with Indian Standards on drawing practices and standard components.
- To make the students understand and interpret drawings of machine components so as to prepare assembly drawings either manually and using standard software packages.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to oneÃƒÂ¢??s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**Course Outcomes (COs)**

1. Translate isometric projection to orthographic projection and vice versa.
2. Combine the various views of a machine component.
3. Construct orthographic views of machine components and assemblies.
4. Design machine components and assembly using drawing sheets with international standards for effective communication among engineers through the design.
5. Develop orthographic views of machine components with help of CAD packages.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 2 | | 3 | | | | | | - | 2 | 3 | | | | |
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**1** **3 Hours**

**EXPERIMENT 1**

Conversion of pictorial views.

**2** **3 Hours**

**EXPERIMENT 2**
Sectional views of machine component.

**3** **3 Hours**

**EXPERIMENT 3**
Drawings of standard components.

**4** **3 Hours**

**EXPERIMENT 4**
Drawings of standard assemblies with components.

**5** **3 Hours**

**EXPERIMENT 5**
Drawings of small assemblies with components.

**6** **3 Hours**

**EXPERIMENT 6**
Detailed drawings of assembly.

**7** **3 Hours**

**EXPERIMENT 7**
Drawing of large assembly with components drawings assembly and sub assembly drawings.

**8** **3 Hours**

**EXPERIMENT 8**
Preparation and explanation on production drawings.

**9** **2 Hours**

**EXPERIMENT 9**
Process sheet for a component with maximum five operations.

**10** **2 Hours**

**EXPERIMENT 10**
Sample Blue prints - Reading.

**11** **2 Hours**

**EXPERIMENT 11**
3D modeling using CAD

**Total: 30 Hours**

**Reference(s)**

1. N. D. Bhatt, "Machine Drawing", 49th Edition, Charotar Publishing House, 2014. 2. P.S.G. Design Data Book
2. K.L. Narayana, "Machine Drawing", 4th Edition, New Age International Pvt. Ltd.,2010.
3. Singh S, "Fundamentals of Machine Drawing", 2nd Edition, PHI Learning Private Limited-New Delhi, 2012.

4. John K.C, "Textbook of Machine Drawing", 1st Edition, PHI Learning Private Limited-New Delhi, 2009.

## 18GE301 SOFT SKILLS - VERBAL ABILITY 2 0 0 0

**Course Objectives**

- To help students gain adequate proficiency in vocabulary
- To help students become proficient in basic writing skills related to workplace communication
- To read and understand unabridged text

**Programme Outcomes (POs)**
**Course Outcomes (COs)**

1. Take up verbal ability part of the placement tests with confidence
2. Write with confidence in professional and workplace communication
3. Distinguish fact from opinion by reading passages from a text

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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**UNIT I** **15 Hours**

**INTRODUCTION**

Synonyms - Antonyms - Word Groups - Verbal Analogies - Etymology - Critical Reasoning - Cloze Test - One Word Substitution - Idioms and Phrases - Text & Paragraph Completion.

**UNIT II** **15 Hours**

**BASICS OF VERBAL APTITUDE**

Sentence Formation - Paragraph Formation - Change of Voice - Change of Speech - Reading Comprehension - Sentence Equivalence - Jumbled Sentences - Spotting Errors -Homophones Homonyms - Commonly Mispronounced/Misspelt Words.

**Total: 30 Hours**

**Reference(s)**

1. Murphy, Raymond. English Grammar in Use A Self-Study Reference and Practice Book for Intermediate Learners of English. IV Edition. United Kingdom: Cambridge University Press. 2012.
2. Lewis, Norman. Word Power Made Easy. New York: Pocket Books. 1991.
3. Baron"s The Official Guide for New GMAT Review, New Jersey: John Wiley & Sons, Inc. 2015.

## 18AE401 AIRCRAFT STRUCTURES I 3 1 0 4

**Course Objectives**

- To acquaint students with the fundamentals of structural mechanics and analytical approaches for analysis of aircraft structures
- To learn about linear elasticity and failure theories and apply it to analyze the components subjected to typical aircraft loading conditions

**Programme Outcomes (POs)**

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

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

**Course Outcomes (COs)**

1. Analyse statically determinate structures with different methods.
2. Analyse statically indeterminate structures with different methods.
3. Apply energy methods to determine slope and deflection of different structures.
4. Analyse columns including beam column with various end conditions by Euler's theory and south well plot method.
5. Apply different failure theories to analyse the aircraft structural problems.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 3 | 2 | 3 | | | | | | | | | | | | | |
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| 5 | 3 | 2 | | | | | | | | | | | | | |

**UNIT I** **15 Hours**

**TRUSS AND CONTINUOUS BEAM**

Plane truss analysis- method of joints- method of sections -method of shear-3-D trusses-principle of super position, Clapeyrons 3 moment equation and moment distribution method for indeterminate beams.

**UNIT II** **12 Hours**

**ENERGY METHODS**

Strain Energy in axial, bending, torsion and shear loadings. Castiglianos theorems and their applications. Energy theorems-dummy load & unit load methods- energy methods applied to statically determinate and indeterminate beams, frames, rings & trusses.

**UNIT III** **12 Hours**

**COLUMNS**

Eulers column curve- inelastic buckling-effect of initial curvature-Southwell plot- columns with eccentricity - use of energy methods -theory of beam columns-beam columns with different end conditions-stresses in beam columns.

**UNIT IV** **12 Hours**

**FAILURE THEORIES**

Ductile and brittle materials-maximum principal stress theory - maximum principal strain theory - maximum shear stress theory - distortion energy theory - octahedral shear stress theory.

**UNIT V** **12 Hours**

**INDUCED STRESSES**

Thermal stresses - impact loading- Fatigue- Creep - Stress Relaxation

**FOR FURTHER READING**

Stress resultant for slender members - Bending of symmetrical and unsymmetrical sections - Sectional properties - Stress state in slender members.

**Total: 78 Hours**

**Reference(s)**

1. James M. Gere & Barry J Goodno "Mechanics of Materials"cengage Learning Custom Publishing; 8th edition, 2012.
2. Megson T M G, "Aircraft Structures for Engineering students" Butterworth-Heinemann publisher, 5th edition, 2012.
3. Prof S K Maitin, "Advanced Strength of Materials", NPTEL, Web course, Department of Mechanical Engineering, Indian Institute of Technology, Bombay.
4. N.C. Pandya, C.S. Shah, "Elements of Machine Design", Charotar Publishing House, 15th edition, 2009.
5. Donaldson, B.K., "Analysis of Aircraft Structures - An Introduction" Cambridge University Press publishers, 2 ndedition , 2008
6. N.C. Pandya, C.S. Shah, "Elements of Machine Design", Charotar Publishing House, 15th edition, 2009.

## 18AE402 AERODYNAMICS 3 0 2 4

**Course Objectives**

- To introduce the concepts of mass, momentum and energy conservation relating to aerodynamics.
- To understand the concept of superposition of elementary flows for linear incompressible flow.
- To understand the theoretical concepts underlying the development of lift, drag, and movement forces on aeronautical vehicles.
- To provide basic knowledge about how to analyze and evaluate experimental data.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**Course Outcomes (COs)**

1. Apply the concept of Basic Fluid mechanics into aerodynamics to predict the suitable governing equations.
2. Obtain mathematical model of different types of flows and its combinations. Also find the pressure and velocity distribution for the simple objects.
3. Develop a mathematical model using conformal transformation for the aerofoil.
4. Develop a mathematical model using conformal transformation for the aerofoil.
5. Interpret the boundary layer over the surface and to evaluate the velocity distribution and flow separation.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | | | | | 1 | | | | | | | | |
| 2 | 3 | 1 | | 1 | | | | | | | | | | | |
| 3 | 1 | 3 | | 1 | | | | | | | | | | | |
| 4 | 1 | 3 | | 1 | | | | | | | | | | | |
| 5 | 3 | 1 | | 1 | | | | | | | | | | | |

**UNIT I** **10 Hours**

**REVIEW OF BASIC FLUID MECHANICS**

Euler equation, incompressible bernoullis equation - Continuity, momentum and energy equations in integral and differential form in Cartesian co-ordinate system.

**UNIT II** **8 Hours**

**TWO DIMENSIONAL FLOWS**

streamline, stream function, irrotational flow, potential function, elementary flows- Source, Sink, Free and Forced vortex, uniform parallel flow. Their combinations, Pressure and velocity distributions on bodies with and without circulation - KuttaJoukowskis theorem

**UNIT III** **8 Hours**

**CONFORMAL TRANSFORMATION**

Complex potential, methodology of conformal transformation-Joukowski transformation and its application to fluid flow problems, Kutta condition, Blasius theorem.

**UNIT IV** **9 Hours**

**AIRFOIL AND WING THEORY**

Joukowski, Karman - Trefftz, Profiles - Thin aerofoil theory and its applications. Vortex line, Horse shoe vortex, Biot and Savart law, Lifting line theory and its limitations.

**UNIT V** **10 Hours**

**BOUNDARY LAYER THEORY**

Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, energy thickness, boundary layer equations for a steady, two dimensional incompressible flow, boundary layer growth over a flat plate, critical Reynolds number, blasius solution.

**FOR FURTHER READING**

Fluid properties, Flow over a circular cylinder, study of air flow over airfoil, Applications of conformal transformation, boundary layer theory and relation between viscosity and temperature.

**1** **3 Hours**

**EXPERIMENT 1**

Calibration of subsonic wind tunnel.

**2** **3 Hours**

**EXPERIMENT 2**

Flow visualization studies on low speed flow over a cylinder.

**3** **3 Hours**

**EXPERIMENT 3**

Flow visualization studies on low speed flow over a flat plate at different angles of incidence.

**4** **3 Hours**

**EXPERIMENT 4**

Flow visualization studies on low speed flow over a symmetrical aerofoil at different angles of incidence.

**5** **3 Hours**

**EXPERIMENT 5**

Flow visualization studies on low speed flow over a cambered aerofoil at different angles of incidence.

**6** **3 Hours**

**EXPERIMENT 6**

Measurement of velocity profile on a flat plate and comparison with Blasius profile.

**7** **3 Hours**

**EXPERIMENT 7**

Pressure distribution over a circular cylinder and compare with theoretical and experimental result.

**8** **3 Hours**

**EXPERIMENT 8**

Pressure distribution over a symmetric airfoil.

**9** **3 Hours**

**EXPERIMENT 9**

Pressure distribution over a cambered airfoil.

**10** **3 Hours**

**EXPERIMENT 10**

Force and moment measurement using wind tunnel balance.

**Total: 75 Hours**

**Reference(s)**

1. J. D. Anderson, "Fundamentals of Aerodynamics", 5th Edition, McGraw Hill Education India Private Limited, 2010.
2. E. L. Houghton, "Aerodynamics for Engineering students", 6th edition, Elsevier, 2012.
3. EthirajanRathakrishnan, "Theoretical Aerodynamics", 1st Edition, Wiley Publications, 2013.

4. L. J. Clancey, "Aerodynamics", Shroff Publications, 2006.
5. http://nptel.ac.in/courses/101105059/

**18AE403 AIRCRAFT PROPULSION 2 1 2 4**

**Course Objectives**

- To build up necessary background for understanding the basics of propulsion.
- To understand the application of various experimental fluid mechanics correlations in propulsion
- To learn fundamental calculations in fluid mechanics.
- To understand the basic concepts of compressible fluid flow.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Analyse the different modes of fluid mechanics and heat transfer.
2. Analyse the fluid operating parameters and energy transfer parameters.
3. Analyse the incompressible and compressible flow propulsion.
4. Apply the various propulsion techniques.
5. Analyse the turbine performance.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 3 | 2 | 1 | 2 | | | | | | | | | | | |
| 3 | 3 | 2 | 1 | 2 | | | | | | | | | | | |
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| 5 | 2 | 2 | | | | | | | | | | | | | |

**UNIT I** **6 Hours**

**FUNDAMENTAL OF GAS TURBINE ENGINES**

Review of thermodynamic cycles, Various method to improve efficiency and work output of gas turbine, Fundamentals of gas turbine engine use as aircraft power plant, Fundamental thrust equation,

Factors affecting the thrust, Effect of pressure temperature and velocity on thrust, Different types of aircraft power plant - Performance characteristics - comparison

**UNIT II** **6 Hours**

**AIRCRAFT INLETS AND NOZZLE**

Basic of one dimensional Inlet flow - Subsonic Inlet - Supersonic Inlet - Internal, External and Mixed compression inlet - Mass flow characteristics - starting problem on supersonic inlets -. Applications to Nozzles and Exhaust velocity of nozzle - Area-Mach relation and types of nozzle- - nozzle efficiency - losses in nozzles - over expanded and under - expanded nozzles.

**UNIT III** **6 Hours**

**AIRCRAFT COMPRESSORS**

Centrifugal compressor: Principle of operation, Velocity Triangle, Work done and Pressure rise - Inlet Duct; Impeller; Slip factor - Centrifugal Compressor Characteristics: Surging and Choking. Axial Flow Compressor: Elementary theory, Velocity triangle,and Stage pressure rise - Factors affecting stage pressure ratio - Degree of reaction - free vortex design - Axial Compressor Characteristics.

**UNIT IV** **6 Hours**

**COMBUSTION CHAMBER**

Types of combustion chambers in aircraft engines - Gas turbine Combustion Mechanism : Flame stabilization and Flame Tube cooling - Important Combustion parameters: equivalence ratio, Percentage of Theoretical air and Excess air, Pressure losses, Combustion efficiency, Combustion intensity - Combustion Stability limits and Instability - Fuel injection systems - Gasturbine Emissions.

**UNIT V** **6 Hours**

**AIRCRAFT TURBINES**

Impulse and reaction blading of gas turbines - Velocity triangles and power output - Elementary theory - Vortex theory - Choice of blade profile, pitch and chord - Estimation of stage performance - Limiting factors in gas turbine design- Overall turbine performance - Methods of blade cooling - Matching of turbine and compressor.

**FOR FURTHER READING**

Advanced jet engine cycles: Variable cycle engines - Basics on the influence of three dimensional flow in the axial compressor - Factors limiting Turbine design - Types of fuels and their properties.

**1** **3 Hours**

**EXPERIMENT 1**

Dismantling and reassembling of an aircraft piston engine

**2** **3 Hours**

**EXPERIMENT 2**

Dismantling and reassembling of an aircraft jet engine

**3** **3 Hours**

**EXPERIMENT 3**

Measurement of forced convective heat transfer over a flat plate

**4** **3 Hours**

**EXPERIMENT 4**

Measurement of free convective heat transfer over a flat plate

**5** **3 Hours**

**EXPERIMENT 5**
Combustion performance studies in a ramjet combustion chamber

**6** **3 Hours**

**EXPERIMENT 6**
Study of performance of a propeller

**7** **3 Hours**

**EXPERIMENT 7**
Determination of calorific value and moisture content of an aviation fuel

**8** **3 Hours**

**EXPERIMENT 8**
Study of flow using free jet

**9** **3 Hours**

**EXPERIMENT 9**
Study of flow using wall jet

**10** **3 Hours**

**EXPERIMENT 10**
Nozzle performance study using nozzle pressure test rig

**Total: 75 Hours**

**Reference(s)**

1. P.G. Hill and C.R. Peterson, "Mechanics & Thermodynamics of Propulsion", Addison - Wesley Longman INC, 2015.
2. H. Cohen, G. F. C. Rogers and H. I. H. Saravanamuttoo, "Gas Turbine Theory", Pearson Education, 2017.
3. Jack D. Mattingly, "Element of Propulsion- Gas turbine and rockets", AIAA Education Series, New York, 2016.
4. M. L. Mathur and R. P. Sharma, "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 2010.
5. http://nptel.ac.in/courses/101101002/

## 18AE404 AIRCRAFT SYSTEMS AND INSTRUMENTS

**2 0 2 3**

**Course Objectives**

- To describe the principle and working of aircraft systems and instruments.
- To know about the hydraulic and pneumatic systems in aircraft.
- To describe the working principle and components of the aircraft auxiliary systems.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

**Course Outcomes (COs)**

1. Identify the basic of aircraft hydraulic and pneumatic systems.
2. Explain the working of the aircraft instruments systems.
3. Compare the working of aircraft control systems and brake systems.
4. Explain the construction and functionality of an aircraft engine systems
5. Interpret the construction and working of an aircraft auxiliary system.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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**UNIT I** **9 Hours**

**BASIC OF AIRCRAFT SYSTEMS**

Principles of hydraulics-types of hydraulic fluid-hydraulic reservoir-hydraulic filter-pressure control devices- accumulator-hydraulic actuator-hydraulic system for aircraft -open and closed systems-pneumatic system-component-working principles-advantages.

**UNIT II** **8 Hours**

**INSTRUMENTS SYSTEMS**

Principles of instrument operations- flight instruments altimeter, airspeed indicator, airspeed angle of attack indicator, Mach meter, accelerometer,Gyroscopic Instruments, magnetic compass,-engine instruments-tachometer, oil pressure indicator, oil temperature indicator-fuel quantity indicator-fuel flow meter.

**UNIT III** **11 Hours**

**AIRCAFT CONTROL AND BRAKE SYSTEMS**

Conventional Systems - Power assisted and fully powered flight controls - Power actuated systems - Push pull rod system, flexible push full rod system- Components - Modern control systems - Digital fly by wire systems - Auto pilot system classification of landing gear landing gear components-retraction systems-aircraft brake systems and its component.

**UNIT IV** **9 Hours**

**AIRCRAFT FUEL AND PRESSURIZATION SYSTEM**

Fuel systems -.fuel system components-types of fuel systems- typical aircraft fuel system-cabin cooling systems-cabin pressurization systems-oxygen systems.

**UNIT V** **8 Hours**

**AUXILIARY SYSTEM**

Fire protection systems fire detector, smoke and gas detection system ice protection system Rain removal systems water and waste systems position and warning systems

**FOR FURTHER READING**

Multi engine fuel systems - Fuel System for rocket engines-Apollo-II spacecraft control systems-electric brake systems.

**1** **3 Hours**

**EXPERIMENT 1**

Flow test to assess of filter element clogging.

**2** **3 Hours**

**EXPERIMENT 2**

Control rigging for Cessna aircraft.

**3** **3 Hours**

**EXPERIMENT 3**

Functional Test to adjust operating pressure

**4** **3 Hours**

**EXPERIMENT 4**

Pressure Test To assess hydraulic External/Internal Leakage

**5** **3 Hours**

**EXPERIMENT 5**

Brake Torque Load Test on wheel brake units

**6** **3 Hours**

**EXPERIMENT 6**

Pressure Test procedure on fuel system components.

**7** **3 Hours**

**EXPERIMENT 7**

Aircraft Jacking Up procedure.

**8** **3 Hours**

**EXPERIMENT 8**

Aircraft Leveling procedure.

**9** **3 Hours**

**EXPERIMENT 9**

Aircraft Symmetry Check procedure.

**10** **3 Hours**

**EXPERIMENT 10**

Maintenance and rectification of snags in hydraulic and fuel systems.

**Total: 75 Hours**

**Reference(s)**

1. J. L. McKinley and R. D. Bent, "Aircraft Maintenance & Repair", Tata McGraw-Hill, 2010.
2. General Hand Books of Airframe and Powerplant Mechanics, U. S. Dept. of Transportation, Federal Aviation Administration, the English Book Store, New Delhi 1995.
3. E. H. J. Pallet, "Aircraft Instruments & Principles", Pitman & Co., 1997.
4. Treager, S., "Gas Turbine Technology", Tata McGraw-Hill, 2008

## 18AE405 HEAT TRANSFER 3 0 2 4

**Course Objectives**

- To familiarize conduction heat transfer mechanisms
- To expose the mechanisms of free and forced convection
- To develop the shape factor algebra for black body radiation and grey body radiation
- To demonstrate the phase change heat transfer and calculate the performance of heat exchanging devices

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**Course Outcomes (COs)**

1. Analyse three basic modes of heat transfer to evaluate one dimensional steady state and transient heat conduction based problems
2. Apply the empirical relations of convection heat transfer and analyse the laminar and turbulent flows under free and forced convection
3. Analyse the heat exchange between non - black bodies, simple vapour compression and absorption refrigeration system to evaluate the rate of heat transfer in radiation shields
4. Integrate the concepts of phase change heat transfer & compare the thermal performance of heat exchangers using LMTD or NTU approach
5. Identify the heat transfer problems in gas turbines and rocket thrust chambers.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 2 | 2 | 1 | | 2 | | | | | | | | |
| 2 | 2 | 3 | 2 | 2 | 1 | | 2 | | | | | | | | |
| 3 | 3 | 3 | 2 | 2 | | | 2 | | | | | | | | |
| 4 | 2 | 3 | 2 | 2 | | | 2 | | | | | | | | |
| 5 | 2 | 3 | 2 | 2 | | | 2 | | | | | | | | |

**UNIT I** **9 Hours**

**CONDUCTION**

Governing equation in Cartesian, cylindrical and spherical coordinates. 1-D steady state heat conduction with and without heat generation. Composite wall- electrical analogy - critical thickness of insulation - heat transfer from extended surface - effect of temperature on conductivity- 1-D transient analysis.

**UNIT II** **9 Hours**

**CONVECTION**

Review of basic equations of fluid flow - dimensional analysis- forced convection - laminar flow over flat plate and flow through pipes-flow across tube banks. Turbulent flow over flat plate and flow through pipes -free convection - heat transfer from vertical plate using integral method - empirical relations.

**UNIT III** **9 Hours**

**RADIATION**

Basic definitions - concept of black body - laws of black body radiation-radiation between black surfaces - radiation heat exchange between grey surfaces - radiation shielding - shape factor- electrical network analogy in thermal radiation systems.

**UNIT IV** **9 Hours**

**HEAT EXCHANGERS**

Classification - temperature distribution - overall heat transfer co-efficient, heat exchange analysis - LMTD and NTU methods.

**UNIT V** **9 Hours**

**HEAT TRANSFER PROBLEMS IN AEROSPACE ENGINEERING**

Heat transfer problems in gas turbines, rocket thrust chambers- aerodynamic heating - ablative heat transfer.

**FOR FURTHER READING**

Isentropic flow of ideal gases through nozzles - Rankine Cycle, Classifications of jet engines Simple jet propulsion system - Thrust of rocket motor - Specific impulse.

**1** **5 Hours**

## EXPERIMENT 1

Determination of effectiveness of a parallel flow heat exchanger

**2** **5 Hours**

## EXPERIMENT 2

Determination of effectiveness of a counter flow heat exchanger

**3** **5 Hours**

**EXPERIMENT 3**
Determination of conductive heat transfer coefficient.

**4** **5 Hours**

**EXPERIMENT 4**
Determination of thermal resistance of a composite wall

**5** **5 Hours**

**EXPERIMENT 5**
COP test on a vapour compression refrigeration test rig

**6** **5 Hours**

**EXPERIMENT 6**
COP test on a vapour compression air-conditioning test rig

**Total: 75 Hours**

**Reference(s)**

1. S. C. Sachdeva, "Fundamentals of Engineering Heat & Mass Transfer", Wiley Eastern Ltd., New Delhi, 2008.
2. J. P. Holman, "Heat Transfer", McGraw-Hill Book Co.,Inc., New York, 9th Edn.,2001.
3. Yunus, A.Cengel, "Heat Transfer-A Practical Approach", Tata McGraw Hill, Third edition, 2008.
4. P.K. Nag, "Heat and Mass Transfer", Tata McGraw Hill, Second edition, 2007.
5. Mathur,M. and Sharma,R.P., "Gas Turbine and Jet and Rocket Propulsion", Standard Publishers, Fourth edition New Delhi, 2014.
6. Sutton, G.P., "Rocket Propulsion Elements", John Wiley and Sons, Eighth Edition, 2010.

## 18AE406 CONTROL THEORY 3 0 0 3

**Course Objectives**

- To understand the mechanism of control engineering and the input-output relationship of basic control systems.
- To analyze the flow of inputs through the areas in the control system.
- To extract the stability and frequency response methods used for aircraft systems performance.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. Utilize the knowledge of aeronautical engineering in innovative, dynamic and challenging environment for design and development of new products.

n. Impart professional skills through simulation, language skills and general purpose CAE packages to solve practical problems of components in design and analysis to meet the airworthiness requirements for flight vehicles.

**Course Outcomes (COs)**

1. Explain the mechanical and electrical systems used for controlling aircraft operation.
2. Analyze the influence of open loop and feedback control system in system accuracy.
3. Evaluate the time response pararameters of control system with respect to test input signals.
4. Analyse the frequency response and stability of a system using graphical methodologies.
5. Explain the operation characteristics of Digital control system.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | | | | | | | | | | | 2 | 2 | |
| 2 | 1 | 2 | | | | | | | | | | | 2 | 2 | |
| 3 | 1 | 2 | | | | | | | | | | | 3 | 2 | |
| 4 | 1 | 2 | 3 | | | | | | | | | | 2 | 3 | |
| 5 | 1 | | | | | | | | | | | | 2 | 3 | |

**UNIT I** **9 Hours**

**INTRODUCTION TO BASIC SYSTEMS**

Historical Evolution - simple Pneumatic, Hydraulic and Thermal control systems, Mechanical Translational and Rotation systems - elements, Input and Output relations- Electrical Analogies - Development of flight control systems.

**UNIT II** **9 Hours**

**OPEN AND CLOSED LOOP CONTROL SYSTEMS**

Basic terminologies: Open loop - Feedback control systems - Block diagram rules for control systems Analysis - Signal Flow Graph Algorithm.

**UNIT III** **9 Hours**

**TIME RESPONSE EQUATIONS AND FUNCTIONS**

Types of test input signals -Response of systems to different inputs -Step, Ramp, Impulse and Parabolic, Time response of first order system for unit step input - Time Domain Specfications - Steady State Error constant.

**UNIT IV** **9 Hours**

**CONCEPT OF STABILITY**

Basics on stability of system - Routh Hurwitz Stability -Necessary and sufficient conditions, Root Locus Stability Method - Frequency Response Bode Techniques.

**UNIT V** **9 Hours**

**DIGITAL CONTROL SYSTEM**

Introduction and Functional blocks-Digital Control System- Proportional,Derivative and Integral controller terms - PID Controller transfer function - PID Autopilot System.

**FOR FURTHER READING**

Modern Digital Control System - Digital Control Computers.

**Total: 45 Hours**

**Reference(s)**

1. Ogato, "Modern Control Engineering", Fifth Edition, Prentice Hall of India Pvt. Ltd. New Delhi, 2009.
2. M. Gopal, "Control Systems, Principles and design" Latest Edition Tata McGraw-Hill Publication, New Delhi, 2010.
3. Naresh K. Sinha, "Control Systems",New edition, New Age International Publishers, New Delhi,2009.
4. J. J. D. Azzo and C. H. Houpis, "Feedback control system analysis and synthesis",3rd Edition McGraw Hill International pvt. Ltd, 2009.

## 18AE407 MODELING LABORATORY 0 0 2 1

**Course Objectives**

- To teach and train the students in the lab about the design and drafting of aero components
- To teach the 3D modeling, assembly of machines and surface modeling

**Programme Outcomes (POs)**

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Understand the basics of three dimensionalmodeling
2. Apply the knowledge of Machine drawing to generate 3D models using Software packages.
3. Apply the CAD tools for surface modeling of aircraft components.
4. Apply the CAD Tools to assemble the machine parts and analyze the dynamics of the machines.
5. Apply the cad tools for drafting and dimensioning of the components and machines as per the standards.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | | | 1 | | 2 | | | | | | | | | | |
| 3 | | | 1 | | 3 | | | | | | | | | | |
| 4 | | | 1 | | 3 | | | | | | | | | | |
| 5 | | | 1 | | 2 | | | | | | | | | | |

**1** **3 Hours**

**EXPERIMENT 1**

Two dimensional drafting using sketcher.

**2** **3 Hours**

**EXPERIMENT 2**

Three dimensionalmodeling of an aircraft control system components. (bell crank, turnbuckle. etc)

**3** **3 Hours**

**EXPERIMENT 3**

Three dimensionalmodeling of an aircraft landing gear component.

**4** **3 Hours**

**EXPERIMENT 4**

Conversion of 2d drawing in to three dimensional models.

**5** **3 Hours**

**EXPERIMENT 5**

Three dimensional assemblies of a connecting rod and piston.

**6** **3 Hours**

**EXPERIMENT 6**

Three dimensional assemblies of a screw jack.

**7** **3 Hours**

**EXPERIMENT 7**

Surface modeling of Wing/ fuselage using NACA aerofoil.

**8** **3 Hours**

**EXPERIMENT 8**

Design of aircraft components using sheet metal design.

**9** **3 Hours**

**EXPERIMENT 9**

2D drafting of assembled models.

**10** **3 Hours**

**EXPERIMENT 10**

2D drafting of aircraft components.

**Total: 30 Hours**

**18HS001 ENVIRONMENTAL SCIENCE** **2 0 0 0**

**Course Objectives**

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life and stimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

**Programme Outcomes (POs)**

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

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

**Course Outcomes (COs)**

1. Examine the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. Impact the existing environmental challenges related to pollution and its management
4. Select suitable strategies for sustainable management of components of environmental science
5. Correlate the impacts of population and human activities on environment

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | |
| 2 | 1 | 1 | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | |
| 4 | 1 | | | | | | | | | | | | | | |
| 5 | 2 | | | | | | | | | | | | | | |

**UNIT I** **6 Hours**

**NATURAL RESOURCES**

Forest resources: Use - over exploitation - deforestation - case studies. Water resources: Use - over utilization of surface and ground water - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, biomagnification). Energy resources: renewable (solar, wind, and hydro).

**UNIT II** **6 Hours**

**ECOSYSTEMS AND BIODIVERSITY**

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: desert ecosystem. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

**UNIT III** **6 Hours**

**ENVIRONMENTAL POLLUTION**

Pollution: Definition - causes - effects - control measures of air pollution - water pollution : (Sewage water treatment by activated sludge and trickling filter process) - noise pollution- thermal pollution. Disaster management: causes - effects - control measures of floods Ã¢?? earthquake

**UNIT IV** **7 Hours**

**SOCIAL ISSUES AND ENVIRONMENT**

Sustainable development : Definition - Unsustainable to sustainable development - solid waste management - causes - effects - 5R Principles (landfills, incineration, composting). Water

conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. E-waste.

**UNIT V** **5 Hours**

**HUMAN POPULATION AND ENVIRONMENT**

Human population: Population growth - characteristics - variation among nations - population explosion - value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

**FOR FURTHER READING**

Human rights:Biomedical waste -Identification of adulterants in food materials

**Total: 30 Hours**

**Reference(s)**

1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering , 4th Multi Colour Edtion, New Age International Publishers, New Delhi, 2014
2. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons
3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press
5. A. K. De, Environmental Chemistry, 7th Edition , New age international publishers, New Delhi, 2014

## 18GE401 SOFT SKILLS-REASONING 2 0 0 0

**Course Objectives**

- To acquire command of both the receptive skills (Listening, Reading) and the productive skills (Writing and Speaking) of English language
- To understand and make effective use of English language in business contexts

**Programme Outcomes (POs)**

**Course Outcomes (COs)**

1. Listen, Read, Speak, and Write Business English at the level of independent users
2. Appear for the Business English Certificate (BEC) Vantage level examination conducted by the Cambridge Assessment English

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | |

**UNIT I** **15 Hours**

**LISTENING AND READING**

Listening for writing short answers - filling gaps in sentences - identifying topic, context and function - identify different functions of language in business situations - identify prompts -identify paraphrases of required information

Scanning - reading for gist - understanding sentence structure - error identification - identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

**UNIT II** **15 Hours**

**WRITING AND SPEAKING**

Business emails - notes - memos to colleagues or friends - giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining - apologising - reassuring - complaining - describing - summarising - recommending - persuading turn - taking - sustaining interaction - initiating - responding - giving personal information - talking about present circumstances, past experiences and future plans - expressing opinion - speculating - organising a larger unit of discourse - giving information - expressing and justifying opinions - speculating - comparing and contrasting - agreeing and disagreeing

**1** **15 Hours**

## LISTENING AND READING

Listening for writing short answers - filling gaps in sentences - identifying topic, context and function - identify different functions of language in business situations - identify prompts -identify paraphrases of required information - Scanning - reading for gist - understanding sentence structure - error identification - identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

**2** **15 Hours**

## WRITING AND SPEAKING

Business emails - notes - memos to colleagues or friends - giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining - apologising - reassuring - complaining - describing - summarising - recommending - persuading turn - taking - sustaining interaction - initiating - responding - giving personal information - talking about present circumstances, past experiences and future plans - expressing opinion - speculating - organising a larger unit of discourse - giving information - expressing and justifying opinions - speculating - comparing and contrasting - agreeing and disagreeing

**Total: 60 Hours**

**Reference(s)**

1. Whitehead, Russell and Michael Black. Pass Cambridge BEC Vantage Self - study Practice Tests with Key, Heinle - a part of Cengage Learning, Delhi, 2003.

## 21AE501 GAS DYNAMICS 3 1 0 4

**Course Objectives**

- Understand the behaviour of airflow both internal and external in compressible flow regime with particular emphasis on supersonic flows.
- Understand the basic details of flow with friction, flow with heat transfer and supersonic wind tunnels.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**Course Outcomes (COs)**

1. Apply the concept of continuum, compressibility, and gas flow thermodynamics to compressible fluid flow.
2. Analyse the flow properties variation across a normal shockwave and oblique shockwave.
3. Analyse the flow properties variation across an expansion fan and the performance of CD nozzle, supersonic inlet, and supersonic wind tunnel.
4. Evaluate the flow properties in the flow of a perfect gas in a constant area duct with friction, or heat transfer.
5. Apply the design concepts to increase the performance of an aircraft during transonic and supersonic speeds.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 2 | | | | | | | | | 2 | 1 | | |
| 2 | 2 | 3 | 2 | | | | | | | | | 2 | 1 | | |
| 3 | 2 | 3 | 2 | | | | | | | | | 2 | 1 | | |
| 4 | 2 | 3 | 2 | | | | | | | | | 1 | 1 | | |
| 5 | 2 | 3 | 2 | | | | | | | | | 2 | 1 | | |

**UNIT I** **8 Hours**

**ONE DIMENSIONAL COMPRESSIBLE FLOW**

Continuum, Compressibility, State, Continuity, Momentum and Energy equations, Adiabatic steady state flow equations, Velocity of sound, Isentropic process relations, Mach waves and Mach angles, Area-Velocity-Mach number relation.

**UNIT II** **10 Hours**

**NORMAL AND OBLIQUE SHOCK WAVES**

Normal shock equations, Prandtl equation and Rankine-Hugonoit relation, Pitot-Static tube and its corrections for subsonic and supersonic flows, Oblique shocks and corresponding equations, Strong and weak oblique shocks, Attached and detached shocks, Flow past wedges, cones and concave corners, Hodograph, Pressure ratio-flow turning angle plane and Shock polar.

**UNIT III** **10 Hours**

**EXPANSION FLOWS AND FLOWS INVOLVING SHOCKS AND EXPANSION**

Prandtlmeyer expansion, Expansion hodograph, Families of shocks, Reflection and interaction of shocks and expansion waves, Methods of characteristics, Two dimensional supersonic nozzle contours, CD nozzle - Performance under various back pressures, Supersonic Wind tunnel - Design.

**UNIT IV** **6 Hours**

**FLOW WITH FRICTION AND HEAT TRANSFER**

Rayleigh flow, Practical examples of Rayleigh flow - Numerical problems, Fanno flow, Practical examples of Fanno flow - Numerical problems.

**UNIT V** **11 Hours**

**COMPRESSIBLE FLOW THEORIES AND TRANSONIC FLOW**

Small perturbation potential theory, Prandtl- Glauert affine transformation relations for subsonic flows, Two dimensional supersonic flow theory, Supersonic Airfoils - lift, drag, pitching moment and center of pressure, Critical Mach numbers, Lift and Drag divergence, Shock induced separation, Characteristics of swept wings, Effects of thickness, camber and aspect ratio, Transonic area rule, Tip effects.

**FOR FURTHER READING**

Thermodynamics relations and their properties, Types of high speed aircrafts and their structures, Study of flow in pipes and combustion chamber, Supersonic test facilities, Supersonic flow visualization.

**Total: 60 Hours**

**Reference(s)**

1. J. D. Anderson, "Fundamentals of Aerodynamics", Fifth Edition, McGraw Hill Education India Private Limited, 2010.
2. E. Radhakrishnan, "Gas Dynamics", Fifth Edition, PHI Learning Private Limited - New Delhi, 2014.
3. S.M. Yahya, "Fundamentals of Compressible Flow", New Age Science Ltd, 2009.
4. P Balachandran, "Gas Dynamics for Engineers", PHI Learning Private Limited - New Delhi, 2010.
5. http://nptel.ac.in/courses/112103021/
6. http://nptel.ac.in/courses/101106044/

## 21AE502 AIRCRAFT STRUCTURES II 3 0 2 4

**Course Objectives**

- To provide the knowledge of stresses due to unsymmetrical sections and loads with different methods adopted
- To provide the knowledge of open section and shear flow calculation and shear center estimation
- To provide the knowledge of closed section and shear flow calculation and shear center estimation for single and two cell box type structures

- To provide the practical exposure to estimate allowable stresses due to stresses calculated (objectives 1 to 3) to check the strength of the component and to estimation of Margins of Safety.
- To provide the preliminary design and analysis of an aircraft wing and fuselage

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
m. Utilize the knowledge of aeronautical engineering to provide realistic solutions in the field of aerodynamics, aircraft structures, avionics and propulsive systems.
n. Impart professional skills through modelling and simulation tools in design and analysis to meet the airworthiness requirements.

**Course Outcomes (COs)**

1. Evaluate the stresses in the aircraft structural components like beams with skew loads. Also calculate the stresses with different axis like Principal plane, NA plane and two mutually perpendicular axis
2. Analyse the shear flow over the aircraft structural components with open sections like Z-section, C section, T-section etc and finding the shear centre and the importance
3. Analyse the shear flow and shear center of closed section like wing section and fuselage sections
4. Apply different methods of calculating the allowable stresses to varying sections.
5. Analyse the stresses in wing and fuselage sections under different loading conditions.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 2 | 3 | 1 | | | | 2 | 2 | | | 1 | 1 | |
| 2 | 3 | 3 | 2 | 3 | 1 | | | | 2 | 2 | | | 1 | 1 | |
| 3 | 3 | 3 | 2 | 3 | 1 | | | | 2 | 2 | | | 1 | 1 | |
| 4 | 3 | 3 | 1 | 3 | | | | | 2 | 2 | | | 1 | | |
| 5 | 3 | 3 | 1 | 3 | | | | | 2 | 2 | | | 1 | | |

**UNIT I** **9 Hours**

**UNSYMMETRICAL BENDING**

Unsymmetrical beam sections - bending - methods of stresses calculation

**UNIT II** **9 Hours**

**SHEAR FLOW IN OPEN SECTIONS**

Concept of shear flow in thin walled sections - shear flow distribution in symmetric and unsymmetrical sections - shear center calculations.

**UNIT III** **9 Hours**

**SHEAR FLOW IN CLOSED SECTIONS**

Shear flow due to Bredt - Batho theory - single cell and multi-cell boxes subject to torsion and bending - walls effective and ineffective for bending - shear center calculations.

**UNIT IV** **9 Hours**

**BUCKLING OF PLATES**

Concept and importance of allowable - methods for local buckling stress of thin walled sections - crippling strength estimation- thin skin stringer panel- effective skin width - inter rivet buckling-skin stringer panel-Integrally stiffened panels-cutouts-Lightly loaded beams-combined loading

**UNIT V** **9 Hours**

**STRESS ANALYSIS OF WING AND FUSELAGE**

Types of aircraft loads - V-n diagram - distribution of loads on fuselage and wing structure to the nearest approximation - shear force and bending moment distribution over the aircraft wing and fuselage - calculate all stresses due to the applied loads for sheet metal wing type carryout complete tension field beams & semi-tension field beam theory.

**FURTHER READING**

Moment of inertia of different sections- polar moment of inertia for open section- moment of inertia for closed sections with stringers- buckling effect on cantilever, fixed beams- types of joints and their structures.

**1** **6 Hours**

## EXPERIMENT 1

Unsymmetrical bending of beams

**2** **6 Hours**

## EXPERIMENT 2

Shear center location for open sections

**3** **6 Hours**

## EXPERIMENT 3

Shear center location for closed sections

**4** **6 Hours**

## EXPERIMENT 4

Buckling of thin plates

**5** **6 Hours**

**EXPERIMENT 5**

Wagner beam - Tension field beam.

**Total: 75 Hours**

**Reference(s)**

1. T. M. G. Megson, "Aircraft Structures for Engineering Students", Butterworth Heinemann, 2012.
2. Michael Chun-Yung Niu, "Airframe Structural Design: Practical Design Information and Data on Aircraft Structures", 2nd edition, Adaso/Adastra Engineering Center, 2006
3. Prof S K Maiti, "Advanced Strength of Materials", NPTEL, Web course, Department of Mechanical Engineering, Indian Institute of Technology, Bombay
4. Peery D.J," Aircraft Structures",2nd Edition, McGraw Hill.
5. B. K. Donaldson, "Analysis of Aircraft Structures - An Introduction", 2nd Edition, Cambridge University Press.

## 21AE503 ROCKET PROPULSION 3 1 0 4

**Course Objectives**

- To learn the principles behind aircraft and rocket propulsion systems.
- To learn the propulsion system performance information at various condition.
- To understand the application of various propellant systems and their properties.
- To assess the rocket component and understand their design process.
- To understand the working principle of different spacecraft propulsion techniques.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. Impart professional skills through modelling and simulation tools in design and analysis to meet the airworthiness requirements.

**Course Outcomes (COs)**

1. Apply the concepts of isentropic flow to understand the functioning of propulsive nozzles - Convergent and Convergent – divergent.
2. Analyse the concepts and operational principles of air breathing engines - Ramjets and Scramjets.
3. Apply the fundamental equations of rocket propulsion like thrust equation, equations for characteristic velocity, critical velocity and their inter-relationships to estimate the rocket performance.
4. Analyse the working of solid and liquid propellant rocket motors, design considerations, heat transfer aspects and comparative performance.
5. Analyse the working of electric, ion and nuclear rockets along with conceptual study of solar sails, nozzle less propulsion

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | 2 | 1 | | | | | | | | 1 | | 1 | |
| 2 | 3 | 2 | 2 | | | | | | | 1 | | | | 1 | |
| 3 | 3 | 2 | 2 | 2 | 1 | | | | | 1 | | | | 1 | |
| 4 | 3 | 2 | 2 | 2 | 1 | | | | | | | | | 1 | |
| 5 | 3 | 3 | 2 | | | | | | | | | 1 | | 1 | |

**UNIT I** **9 Hours**

**RAMJET AND SCRAMJET ENGINE**

Introduction and Operating principle - sub critical, critical and supercritical operation - combustion in ramjet engine - ramjet performance - sample ramjet design calculations - introduction to scramjet - preliminary concepts in supersonic combustion - integral ram- rocket- numerical problems.

**UNIT II** **10 Hours**

**BASICS OF ROCKET PROPULSION**

Operating principle - Thrust equation - Definitions of performance parameters and design factors (Specific impulse, Thrust Coefficient, Characteristic Velocity and Critical Velocity) and relationship between them - internal ballistics- rocket nozzle classification - rocket performance considerations - numerical problems.

**UNIT III** **9 Hours**

**SOLID ROCKET ENGINE**

Solid propellant rockets - selection criteria of solid propellants - important hardware components of solid rockets - propellant grain design considerations

**UNIT IV** **9 Hours**

**LIQUID AND HYBRID ENGINE**

liquid propellant rockets - selection of liquid propellants - thrust control in liquid rockets - cooling in liquid rockets and solid rocket motor - limitations of hybrid rockets - relative advantages of liquid rockets over solid rockets - Thrust reversal and Thrust Vectoring Control Techniques - numerical problems.

**UNIT V** **8 Hours**

**ADVANCED SPACE PROPULSION TECHNIQUES**

Electric rocket propulsion - ion propulsion techniques - nuclear rocket - types - solar sail- preliminary concepts in nozzleless propulsion.

**FOR FURTHER READING**

Basic review thermodynamics and gas dynamics - Actual mass flow rate through nozzle and equilibrium conditions - Advantages, disadvantages, limitations and comparison with jet engines - Study of Indian launch vehicles and missiles - Liquid engine cycles.

**Total: 60 Hours**

**Reference(s)**

1. G. P. Sutton, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 8th Edition, 2010.
2. P.G. Hill and C.R. Peterson, "Mechanics & Thermodynamics of Propulsion", Addison, Wesley Longman INC, 2015.
3. H. Cohen, G. F. C. Rogers and H. I. H. Saravanamuttoo, "Gas Turbine Theory", Pearson Education, 2010.
4. C. V. Gorden, "Aero thermodynamics of Gas Turbine and Rocket Propulsion", AIAA Education Series, New York, Third Edition, 1998.
5. M. Mathur and R. P. Sharma, "Gas Turbines and Jet and Rocket Propulsion", Standard Publishers, New Delhi, 2005.
6. M. J. L. Turner, "Rocket and Spacecraft Propulsion", Springer Praxis Publishing, 3rd Edition, 2008.

## 21AE504 FINITE ELEMENT ANALYSIS 3 1 0 4

**Course Objectives**

- To provide the exposure for various approximations based on Raleigh-Ritz, Galerkin and numerical approximation methods of solution and to understand the concept of numerical analysis of structural components
- To provide the exposure to the formulation and the procedure of the finite element method for 1D elements
- To provide the exposure to the formulation and the procedure of the finite element method for 2D plate elements (CST and LST elements). Exposure to global, local and natural co-ordinate system
- To provide the basic knowledge of Iso-parametric for 2D quadrilateral Element Formulation (4 8 and 9 node elements). To provide the knowledge of iso-parametric, sub-parametric and super-parametric elements. Exposure to numerical integration method
- To impart the knowledge of field problems like Heat transfer, CFD and potential flows.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Utilize the knowledge of aeronautical engineering to provide realistic solutions in the field of aerodynamics, aircraft structures, avionics and propulsive systems.
n. Impart professional skills through modelling and simulation tools in design and analysis to meet the airworthiness requirements.

**Course Outcomes (COs)**

1. Apply the principles and theories of Finite Element method to engineering problems.
2. Apply one dimensional finite element method procedure to solve the bar, beam and truss type problems.
3. Apply FEM procedure on continuum elements to solve for the components of aircraft.
4. Apply the numerical methods to formulate the higher order and isoperimetric problems in aircraft.
5. Evaluate temperature distribution of one and two dimensional heat transfer problems & fluid flow problems and Analyze the aircraft engine and structural components using commercial Software.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 1 | 1 | | | | | | 1 | | 1 | 1 | 1 | |
| 2 | 3 | 3 | 1 | 1 | | | | | | 1 | | 1 | 1 | | |
| 3 | 3 | 3 | | | 1 | | 1 | | | 1 | | 1 | 1 | 1 | |
| 4 | 3 | 2 | | | | | 1 | | | 1 | | 1 | 1 | | |
| 5 | 3 | 3 | 1 | | 1 | | | | | 1 | | 1 | 1 | 2 | |

**UNIT I** **8 Hours**

**INTRODUCTION**

Application of Raleigh-Ritz and Galerkin and weighted residual approach to structural mechanics problems.

**UNIT II** **10 Hours**

**DISCRETE**

Development of bar elements and its application - uniform section, varying section - types of loading - mechanical and thermal - development of 2D plane truss from basic bar element development of beam element - problems for various loading and boundary conditions - development of Frame elements - longitudinal and lateral vibration. Use of local and natural coordinates.

**UNIT III** **8 Hours**

**CONTINUUM ELEMENTS**

Definitions of Plane stress, Plane strain and axi-symmetric problems - Derivation of stress strain matrices for CST and LST and axi-symmetric elements - traction conversion to nodal loads

**UNIT IV** **9 Hours**

**ISOPARAMETRIC ELEMENTS**

Definitions of shape function - properties of shape function - construction of shape functions for 4, 8 and 9 node quadrilateral elements,stiffness matrix and consistent load vector - numerical integration for 1 and 2 sampling points and evaluation of element stiffness matrices using numerical integration.

**UNIT V** **10 Hours**

**FIELD PROBLEM AND METHODS OF SOLUTIONS**

Definition of heat transfer - steady state Heat transfer - derivation of matrices for conduction, convection and load vectors due to convection, heat flux and source - application to strait and tapered fins - multi wall problems - introduction to CFD and torsion field problems

**FURTHER READING**

Historical background of finite element method -FE model for correctness and to validation-differences between finite element, finite difference and finite volume methods.

**Total: 60 Hours**

**Reference(s)**

1. Reddy J.N., "An Introduction to Finite Element Method", McGraw Hill, third edition, 2005.
2. Tirupathi.R. Chandrapatha and Ashok D. Belegundu, Introduction to Finite Elements in Engineering", Prentice Hall India, Fourth edition, 2012.
3. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985
4. Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw Hill, 2000.
5. Rao. S.S., "Finite Element Methods in Engineering," Butterworth and Heinemann, 2001

## 21AE507 STRUCTURAL SIMULATION LABORATORY

**0 0 2 1**

**Course Objectives**

- To train the students for structural analysis using FEM based software packages
- To introduce the problems and modern calculation methods in stress analysis of aircraft structures, as well as their application to solving real problems.
- To introduce the modern computational methods for stress analysis related to airframe structures.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Utilize the knowledge of aeronautical engineering to provide realistic solutions in the field of aerodynamics, aircraft structures, avionics and propulsive systems.
n. Impart professional skills through modelling and simulation tools in design and analysis to meet the airworthiness requirements.

**Course Outcomes (COs)**

1. Analyse the effects of loads on physical structures and their components.
2. Evaluate the given problem fitness for use, from the results of the analysis.
3. Create the aircraft structural components using modeling software.
4. Analyse structural problems using Fem based software packages.
5. Analyse the data obtained using the Computer packages.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 2 | 3 | 3 | | 1 | 2 | 1 | 3 | | 2 | 2 | 3 | |
| 2 | 3 | 3 | 2 | 3 | 3 | | 1 | 2 | 1 | 3 | | 2 | 2 | 3 | |
| 3 | 3 | 3 | 2 | 3 | 3 | | 1 | 2 | 1 | 3 | | 2 | 2 | 3 | |
| 4 | 3 | 3 | 2 | 3 | 3 | | 1 | 2 | 1 | 3 | | 2 | 2 | 3 | |
| 5 | 3 | 3 | 2 | 3 | 3 | | 1 | 2 | 1 | 3 | | 2 | 2 | 3 | |

**1** **2 Hours**

**EXPERIMENT 1**

Stress analysis using bar element

**2** **2 Hours**

**EXPERIMENT 2**

Drawing SFD and BMD using beam element

**3** **2 Hours**

**EXPERIMENT 3**
Finding the member force in truss structure

**4** **3 Hours**

**EXPERIMENT 4**
Structural analysis using 2D elements

**5** **3 Hours**

**EXPERIMENT 5**
Structural analysis using axi-symmetric elements

**6** **3 Hours**

**EXPERIMENT 6**
Structural analysis using solid elements

**7** **3 Hours**

**EXPERIMENT 7**
Thermal Conduction analysis of structures

**8** **3 Hours**

**EXPERIMENT 8**
Thermal stress analysis of structures

**9** **3 Hours**

**EXPERIMENT 9**
Model analysis of structures

**10** **3 Hours**

**EXPERIMENT 10**
Structural analysis of a column

**11** **3 Hours**

**EXPERIMENT 11**
Aircraft applications based structural problem solving using FEM Packages

**Total: 30 Hours**

**21AE508 AIRCRAFT STRUCTURES AND ENGINE REPAIR LABORATORY** **0 0 2 1**

**Course Objectives**

- To explain the maintenance practices of an air-frame and engines.
- To exemplify various metal joining processes and gain welding skills.
- To demonstrate the Pipe bending process.
- To inspect the material by non-destructive methods.
- To develop skill for making a product using composite manufacturing process.

**Programme Outcomes (POs)**
a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
o. Develop systems and components with innovative techniques, efficient management and maintenance practices.

**Course Outcomes (COs)**

1. Develop the aircraft components with the help of composite materials.
2. Evaluate the strength of composite materials.
3. Analyse the various engine components and assemble the engine in order to find out the defects.
4. Apply maintenance procedure to Aircraft Engines.
5. Analyse the defects of aircraft engine components using NDT.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 2 | 1 | 1 | 3 | | 1 | 2 | | 2 | 3 | | | | | 1 |
| 3 | 2 | 1 | 1 | 3 | | | | | | 3 | | | | | 1 |
| 4 | 2 | 2 | 1 | 2 | 3 | 1 | | 1 | | 3 | | | | | 1 |
| 5 | 2 | 2 | 1 | | | | | | | 3 | | | | | 1 |

**1** **3 Hours**

**EXPERIMENT 1**

Preparation of Laminate Composite using hand layup procedure

**2** **3 Hours**

**EXPERIMENT 2**
Preparation of laminate Composite using Vacuum Bagging Method

**3** **3 Hours**

**EXPERIMENT 3**
Evaluate the strength of laminate composite

**4** **3 Hours**

**EXPERIMENT 4**
Pipe bending and flaring

**5** **3 Hours**

**EXPERIMENT 5**
Preparation of Sandwich composite

**6** **3 Hours**

**EXPERIMENT 6**
Piston Engine Components - dimensional checks

**7** **3 Hours**

**EXPERIMENT 7**
Jet Engine components- identification and dimensional checks.

**8** **3 Hours**

**EXPERIMENT 8**
Internal Defect identification by Ultrasonic testing for metal components

**9** **3 Hours**

**EXPERIMENT 9**
Surface Defect identification by Magnetic particle testing and dye-penetrant testing for metal components

**10** **3 Hours**

**EXPERIMENT 10**
Defect identification by using Acoustic Emission test for Composite materials.

**Total: 30 Hours**

**18GE501 SOFT SKILLS - APTITUDE I** **0 0 2 0**

**Course Objectives**

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

**Programme Outcomes (POs)**
**Course Outcomes (COs)**

1. Explain various concepts of number systems and their techniques in solving the percentage, average and age problems.

2. Analyse the profit and loss of real time situations and the relation between ratio, proportion and variation.
3. Apply different techniques to find the distance, speed and time of various moving objects.
4. Understand the concepts of coding, sequences and series, data interpretation and critical reasoning to solve real time logical reasoning problems.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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**1** **2 Hours**

**NUMBER SYSTEMS**

Introduction - Definition - Classification on Numbers- Power cycles and remainders - Short cut process- Concept of Highest Common Factor-Concept of Least Common Multiple- Divisibility-Number of zeros in an expression.

**2** **2 Hours**

**PERCENTAGE**

Introduction - Definition and Utility of Percentage - Importance of base/denominator for percentage calculations-Concept of percentage values through additions-Fraction to percentage conversion table.

**3** **3 Hours**

**AVERAGES AND AGES**

Introduction-Average of different groups-Addition or removal of items and change in average-Replacement of some of the items.

**4** **3 Hours**

**RATIO, PROPORTIONS AND VARIATION**

Introduction- Ratio- Properties-Dividing a given number in the given ratio-Comparison of ratios-Proportions-Useful results on proportion- Continued proportion-Relation among the quantities more than two-Variation.

**5** **2 Hours**

**PROFIT AND LOSS**

Gain/Loss and percentage gain or percentage loss-Multiplying equivalents to find sale price-Relation among cost price, sale price, gain/loss and percentage gain or percentage loss-An article sold at two different selling price-Two different articles sold at same selling price-Percentage gain or percentage loss on selling price-Percentage gain or percentage loss on whole property.

**6** **2 Hours**

**TIME AND WORK**

Introduction-Basic concepts-Concepts on working with different efficiencies-Pipes and Cisterns-Work Equivalence (Man Days) -Alternative approach.

**7** **2 Hours**

**TIME, SPEED AND DISTANCE**

Definition-Basics of Time, Speed and Distance - Relative speed-Problems based on Trains-Problems based on Boats and Streams-Problems based on Races-Time taken with two difference modes of transport-Time and distance between two moving bodies.

**8** **3 Hours**

**CODING AND DECODING**

Introduction-Description of Coding method-Coding patterns - Concepts of Coding and Decoding-Problems involving Coding and Decoding methods.

**9** **2 Hours**

**SEQUENCE AND SERIES**

Introduction-Sequences of real numbers - Number and Alphabet series-Description of Number and Alphabet series-Analogy-Odd man out-Power series.

**10** **3 Hours**

**DATA SUFFICIENCY**

Introduction to Data Sufficiency - Overview of the wide variety of Data Sufficiency problems - Basic introduction on how to determine what information is sufficient to solve a given problem - Common pitfalls to avoid.

**11** **3 Hours**

**DIRECTION**

Introduction to Direction - sense test - Overview of the wide variety of Direction problems-Direction-Plotting diagrams.

**12** **3 Hours**

**CRITICAL REASONING**

Introduction-Basic concept of critical reasoning- Weaken the argument-Strengthen the argument-Flaw in the argument-Evaluate the conclusion.

**Total: 30 Hours**

**Reference(s)**

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

**21HS002 HUMAN VALUES AND ETHICS** **2 0 0 2**

**Course Objectives**

- To understand Human Values and ethical theory.
- To understand codes of ethics, work place responsibilities, rights, engineering experimentation, global issues and contemporary ethical issues.
- To understand personal ethics, legal ethics, cultural ethics and engineers responsibility.

**Programme Outcomes (POs)**
**Course Outcomes (COs)**

1. Articulate engineering ethics theory with sustained lifelong learning.
2. Adopt a good character and follow high professional ethical life.
3. Contribute to shape a better character by following ethical actions.
4. Confront and resolve moral issues occurred during technological activities.
5. Resolve moral and ethical problems through exploration and assessment by established experiments.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 5 | | | | | | | | | | | | | | | |

**UNIT I** **6 Hours**

**HUMAN VALUES**

Morals and Ethics - Honesty - Integrity - Values - Work Ethic - Civic Virtue - Respect for Others - Living Peacefully - Caring and Sharing - Self-Confidence - Courage - Co-operation - Commitment - Empathy.

**UNIT II** **6 Hours**

**ENGINEERING ETHICS AND PROFESSIONALISM**

Scope of Engineering Ethics- Variety of moral issues - Types of inquiry - Accepting and sharing responsibility - Ethical dilemmas - Moral autonomy - Kohlbergs and Gilligans theory - Consensus and controversy - Profession and Professionalism - Models of Professional Roles - Right action theories - Senses of corporate responsibility - Codes of ethics: Importance - justification - limitation - Abuse.

**UNIT III** **6 Hours**

**ENGINEERING AS SOCIAL EXPERIMENTATION**

Engineering as experimentation - Engineers as responsible experimenters - Balanced outlook on law - Cautious optimism - Safety and risk - Assessing and reducing risk - Safe exits - The Challenger case study - Bhopal Gas Tragedy - The Three Mile Island and Chernobyl.

**UNIT IV** **6 Hours**

**WORKPLACE RESPONSIBILITIES AND RIGHTS**

Fundamental Rights - Responsibilities and Duties of Indian Citizens - Teamwork - Ethical corporate climate - Collegiality and loyalty - Managing conflict - Respect for authority - Collective bargaining - Confidentiality - Conflicts of interest - Occupational crime - Professional rights - Employee rights.

**UNIT V** **6 Hours**

**GLOBAL ISSUES**

Multinational corporations: Technology transfer and appropriate technology - International rights - promoting morally just measures - Environmental ethics: Engineering, ecology - economics - Human and sentient centred - and bio and eco centric ethics - Computer ethics and internet - Engineers as managers - Consulting engineers - Engineers as expert witnesses and advisors - Moral leadership.

**FOR FURTHER READING**

Sample code of ethics like IETE,ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management.

**Total: 30 Hours**

**Reference(s)**

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering, 4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi, 2014.
2. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi, 2012.
3. R S Naagarazan, A text book on professional ethics and human values, New age international (P)limited, New Delhi,2006.
4. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
5. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics - Concepts and Cases, Wadsworth Thompson Learning, United States, 2005.
6. http://www.slideworld.org/slidestag.aspx/human-values-and- Professional-ethics.

## 21AE602 FLIGHT DYNAMICS 3 1 0 4

**Course Objectives**

- To impart the necessary background for understanding the physical behavior of flight during maneuvers.
- To understand the application of various aircraft components towards the longitudinal & lateral stability.
- To understand the application of various aircraft components towards the dynamic stability and control.
- To describe the performance of aircraft and its component during different maneuvers.
- To understand the basic concepts of special maneuvers like spin, dutch roll, auto rotation and spiral divergence.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
m. Utilize the knowledge of aeronautical engineering to provide realistic solutions in the field of aerodynamics, aircraft structures, avionics and propulsive systems.
n. Impart professional skills through modelling and simulation tools in design and analysis to meet the airworthiness requirements.
o. Develop systems and components with innovative techniques, efficient management and maintenance practices.

**Course Outcomes (COs)**

1. Analyze the aerodynamic performance characteristics of the airplane operating under various operating conditions
2. Evaluate the range and endurance of the aircraft of the aircraft and to apply in the aircraft design process.
3. Analyze the static longitudinal stability of an aircraft.
4. Analyze the lateral and directional static stability with respect to different control surfaces.
5. Analyze the dynamic stability and solve the characteristics equation for control of the aircraft.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 3 | 1 | | | | | 1 | | | | 1 | 1 | 3 |
| 2 | 3 | 3 | 2 | 1 | | | | | 1 | | | | 2 | 1 | 3 |
| 3 | 3 | 2 | 1 | 2 | | | | | 1 | 1 | | | 2 | 1 | 3 |
| 4 | 3 | 2 | 1 | 2 | 1 | | | | 2 | 1 | | | 2 | 1 | 3 |
| 5 | 3 | 3 | 2 | | | | | 1 | 2 | | | | 2 | 1 | 3 |

**UNIT I** **7 Hours**

**AERODYNAMICS CHARACTERISTICS OF AIRPLANE**

International Standard Atmosphere, Degree of freedom of rigid bodies in space, Forces and moments acting on a rigid flight vehicle - Equation of motion, Lift curves, Drag - Different types of drag - Drag polar from low speed to high speeds, Variation of thrust, power and SFC with velocity and altitude for air breathing engines.

**UNIT II** **11 Hours**

**AIRCRAFT PERFORMANCE**

Performance of an airplane in steady level flight - Condition for minimum drag and power required - Range and Endurance, Climbing flight - Maximum rate of climb, Gliding flight - Maximum range and

minimum rate of sink, Turning flight (Level turn, Pull up and Pull down maneuvers) - Maximum turn rate and minimum turn radius, Take-off and landing performance, V-n diagram.

**UNIT III** **10 Hours**

**STATIC LONGITUDINAL STABILITY**

Introduction to static and dynamic stability - Inherently stable and marginal stable airplanes - Purpose of controls in airplanes, Static Longitudinal stability - Wing contribution - Tail contribution - Effects of other parts (fuselage, nacelle and etc..) - Neutral point - Influence of CG location - Static margin - Power effects, Stability criterion, Hinge moment - Stick fixed and stick free longitudinal stability.

**UNIT IV** **8 Hours**

**LATERAL AND DIRECTIONAL STATIC STABILITY**

Introduction to lateral and directional static stability and control - Coupling between rolling and yawing moments - Weather cocking effect - Dihedral effect - Wing Sweep angle effect - Corkscrew effect (Spiralling slipstream) - Keel Effect - Adverse yaw - Aileron reversal - Rudder requirements - One engine inoperative condition - Rudder lock.

**UNIT V** **9 Hours**

**DYNAMIC STABILITY**

Longitudinal dynamic stability: Equations of motion - Stability derivatives - Characteristic equation of stick fixed case - Modes and stability criterion - Effect of freeing the stick, Lateral and directional dynamic stability: Spiral & directional divergence - Dutch roll - Auto rotation - spin & spin recovery.

**FOR FURTHER READING**

Center of pressure and Aerodynamic center, Limitations of pull up and push over, Static longitudinal stability: Stick force gradients - Stick force per "g" - Aerodynamic Balancing, Determination of neutral points and maneuver points from flight test, Comparison of various lateral and directional stability components.

**Total: 60 Hours**

**Reference(s)**

1. Courtland D. Perkins, Robert E. Hage, "Airplane Performance stability and Control", Wiley India Pvt Ltd, 2011.
2. Robert Nelson, "Flight Stability and Automatic Control", 2nd Edition, McGraw Hill Education (India) Private Limited, 2007.
3. Bernard Etkin, Lloyd Duff Reid, "Dynamics of Flight Stability and Control", 3rd Edition, Wiley India Pvt Ltd, 2010.
4. A. W. Babister, "Aircraft Dynamic Stability and Response", Pergamon Press, 2013.
5. http://nptel.ac.in/courses/101104061/
6. http://nptel.ac.in/courses/101104062/

## 21AE603 AVIONICS 3 0 2 4

**Course Objectives**

- To attribute the fundamentals applications of Avionics components implemented in flight vehicles.
- To extract the method of integrating the avionics systems and networking phenomenon.
- To introduce the layout and the structure of Modern Glass cockpit section.
- To familiarize the knowledge on advanced systems integrated in the cockpit units
- To introduce the implementation of RADAR technology in the modern cockpit.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. 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.
m. Utilize the knowledge of aeronautical engineering to provide realistic solutions in the field of aerodynamics, aircraft structures, avionics and propulsive systems.
n. Impart professional skills through modelling and simulation tools in design and analysis to meet the airworthiness requirements.
o. Develop systems and components with innovative techniques, efficient management and maintenance practices.

**Course Outcomes (COs)**

1. Apply the concept of Avionics to execute the mission profile of Aviation Units.
2. Analyse the impact of introducing the data buses and standards for integrating the systems and subsystems.
3. Analyze the conceptual methodology design and construct the Modern cockpit unit
4. Analyze the operational behaviour of advanced cockpits.
5. Analyze the operating principles RADAR based cockpit instruments integrated in the cockpit.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | | 2 | 1 | 1 |
| 2 | 1 | 2 | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | | 2 | 1 | 1 |
| 3 | 1 | 2 | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | | 2 | 1 | 1 |
| 4 | 1 | 2 | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | | 2 | 1 | 1 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 1 | 2 | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | | 2 | 1 | 1 |

**UNIT I** **9 Hours**

**AIRCRAFT AVIONICS**

Introduction to Avionics: Need for avionics in civil, military and spacecraft - Evolution of Avionics Architectures - Avionics system Design approaches and Factors - DO-178B and DO254 Avionics standards.

**UNIT II** **9 Hours**

**AVIONICS INTEGRATION**

Data buses, Protocols and network topology - Characteristics of ARINC 429 and ARINC 629 Data bus - MILSTD 1553B data bus design standards - Modern Integrated Modular Avionics Unit.

**UNIT III** **9 Hours**

**MODERN COCKPIT**

Layout of Glass cockpit - Electronic Flight Instrument System -Primary Flight Display - Multi-Function Display - Engine Indicating and Crew Alerting system - Head Up Disply - Helmet Mounted Display - Next Generation cocpit System and Aircraft Operations - Cockpit Design Standards.

**UNIT IV** **9 Hours**

**ADVANCED AVIONICS SYSTEMS**

Ground proximity warning system - Traffic Collision Avoidance System - Air Data Computer System - Concept of Auto landing - Flight Management Systtem: Flight Planning and Path Optimization Techniques.

**UNIT V** **9 Hours**

**RADAR AVIONCS**

RADAR -Basic terminologies and Classifications - Functions of Airborne RADAR system - On-board weather RADAR system - Operation of Electronic warfare system.

**FOR FURTHER READING**

Navigation and Communication system

**1** **3 Hours**

## EXPERIMENT 1

Simulation of Altitude hold and Heading hold operation using Glass cockpit Electronic control unit.

**2** **3 Hours**

## EXPERIMENT 2

Demonstrate the frequency mapping process to execute the Autolanding Operation.

**3** **3 Hours**

## EXPERIMENT 3

Execute the Flight Plan algorithm using navigational chart with real time flight simulator.

**4** **3 Hours**

## EXPERIMENT 4

Execute the radio frequency based navigation guidance using Cockpit control Unit.

**5** **3 Hours**

**EXPERIMENT 5**
Execute the waveform generation using Cathode Ray Oscilloscope interfacing with Digital to Analog converter.

**6** **3 Hours**

**EXPERIMENT 6**
Design the circuits to verify the operation of Multiplexer and Demultiplexer data conversion process using Digital IC Trainer.

**7** **3 Hours**

**EXPERIMENT 7**
Design the circuits to execute digital inputs arithmetic operation using Digital IC trainer Kit.

**8** **3 Hours**

**EXPERIMENT 8**
Execute the 8-bit and 16 bit data processing algorithm using programming techniques of 8085 Microprocessor.

**9** **3 Hours**

**EXPERIMENT 9**
Simulation of pitch rate Auto-pilot system with closed loop control feedback mechanism.

**10** **3 Hours**

**EXPERIMENT 10**
Measurement of Primary Flight Display data using Digital Glass cockpit system.

**Total: 75 Hours**

**Reference(s)**

1. Spitzer, C.R., "Digital Avionic Systems", The Blackburn Press; Second, Edition, 2007.
2. Helfrick, A. "Principles of Avionics", 6th Edition, Avionics Communications Inc., 2010.
3. Brain Kendal, "Manual of Avionics", 3rd Edition, the English Book House, New Delhi, 1993.
4. Middleton, D.H., Ed., "Avionics Systems", New edition, Longman Scientific and Technical,Longman Group UK,2005.
5. Dale R. Cundy and Rick S. Brown, "Introduction to Avionics", Pearson Education, 2010.
6. Ian Moir and Allan Seabridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", Wiley India Pvt Ltd; Third edition, 2012.

## 21AE607 FLOW SIMULATION LABORATORY 0 0 2 1

**Course Objectives**

- To train the students for flow analysis using CFD based software packages.
- To introduce the problems and modern calculation methods in different types of flows aircrafts, as well as their application to solving real problems.
- To impart knowledge about Flow properties of viscous and inviscid flows.
- To impart the knowledge of turbulence models and multistage time stepping methods in CFD.
- To provide knowledge on the advantages of Flow Simulation instead of Real-time Experiments.

**Programme Outcomes (POs)**

b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
m. Utilize the knowledge of aeronautical engineering to provide realistic solutions in the field of aerodynamics, aircraft structures, avionics and propulsive systems.
n. Impart professional skills through modelling and simulation tools in design and analysis to meet the airworthiness requirements.

**Course Outcomes (COs)**

1. Analyse the various flow phenomena.
2. Analyse the flow characteristics over cylinder and airfoil.
3. Analyse the effects of boundary layer and supersonic flows.
4. Evaluate the internal flow parameters.
5. Analyse the external flow phenomenon in three dimensional models.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 3 | 3 | 3 | 3 | | | 1 | | 3 | | | 2 | 2 | |
| 2 | | 3 | 3 | 3 | 3 | | | 1 | | 3 | | | 2 | 2 | |
| 3 | | 3 | 3 | 3 | 3 | | | 1 | | 3 | | | 2 | 2 | |
| 4 | | 3 | 3 | 3 | 3 | | | 1 | | 3 | | | 2 | 2 | |
| 5 | | 3 | 3 | 3 | 3 | | | 1 | | 3 | | | 2 | 2 | |

**1** **3 Hours**

**EXPERIMENT 1**

Design, mesh and perform analysis of Laminar flow and turbulent flow in a duct and its interaction.

**2** **3 Hours**

**EXPERIMENT 2**

Design, mesh and perform analysis of Steady flow past a cylinder.

**3** **3 Hours**

**EXPERIMENT 3**

Design, mesh and perform analysis of Un-steady flow past a cylinder.

**4** **3 Hours**

**EXPERIMENT 4**

Design, mesh and perform analysis of Flow over an Airfoil.

**5** **3 Hours**

**EXPERIMENT 5**

Design, mesh and perform analysis of boundary layer over a flat plate.

**6** **3 Hours**

**EXPERIMENT 6**

Design, mesh and perform analysis of Supersonic flow over a wedge and cone

**7** **3 Hours**

**EXPERIMENT 7**

Design, mesh and perform analysis of Compressible flow in a C-D nozzle.

**8** **3 Hours**

**EXPERIMENT 8**

Design, mesh and perform analysis of a supersonic inlet.

**9** **3 Hours**

**EXPERIMENT 9**

Design, mesh and perform analysis of 3D transonic flow.

**10** **3 Hours**

**EXPERIMENT 10**

Design, mesh and perform analysis of flow in a combustion chamber.

**Total: 30 Hours**

## 21AE608 AIRCRAFT DESIGN PROJECT 0 0 4 2

**Course Objectives**

- To introduce and develop the basic idea of aircraft design process.
- To make the students to work in a group and understand the concepts involved in Aerodynamic design, Performance analysis, and Stability aspects of differenet types of airplanes.
- To perform comparative studies on different types of airplanes with reference to the design work under taken.
- To learn about preliminary weight estimation, selection of design parameters, power plant selection, aerofoil selection, fixing the geometry of wing, tail, and control surfaces.
- To prepare the layout drawing, construction of balance and three view diagrams of the airplane under consideration.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. 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.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. Utilize the knowledge of aeronautical engineering to provide realistic solutions in the field of aerodynamics, aircraft structures, avionics and propulsive systems.
n. Impart professional skills through modelling and simulation tools in design and analysis to meet the airworthiness requirements.

**Course Outcomes (COs)**

1. Frame the mission requirements, Carryout comparative configuration study of different types of airplanes and Construct comparative data sheets, comparison data graphs and main parameters for the design.
2. Compute the weights of crew, payload, and fuel required to complete the mission, empty weight, mission segment weights and 'cg' location variation.
3. Choose the suitable power plant, aerofoil, geometry of wing, geometry of tail, & control surfaces and Analyze the drag polar, performance characteristics, and stability derivatives.
4. Construct final V-n diagram with gust and maneuverability envelopes for the design study
5. Estimate the loads on an aircraft structural components and able to design the components to meet the load requirements.

**Articulation Matrix**

| C | PO | PO | PO | PO | PO | PO | PO | PO | PO | PO1 | PO1 | PO1 | PSO | PSO | PSO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| O No | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | | |
| 2 | 2 | 3 | 2 | 1 | 1 | | | 1 | 3 | 3 | | 2 | 1 | | |
| 3 | 2 | 3 | 3 | | 2 | 1 | 1 | 1 | 3 | 3 | | 2 | 2 | 1 | |
| 4 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | | 2 | 2 | | |
| 5 | 2 | 3 | 3 | | 2 | | 1 | 1 | 3 | 3 | | 2 | 2 | 1 | |

**1** **6 Hours**

**EXPERIMENT 1**

Preparation of comparative data sheets.

**2** **6 Hours**

**EXPERIMENT 2**

Comparative graphs preparation and selection of main parameters for the design.

**3** **6 Hours**

**EXPERIMENT 3**

Preliminary weight estimations and Geometry selection.

**4** **6 Hours**

**EXPERIMENT 4**

Drag Estimation and Power plant selection.

**5** **6 Hours**

**EXPERIMENT 5**

Detailed performance calculations and stability estimations.

**6** **6 Hours**

**EXPERIMENT 6**

Creating V-n diagram with gust and maneuverability envelopes.

**7** **6 Hours**

**EXPERIMENT 7**

Structural design of wing, vertical and horizontal tails.

**8** **6 Hours**

**EXPERIMENT 8**

Structural design of fuselage.

**9** **6 Hours**

**EXPERIMENT 9**

Structural design of control surfaces and landing gear.

**10** **6 Hours**

**EXPERIMENT 10**

Preparation of detailed design report with three views CAD drawings.

**Total: 60 Hours**

**18GE601 SOFT SKILLS-APTITUDE II** **0 0 2 0**

**Course Objectives**

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

**Programme Outcomes (POs)**
**Course Outcomes (COs)**

1. Apply the concepts of probability, Sets, Permutation and Combinations in estimating data for real time problems.
2. Understand the concept of logarithms, progressions and Simple and Compound interest to solve various practical problems.
3. Analyse objects involving cubes and cuboids in determining the number of sides colored.
4. Interpret various data from graphs and tables to determine ratio, percentage and averages.
5. Apply the logical reasoning skills for identifying age, relations, visual relations and puzzles.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | |

**1** **2 Hours**

**PERMUTATION AND COMBINATION**

Definition-Fundamental rules-Theorems on Permutation-Theorems on Combination.

**2** **2 Hours**

**PROBABILITY**

Concept and Importance of Probability-Underlying factors for real Life estimation of probability-Basic facts about probability-Some important consideration while defining event.

**3** **2 Hours**

**SYLLOGISM AND VENN DIAGRAM**

Concepts on Syllogisms-Venn diagram-Interpretation-Venn diagram-solving.

**4** **4 Hours**

**SIMPLE INTEREST AND COMPOUND INTEREST**

Introduction-Definition - Effect of change of P, R, T on simple interest-Amount-Amount becomes N times the principle-Repayment of debt in equal installments-Rate and time are numerically equal-

Compound Interest-Conversion period-Basic formula-Special cases-To find the principle / Time /Rate-Difference between Compound Interest and Simple Interest-Equal annual installment to pay the borrowed amount.

**5** **2 Hours**

**MIXTURES AND ALLIGATION**

Definition-Alligationrule-Mean value (cost price) of the mixture-Some typical situations where allegation can be used.

**6** **4 Hours**

**CUBE AND LOGARITHM**

Introduction-Basic Concepts of Cube and Cuboid-Problems involving cubes and cuboids of various dimensions-Problems involving coloured cubes and cuboids - Basic concepts of Logarithm-Laws of Logarithms including change of base-Common logarithm (base 10) - Properties of Logarithms to solve equations involving logarithmic expressions.

**7** **2 Hours**

**DATA INTERPRETATION**

Introduction-Ratio-Percentage-Average-Tables - Graphs and Charts.

**8** **2 Hours**

**PROGRESSION AND LOGICAL REASONING**

Arithmetic progression-Geometric progression-Harmonic progression-Theorems related with progressions.

**9** **2 Hours**

**PROBLEM ON AGES**

Introduction-Basic concept-Usage of Percentage and Averages -Applications.

**10** **2 Hours**

**ANALYTICAL REASONING**

Introduction-Basic concept-Non verbal Analytical Reasoning -Arrangements.

**11** **2 Hours**

**BLOOD RELATION**

Introduction-Basic concept-Kinds of relation-Tree diagram -Relations.

**12** **2 Hours**

**VISUAL REASONING**

Introduction-Basic concepts-Odd man out-Next series-Mirror image and water image

**13** **2 Hours**

**SIMPLIFICATIONS**

Introduction-Basic concepts-Arithmetic operations-Equation solving methods-Puzzles.

**Total: 30 Hours**

**Reference(s)**

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.

2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

## 21AE701 VIBRATIONS 3 1 0 4

**Course Objectives**

- To know the methods and principles of vibration analysis and vibration measuring instruments.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**Course Outcomes (COs)**

1. Apply Newton's law and Energy methods to determine the parameters like natural frequency, time period of a mechanical vibrating system.
2. Estimate the important parameters of different vibrating system conditions to analyze the methods of vibration measurement and its control.
3. Determine the natural frequencies of multi degrees of freedom system using different methods of analysis.
4. Apply the governing equation for a vibration of continuous systems and to solve the approximate methods.
5. Analyze the different aero elastic problems to study aircraft and civil structures and explain its prevention methods.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | | | | | | | | | | | | | |
| 2 | 3 | 1 | | 1 | | | | | | | | | | | |
| 3 | 1 | 2 | | 1 | | | | | | | | | | | |
| 4 | 1 | 2 | | 1 | | | | | | | | | | | |
| 5 | 3 | 1 | | 1 | | | | | | | | | | | |

**UNIT I** **7 Hours**

**SINGLE DEGREE OF FREEDOM SYSTEMS**

Simple harmonic motion-addition-Terminologies - Newtons Law - D Alembertsprinciple-Energy Methods for free vibration.

**UNIT II** **10 Hours**

**DAMPED, FORCED VIBRATIONS OF 1 DOF SYSTEM**

Damped vibrations - Forced Vibrations, with and without damping-support excitation- Vibration measuring instruments- helicopter vibration and methods for measurement and control.

**UNIT III** **10 Hours**

**MULTI DEGREES OF FREEDOM SYSTEMS**

Two degrees of freedom systems - Static and Dynamic couplings vibration absorber-Principal co-ordinates, Principal modes and orthogonal condition - Eigen value problems - Hamilton"s principle-Lagrangean equation and application.

**UNIT IV** **9 Hours**

**CONTINUOUS SYSTEMS AND APPROXIMATE METHODS**

Vibration of elastic bodies-Vibration of strings- Longitudinal, Lateral and Torsional vibrations. Rayleigh method- Holzer Method-stodolas method- matrix iteration method.

**UNIT V** **9 Hours**

**ELEMENTS OF AEROELASTICITY**

Concepts- Coupling - Aeroelastic instabilities and their prevention- Basic ideas on wing divergence, loss and reversal of aileron control- Flutter and its prevention.

**Total: 60 Hours**

**Reference(s)**

1. Thammaiah Gowda, D.V.Girish, T.Jagadeesha "Mechanical vibrations", McGraw Hill Education, 2012.
2. Fung Y.C., "An Introduction to the Theory of Aeroelasticity" Dover Publications Inc.,2008.
3. Timoshenko S., "Vibration Problems in Engineering" John Wiley and Sons, New York, 1993.
4. Singiresu S. Rao "Mechanical Vibrations" 5th edition, Prentice Hall, 2010.
5. http://nptel.ac.in/courses/112103111/
6. http://nptel.ac.in/courses/112103112/

## 21AE702 COMPOSITES AND STRUCTURES 3 1 0 4

**Course Objectives**

- To give a thorough treatment of the classification and properties of composite materials and how they can be analysed, with emphasis on physical understanding
- To provide the necessary knowledge and experience to enable the student to perform independent analyses

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Analyzethe materials (fibres, resins, cores) and its properties to design the aircraft composites
2. Analyze the material properties of the composites using micro and macro mechanics approach to construct the composite structures.
3. Analyze the laminated plates with desired properties and predict its failure criteria.
4. Analyze the sandwich panels with desired properties and predict its failure modes.
5. Apply the major manufacturing techniques to fabricate composites materials.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 3 | | 1 | | | | | | | | | | |
| 2 | 1 | 1 | 3 | 3 | | | | | | | | | | | |
| 3 | 1 | 1 | 1 | 2 | 3 | | | | | | | | | | |
| 4 | 1 | 1 | 1 | 2 | 3 | | | | | | | | | | |
| 5 | 1 | 1 | 2 | 3 | 2 | | | | | | | | | | |

**UNIT I** **8 Hours**

**INTRODUCTION TO COMPOSITES**

Definition - Classification of composite materials - Advantages, limitations and application of composite materials - Properties and classifications of reinforcements and matrices - Factors contribute to mechanical performance of composites - Generalized Hookes law

**UNIT II** **11 Hours**

**METHODS OF ANALYSIS**

Micro mechanics - Mechanics of materials approach, elasticity approach to determine material properties - Macro mechanics - Stress-strain relations - Determination of material properties - Mechanical properties of composites: Tensile test, compression test, flexural test, shear test and inter-laminar shear strength

**UNIT III** **9 Hours**

**LAMINATED PLATES**

Governing differential equation for a general laminate, angle ply and cross ply laminates - Failure criteria for composites.

**UNIT IV** **8 Hours**

**SANDWICH CONSTRUCTIONS**

Basic design concepts of sandwich construction - Materials used for sandwich construction - Failure modes of sandwich panels.

**UNIT V** **9 Hours**

**MANUFACTURING TECHNIQUES**

Degree of Cure - Gel time test - Lay-up - Prepregs - Molding: Compression molding, bag molding, autoclave molding and resin transfer molding - Filament winding - Pultrusion - Centrifugal casting - Extrusion methods

**Total: 60 Hours**

**Reference(s)**

1. R. M. Jones, "Mechanics of Composite Materials", 2nd Edition,Taylor& Francis
2. Madhujit Mukhopadhyay," Mechanics of Composite Materials and Structures", Orient Blackswan Pvt Ltd.
3. D. Agarwal, L. J. Broutman and K. Chandrashekhara, "Analysis and Performance of Fiber Composites", 3rd Edition, John Wiley & Sons.
4. R.F. Gibson," Principles of composite material mechanics",3rd Edition, CRC press.
5. Prof.R.Velmurugan, "e-Book on Composite Materials", IIT Madras.
6. Dr.K.V.NagendraGopal,"e-Book on Composite Structures", IIT Madras.

## 21AE707 FLIGHT PERFORMANCE LABORATORY 0 0 2 1

**Course Objectives**

- comprehend and explain various components of UAVs
- comprehend and explain basics of flight and flight control systems
- understand and describe basic regulations applicable to UAV flight

**Programme Outcomes (POs)**

c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to oneÃƒÂ¢??s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**Course Outcomes (COs)**

1. Measure the atmospheric properties using UAV
2. Measure the in-flight performance parameters in the UAV
3. Construct in-flight V-n diagrams

**Articulation Matrix**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| **No** | | | | | | | | | | | | | | | |
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| 2 | | | - | | - | | | | - | | | | | | |
| 3 | | | - | - | - | | | | | | | | | | |

**1** **3 Hours**

**EXPERIMENT 1**

Measurement of atmospheric properties (Altitude, Temperature and Pressure) by flight testing.

**2** **3 Hours**

**EXPERIMENT 2**

Determination of the Climb rate of the given UAV by Flight testing.

**3** **3 Hours**

**EXPERIMENT 3**

Determination of the Range and endurance by Flight testing using an UAV.

**4** **3 Hours**

**EXPERIMENT 4**

Determination of the Range and endurance using Flight simulator.

**5** **3 Hours**

**EXPERIMENT 5**

Determination of the Turn rate using Flight simulator.

**6** **3 Hours**

**EXPERIMENT 6**

Determination of the Turn rate by Flight testing using an UAV.

**7** **3 Hours**

**EXPERIMENT 7**

Demonstration of Short period and Phugoid mode using Flight simulator.

**8** **3 Hours**

**EXPERIMENT 8**

Construction of V-n diagram for a fixed wing UAV by flight test.

**9** **3 Hours**

**EXPERIMENT 9**

Determination of the Glide performance by Flight testing using an UAV.

**10** **3 Hours**

**EXPERIMENT 10**

Demonstration of adverse flight conditions by using flight simulator.

**Total: 30 Hours**

**21AE708 PROJECT WORK I** **0 0 6 3**

**Course Objectives**

- Students in group carry out the literature survey on the topic of their interest, do the design related works of the project work.
- Presentation on literature survey and definition of project work area and title.
- Students in group carry out the fabrication, analysis, experimentation, and design.
- Compilation of the report on their work and submit the same to the university.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to oneÃƒÂ¢??s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Course Outcomes (COs)**

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Apply the technical ideas, strategies and methodologies.
3. Apply new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Conduct the test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare report and present the oral demonstrations.

**Articulation Matrix**

| C | PO | PO | PO | PO | PO | PO | PO | PO | PO | PO1 | PO1 | PO1 | PSO | PSO | PSO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| O No | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 3 | 2 | | | 2 | 1 | | | | | | | | |
| 2 | 2 | 2 | 1 | 3 | | 2 | | | | | 2 | 2 | | | |
| 3 | | | 3 | 2 | 2 | - | | 2 | | | 2 | 2 | | | |
| 4 | | 1 | | 2 | 3 | 1 | 2 | 2 | | | | | | | |
| 5 | | | | | | | | - | 3 | 3 | | 2 | | | |

**Total: 0 Hours**

**0 0 18 9**

## 21AE804 PROJECT WORK II

**Course Objectives**

- Students in group carry out the literature survey on the topic of their interest, do the design related works of the project work.
- Presentation on literature survey and definition of project work area and title.
- Students in group carry out the fabrication, analysis, experimentation, and design.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to oneÃƒÂ¢??s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Course Outcomes (COs)**

1. Analyze the real world problem, identify the requirement and develop the design solutions.
2. Apply the technical ideas, strategies and methodologies to design the airframe
3. Apply new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Apply the test on prototype and examine the cost effectiveness factor.
5. Prepare report and present the oral demonstrations.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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| 1 | | 3 | 2 | | | 2 | 1 | | | | | | | | |
| 2 | 2 | 2 | 1 | 3 | | 2 | | | | | 2 | 2 | | | |
| 3 | | | 3 | 2 | 2 | - | | 2 | | | 2 | 2 | | | |
| 4 | | 1 | | 2 | 3 | 1 | 2 | 2 | | | | | | | |
| 5 | | | | | | | | | 3 | 3 | | 2 | | | |

**Total: 0 Hours**

**18HS201 COMMUNICATIVE ENGLISH II 1 0 2 2**

**Course Objectives**

- Read and understand ideas of complex text on both concrete and abstract topics
- Listen and understand technical discussions in his/her field of specialisation
- Produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options
- Interact with a degree of fluency and spontaneity that makes regular interaction without strain

**Programme Outcomes (POs)**

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

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

**Course Outcomes (COs)**

1. Use appropriate grammar & vocabulary that is expected at the BEC Vantage exam level.
2. Understand the general meaning of non-routine letters, and of a report of predictable / unpredictable topic
3. Write simple reports of factual nature and factual non-routine letters
4. Ask for factual information and understand the answer; and take/pass on workplace messages
5. Express opinions and present arguments to a limited extent; and give simple, prepared presentations on familiar topics

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
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**UNIT I** **9 Hours**

**GRAMMAR3**

Tenses - Future continuous, Future perfect, Future perfect continuous, Past perfect, Past perfect continuous - Adjectives and adverbs - Mixed conditionals - Modals - can't have, needn't have - Modals of deduction and speculation - Narrative tenses - Passives - Phrasal verbs, extended - Relative clauses - Reported speech - Will and going to, for prediction - Wish - Would expressing habits, in the past.

**UNIT II** **9 Hours**

**READING**

Scanning and reading for gist - Understanding text structure - Reading for gist and specific information - Vocabulary and structure - Understanding sentence structure and error identification

**UNIT III** **9 Hours**

**WRITING**

A message, memo or email, Giving instructions, explaining a development, asking for comments, requesting information, agreeing to requests - Business correspondence: explaining, apologising, reassuring, complaining, short report: describing, summarising - proposal: describing, summarising, recommending, persuading.

**UNIT IV** **9 Hours**

**LISTENING**

Listening for and noting specific information - Listening to identify topic, context, Function - Following the main points and retrieving specific information from the text.

**UNIT V** **9 Hours**

**SPEAKING**

Giving personal information: Talking about present circumstances, past experiences and future plans, expressing opinions, speculating - Organising a larger unit of discourse: Giving information and expressing and justifying opinions - Turn-taking: negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing/disagreeing, suggesting, speculating, comparing and contrasting, and decision-making.

1.A Horse and Two Goats - R K Narayan
2.My Lord the Baby - Rabindranath Tagore
3.Twist in the Tale - Jeffery Archer
4.The Third and Final Continent - Jhumpa Lahiri
5.The Gift of the Magi - O Henry

**Total: 45 Hours**

**Reference(s)**

1. Guy Brook-Hart, "BEC Vantage: Business Benchmark Upper-Intermediate- Student's Books" 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Ian Wood, Paul Sanderson, Anne Williams with Marjorie Rosenberg, "Pass Cambridge BEC Vantage- Student's Book" 2nd Edition, Cengage Learning, New Delhi, 2014
3. Michael Handford, Martin Lisboa, Almut Koester, Angela Pitt, "Business Advantage - Student's Book Upper-Intermediate" Cambridge University Press, New Delhi, 2014.
4. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE - Self-study Edition", Cambridge University Press, UK, 2005.

## 18HSC01 CHINESE 1 0 2 2

**Course Objectives**

- To help students appear for HSK Level 1 Exam
- To help students acquire the basics of Chinese language
- To teach the students how to converse in Chinese in various situations

**Programme Outcomes (POs)**

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

**Course Outcomes (COs)**

1. listen and identify individual sounds of Chinese
2. use basic sounds and words while speaking
3. read and understand short passages on familiar topics
4. use basic sentence structures while writing
5. understand and use basic grammar and appropriate vocabulary in completing language tasks

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
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**UNIT I** **9 Hours**

**UNIT 1**

Hello
1.Initials and Finals of Chinese
b,p,m,f,d,,n,l,g,k,h,j,q,x
2. Tones Four
3.Chinese Syllables
4.Tone S

**UNIT II** **9 Hours**

**UNIT 2**

Thank you -
Initials and Finals of Chinese
The Neutral Tone
Rules of Tone Marking and Abbreviation

**UNIT III** **9 Hours**

**UNIT 3**

1. What"s your name - In the school; -In the classroom; -In the school
The Interrogative Pronoun
2 The Sentence
3 Interrogative Sentences with

**UNIT IV** **9 Hours**

**UNIT 4**

She is my Chinese teacher -
In the library
The Interrogative Pronouns
The Structural Particle
The interrogative Particle

**UNIT V** **9 Hours**

**UNIT 5**

Her daughter is 20 years old this year -
1.The Interrogative Pronoun
2. Numbers below 100
3.Indicating a Change
The Interrogative Phrase

**Total: 45 Hours**

**18HSF01 FRENCH** **1 0 2 2**

**Course Objectives**

- To prepare the students for DELF A1 Examination
- To teach them to converse fluently in French in day-to-day scenarios

**Programme Outcomes (POs)**

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

**Course Outcomes (COs)**

1. To help students acquire familiarity in the French alphabet & basic vocabulary
2. listen and identify individual sounds of French
3. Use basic sounds and words while speaking
4. Read and understand short passages on familiar topics
5. Understand and use basic grammar and appropriate vocabulary in completing language tasks

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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**UNIT I** **9 Hours**

**ENTRER EN CONTACT**

La langue francaise, alphabets, les numeros, les jours, les mois. Grammaire Les verbes s"appeler,etre, avoir, les articles definis, indefinis Communication - Saluer, s"informer sur quelquun, demander de se

presenter Lexique - Les alphabets, les nationalites, age, les pays, les couleurs, les jours de la semaine, les mois de l"annee, les professions

**UNIT II** **9 Hours**

**PARTAGER SON LIEU DE VIE**

Les francais et leur habitat, des habitations insolites Grammaire - Verbes - Conjugaison : Present (Avoir / etre / ER, IR, RE : Regulier et Irregulier) - Adjectifs les propositions de lieu Communication - Chercher un logement, d"ecrire son voisin, s"informer sur un logement Lexique - L"habitat, les pieces, l"equipement, la description physique

**UNIT III** **9 Hours**

**VIVRE AU QUOTIDIEN**

Grammaire - Articles contractes, verbes vouloir, pouvoir, devoir, adjective interrogative, future proche Communication- Exprimer ses gouts, parler de ses loisirs, justifier un choix, exprimer une envie Lexique - le temps libre et les loisirs, les saisons, les activites quotidiennes, le temps (le matin, le soir, la nuit)

**UNIT IV** **9 Hours**

**COMPRENDRE SON ENVIRONNEMENT CULTURE**

Grammaire - Verbes - Finir, Sortir, les adjectifs demonstratifs, le passe compose, imparfait Communication - Propose a de faire quelque chose, raconteur une sortie au passe parler un film Lexique - Les sorties, la famille, art, les vetements et les accessoires

**UNIT V** **9 Hours**

**GOUTER A LA CAMPAGNE**

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantite Communication Accepter et refuse rune invitation, donner des instructions, commander au restaurant Lexique Les services et les commerces, les aliments, les ustensiles, argent

**Total: 45 Hours**

**Reference(s)**

1. Saison A1, Methode de francais
2. Hachette FLE

## 18HSG01 GERMAN 1 0 2 2

**Course Objectives**

- To help students appear for the A1 level Examination
- To teach them how to converse fluently in German in day-to-day scenarios

**Programme Outcomes (POs)**

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

**Course Outcomes (COs)**

1. listen and identify individual sounds of German
2. use basic sounds and words while speaking
3. read and understand short passages on familiar topics
4. use basic sentence structures while writing
5. understand and use basic grammar and appropriate vocabulary in completing language tasks

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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**UNIT I** **9 Hours**

**UNIT 1**

Introduction to German language: Alphabet - Numbers - Greetings - Days and Seasons- Working with Dictionary.

**UNIT II** **9 Hours**

**UNIT 2**

Nouns - articles - Speaking about one self - Listening to CD supplied with the books, paying special attention to pronunciation

**UNIT III** **9 Hours**

**UNIT 3**

Regular & Irregular verbs - Personal pronouns - family - Introduction to types of sentences

**UNIT IV** **9 Hours**

**UNIT 4**

Question words-Types of Questions - Nominative case- Verb Conjugation - country - nationalities

**UNIT V** **9 Hours**

**UNIT 5**

Verbs - to be & to have - conjugation - Hobbys - Framing basic Questions and answers

**Total: 45 Hours**

**Reference(s)**

1. Kursbuch and Arbeitsbuch, NETZWERK A1 DEUTSCH ALS FREMDSPRACHE, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2015
2. Langenscheidt Eurodictionary - German - English / English - German, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2009
3. Grundkurs, DEUTSCH Lehrbuch Hueber Munichen, 2007.

**18HSH01 HINDI** **1 0 2 2**

**Course Objectives**

- To help students acquire the basics of Hindi
- To teach them how to converse in Hindi on simple day-to-day situations
- To help students acquire the ability to understand a simple technical text in Hindi

**Programme Outcomes (POs)**
**Course Outcomes (COs)**

1. Construct simple sentences and use vocabulary required for day-to-day conversation.
2. Distinguish and understand the basic sounds of Hindi language.
3. Appear for Hindi examinations conducted by Dakshin Bharat Hindi Prachar Sabha.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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**UNIT I** **9 Hours**

**UNIT 1**

Hindi Alphabet: Introduction - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

**UNIT II** **9 Hours**

**UNIT 2**

Nouns: Genders (Masculine & Feminine Nouns long vowels and short vowels - -Masculine & Feminine - Reading Exercises.

**UNIT III** **9 Hours**

**UNIT 3**

Pronouns and Tenses: Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

**UNIT IV** **9 Hours**

**UNIT 4**

Classified Vocabulary: Parts of body - Relatives - Spices - Eatables - Fruit & Vegetables - Clothes - Directions - Seasons - Professions.

**UNIT V** **9 Hours**

**UNIT 5**

Speaking: Model Sentences and Rhymes - Speaking practice for various occasions.

**Total: 45 Hours**

**Reference(s)**

1. Hindi Prachar Vahini-1 by Dakshin Bharat Hindi Prachar Sabha Chennai
2. B.R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People,Vee Kumar Publications(P)Ltd., New Delhi,2009
3. Videos, Stories, Rhymes and Songs

## 18HSJ01 JAPANESE 1 0 2 2

**Course Objectives**

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquettes

**Programme Outcomes (POs)**
**Course Outcomes (COs)**

1. Recognise and write Japanese alphabet
2. Speak using basic sounds of the Japanese language
3. Apply appropriate vocabulary needed for simple conversation in Japanese language
4. Apply appropriate grammar to write and speak in Japanese language
5. Comprehend the conversation and give correct meaning

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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**UNIT I** **9 Hours**

**UNIT I**

Introduction to Japanese - Japanese script- Pronunciation of Japanese(Hiragana)- (Katakana) Long vowels - Pronunciation of in,tsu,ga - Letters combined with ya,yu,yo - Daily Greetings and Expressions - Numerals. N1 wa N2 desu - N1 wa N2 ja arimasen - S ka N1 mo - N1 no N2 - san - Kore - Sore - Are - Kono N - Sono N - Ano N - Sou desu - Sou ja Arimasen - S1 ka - S2 ka - N1 no N2 - Sou desu ka - Koko - Soko - Asoko - Kochira - Sochira Achira - N1 wa N2 (place) desu - Doko - Dochira - N1 no N2 - Ko - So - A - Do ( Demonstrative words) - O kuni Kanji10 - Technical Japanese Vocabulary (30 Numbers)

**UNIT II** **9 Hours**

**UNIT II**

Introduction to time - Ji - Fun - Pun - Introduction of verbs - V Masu - V Masen - V Mashita - V Masendeshita N (Time) Ni V - N1 Kara - N2 Made - N1 to N2 - S Ne - N (Place) e Ikimasu - Kimasu - Kaerimasu - Doko (e) Mo Ikimasen - Ikimasendeshita - N (Vechile) de Ikimasu - Kimasu - Kaerimasu - N (Person / Animal) to V - Itsu - S Yo N o (transitive) - N o Shimasu - Nani o Shimasuka - Nan and Nani - N (place) de V - V Masenka - V Mashou - o - Kanji 10 - Technical Japanese Vocabulary (30 Numbers) .

**UNIT III** **9 Hours**

**UNIT III**

N (tool/means) de V - Word/Sentence wa Go de Nani desu ka - N (person) Ni Agemasu, etc - N (person) Ni Moraimasu etc - Mou V Mashita - Introduction to Adjectives - N wa Na adj (Na) desu - N wa II adj (II) desu - Na adj Na n - II adj (II) N - Totemo - Amari - N wa Dou desuka - N1 wa Donna N2 desuka - S1 Ga S2 - Dore N ga Arimasu - Wakarimasu - N Ga Sukidesu - Kiraidesu - Jozu desu - Heta desu - Donna N - Yoku - Daitai - Takusan - Sukoshi - Amari - Zenzen - S1 kara S2 - Doushite - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

**UNIT IV** **9 Hours**

**UNIT IV**

N ga Arimasu - Imasu - N1 (place) Ni N2 ga Arimasu - Imasu - N1 (thing/person/place) no N2 (position) - N1 ya N2 - Word (s) desuka - Chirisosu wa Arimasuka - Saying numbers - Quantifier (period) Ni kai V - Quantifier Dake - N dake - Past tense of Noun sentences and Na adjective sentences - Past tense of ii adjective sentences - N1 wa N2 yori adjective desu - N1 to N2 to dochira ga adjective desu ka - N1/N2 no houga adjective desu - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

**UNIT V** **9 Hours**

**UNIT V**

N ga hoshi desu - V masu form tai desu - N (place) e V masu form - N Ni - ikimasu - kimasu - kaerimasu N ni V - N o V - dou ko ka - nani ka - go chuu mon - Verb conjugation - Verb groups - Verb te form - V te form kudasai - V te form imasu - V masu from mashouka - S1 ga S2 - N ga V - V te form mo ii desu - V te form wa ikemasen - V te form imasu Shrimasen - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

**Total: 45 Hours**

**Text Book(s)**

1. Japanese for Everyone: Elementary Main Textbook 1-2, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

**Reference(s)**

1. Japanese for Everyone: Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

## 18GE0P1 NANOMATERIALS SCIENCE 3 0 0 3

**Course Objectives**

- Impart knowledge on Nanoscience
- Explore different techniques of producing nanomaterials
- Create expertise on the applications of nanomaterials in various fields

**Programme Outcomes (POs)**
**Course Outcomes (COs)**

1. Summarize the origin and advance of nanomaterials and its classification
2. Compare the different types of methods adopted for synthesizing nanomaterials
3. Analyze the characterization techniques for analyzing nanomaterials
4. Explain the physical properties exhibited by nanomaterials
5. Organize the nanomaterials developed for advanced technological applications

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
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**UNIT I** **9 Hours**

**NANO SCALE MATERIALS**

Introduction-Feynman's vision-national nanotechnology initiative (NNI) - past, present, future - classification of nanostructures, nanoscale architecture - effects of the nanometer length scale - changes to the system total energy, and the system structures- effect of nanoscale dimensions on various properties - differences between bulk and nanomaterials and their physical properties.

**UNIT II** **9 Hours**

**NANOMATERIALS SYNTHESIS METHODS**

Top down processes - mechanical milling, nanolithography and types based on radiations - Bottom up process physical method: physical vapour deposition, RF sputtering, CVD- chemical method: colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization.

**UNIT III** **9 Hours**

**CHARACTERIZATION TECHNIQUES**

General classification of characterization methods - analytical and imaging techniques - microscopy techniques - electron microscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy - diffraction techniques - X-ray spectroscopy - thermogravimetric analysis of nanomaterials.

**UNIT IV** **9 Hours**

**SEMICONDUCTOR NANOSTRUCTURES**

Quantum confinement in semiconductor nanostructures - quantum wells, quantum wires, quantum dots, super lattices-epitaxial growth of nanostructures-MBE, metal organic VPE, LPE - carbon nano tubes-structure, synthesis and electrical properties -applications- fuel cells - quantum efficiency of semiconductor nanomaterials

**UNIT V** **9 Hours**

**NANOMACHINES AND NANODEVICES**

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- organic LED: basic processes, carrier injection, excitons, optimization - organic photovoltaic cells- particulate and geometrical nanomagnets-magneto resistance.

**Total: 45 Hours**

**Reference(s)**

1. Willam A. Goddard, Donald W.Brenner, "Handbook of Nanoscience, Engineering, and Technology", CRC Press, 2012
2. Charles P. Poole Jr and. Frank J. Owens, "Introduction to Nanotechnology", Wiley Interscience, 2007
3. Guozhong Cao, Y. Wang, "Nanostructures and Nanomaterials-Synthesis, Properties & Applications", Imperials College Press, 2011.
4. T. Pradeep, "NANO: The Essentials Understanding Nanoscience and Nanotechnology", McGraw - Hill Education (India) Ltd, 2012
5. Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan, "Nanoscale Science and Technology", John Wiley and Sons Ltd, 2006
6. Viswanathan B, Aulice Scibioh M, "Fuel cells: Principles and Applications", University Press, 2009.

## 18GE0P2 SEMICONDUCTOR PHYSICS AND DEVICES

**3 0 0 3**

**Course Objectives**

- Impart knowledge in physical properties of semiconducting materials
- Analyze the factors affecting the operation of semiconductor devices
- Apply the physics of semiconductors to develop semiconductor devices

**Programme Outcomes (POs)**

**Course Outcomes (COs)**

1. Exemplify the band gap, drift and diffusion current densities due to carrier transport in semiconductors
2. Analyze the energy band diagram in thermal equilibrium and space charge width of PN junction
3. Illustrate the operation of Bipolar Junction transistor at different modes and different configurations
4. Illustrate the operation of metal oxide field effect transistor and their memory devices

5. Represent the working mechanism of opto-electronic devices

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
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**UNIT I** **9 Hours**

**ENERGY BANDS AND CARRIER TRANSPORT PROPERTIES**

Energy Bands: Formation of energy bands - doping effects - energy levels - electron and hole concept in semiconductor. Carrier transport: Carrier drift-drift current density - conductivity- diffusion current density - total current density

**UNIT II** **9 Hours**

**P-N JUNCTION**

Basic structure and fabrication process of p-n junction - current - voltage characteristics - energy band diagram - equilibrium Fermi levels - depletion region - junction breakdown phenomena - zener - avalanche breakdown.

**UNIT III** **9 Hours**

**BIPOLAR JUNCTION TRANSISTOR**

The basic transistor action - operation in the active mode - current gain - static characteristics - carrier distribution in emitter, base and collector region - modes of operation - current - voltage characteristics of common base and emitter configuration - frequency response and switching of bipolar transistor

**UNIT IV** **9 Hours**

**MOSFET**

The ideal MOS diode - basic fundamentals and characteristics - types - CMOS and BiCMOS - CMOS inverter - MOSFET on insulator - thin film transistor (TFT) - silicon on insulators (SOI) devices - MOS Memory structures - DRAM and SRAM

**UNIT V** **9 Hours**

**PHOTONIC DEVICES**

Radiative transitions and optical absorption-light emitting diodes-organic LED - infrared LED - semiconductor laser - temperature effect - photo detector - photo diode - silicon and compound semiconductor solar cells - efficiency

**Total: 45 Hours**

**Reference(s)**

1. Donald A Neamen, "Semiconductor Physics and Devices", Tata McGraw Hill, 2012
2. S. M. Sze and M. K. Lee, "Semiconductor Devices, Physics and Technology", John-Wiley & Sons, 2015

3. Ben. G. Streetman and S. K. Banerjee , "Solid State Electronic Devices", Pearson Education Ltd, 2015
4. C. Kittel, "Introduction to Solid State Physics", John-Wiley & Sons, 2012
5. J. Millman and C. Halkias, "Electronic Devices and Circuits", Tata McGraw Hill, 2010
6. Hagen Klauk, "Organic Electronics: Materials, Manufacturing and Applications", Wiley-VCH, 2006

## 18GE0P3 APPLIED LASER SCIENCE 3 0 0 3

**Course Objectives**

- Impart knowledge on laser science
- Explore different strategies for producing lasers
- Create expertise on the applications of lasers in various fields

**Programme Outcomes (POs)**
**Course Outcomes (COs)**

1. Illustrate the transition mechanisms and the components of a laser system
2. Compare the different types of lasers based on pumping method, active medium and energy levels
3. Compute the rotation of earth, velocity and distance using lasers and apply the same for day today applications
4. Analyze the role of lasers in surgical and endoscopy applications
5. Apply the laser techniques in industrial applications

**Articulation Matrix**

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**UNIT I** **9 Hours**

**LASER FUNDAMENTALS**

Introduction - principle - absorption and emission of light - thermal equilibrium - Einstein"s prediction - Einstein"s relations - A and B coefficients - condition for large stimulated emission - spontaneous and stimulated emission in optical region - light amplification - condition for light amplification - population inversion- Components of lasers - pumping methods - pumping mechanisms - optical resonator

**UNIT II** **9 Hours**

**LASER BEAM CHARACTERISTICS AND TYPES**

Characteristics of laser - Classification of lasers - principle, construction, working, energy level diagram and applications of molecular gas laser (CO2 laser) - liquid laser (dye laser) - excimer laser - Solid state laser (Nd:YAG laser) - semiconductor laser (homojunction laser).

**UNIT III** **9 Hours**

**LASERS IN SCIENCE**

Introduction - Harmonic generation (SHG) - Stimulated Raman emission - lasers in chemistry - laser in nuclear energy - lasers and gravitational waves - rotation of the earth - measurement of distance - Light detection And Ranging (LIDER) - velocity measurement - holography

**UNIT IV** **9 Hours**

**LASERS IN MEDICINE AND SURGERY**

Light induced biological hazards: Eye and skin - Eye laser surgery - photocoagulations - homeostasis - dentistry - laser angioplasty - different laser therapies - advantages & disadvantages - laser endoscopy.

**UNIT V** **9 Hours**

**LASERS IN INDUSTRY**

Applications in material processing: laser welding - hole drilling - laser cutting- Lasers in electronics industry: information storage - bar code scanner- Lasers in defence: laser based military weapons - laser walls.

**Total: 45 Hours**

**Reference(s)**

1. K. Thiyagarajan and A. K. Ghatak, "LASERS: Fundamentals and Applications", Springer, USA, 2015
2. M. N. Avadhanulu, "An Introduction to Lasers Theory and Applications", S. Chand Publisher, 2013
3. W. Koechner, M. Bass, "Solid State Lasers: a graduate text", Springer Verlag, New York, 2006
4. K. P. R. Nair, "Atoms, Molecules and Lasers", Narosa Publishing House, 2009
5. K. R. Nambiar, "Lasers: Principles Types and Applications", New Age International Publications, 2006
6. A. Sennaroglu, "Solid-State Lasers and Applications", CRC Press, 2006.

## 18GE001 ENVIRONMENTAL SCIENCE AND ENGINEERING

**2 0 0 2**

**Course Objectives**

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life and stimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

**Programme Outcomes (POs)**
**Course Outcomes (COs)**

1. Explain the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. Identify the existing environmental challenges related to pollution and its management
4. Select suitable strategies for sustainable management of components of environmental
5. Correlate the impacts of population and human activities on environment

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
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**UNIT I** **6 Hours**

**NATURAL RESOURCES**

Forest resources: Use - over exploitation - deforestation - case studies. Water resources: Use - over utilization of surface and ground water - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, biomagnification) - water logging - salinity - case studies. Energy resources: renewable(solar, wind, tidal, geothermal and hydroelectric power) - non renewable energy sources

**UNIT II** **6 Hours**

**ECOSYSTEMS AND BIODIVERSITY**

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: forest ecosystem - desert ecosystem - ecological succession. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity - field study

**UNIT III** **6 Hours**

**ENVIRONMENTAL POLLUTION**

Pollution: Definition - causes - effects - control measures of air pollution - water pollution : (Sewage water treatment by activated sludge and trickling filter process) - marine pollution - thermal pollution - noise pollution. Disaster management: causes - effects - control measures of floods - earthquake - cyclone - landslides

**UNIT IV** **7 Hours**

**SOCIAL ISSUES AND ENVIRONMENT**

Sustainable development : Definition - Unsustainable to sustainable development - urban problems related to energy. Environmental ethics - issues and possible solutions - solid waste management - causes - effects - 3R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. Environment protection act: Air (Prevention and control of pollution) act - wildlife protection act

**UNIT V** **5 Hours**

**HUMAN POPULATION AND ENVIRONMENT**

Human population: Population growth - characteristics - variation among nations - population explosion - women and child welfare programmes - value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

**FOR FURTHER READING**

Human rights:E - waste and biomedical waste -Identification of adulterants in food materials

**Total: 30 Hours**

**Reference(s)**

1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering , 4th Multi Colour Edtion, New Age International Publishers, New Delhi, 2014
2. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.
3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press
5. A. K. De, Environmental Chemistry, 7th Edition , New age international publishers, New Delhi, 2014

## 18GE0C1 CORROSION SCIENCE AND ENGINEERING

**3 0 0 3**

**Course Objectives**

- Understand the loss incurred due to corrosion in different sectors and terminologies related to corrosion
- Identify forms and types of corrosion with suitable mechanism
- Apply various methods of corrosion control, corrosion testing and monitoring

**Programme Outcomes (POs)**

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

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

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

**Course Outcomes (COs)**

1. Explain if corrosion can occur under specific operating conditions in a given equipment or construction and indicate regions of immunity, corrosion and passivity of a metal
2. Compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. Identify the corrosion mechanism on steel, iron, zinc and copper metal surfaces
4. Calculate the rate of corrosion on metals using electrochemical methods of testing
5. Propose the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

**Articulation Matrix**

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**UNIT I** **9 Hours**

**CORROSION**

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals - Pourbaix digrams of Mg, Al and Fe and their advantages and disadvantages

**UNIT II** **7 Hours**

**TYPES OF CORROSION**

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion-Catastrophic oxidation corrosion

**UNIT III** **9 Hours**

**MECHANISM OF CORROSION**

Hydrogen embrittlement - corrosion fatigue - filiform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces

**UNIT IV** **10 Hours**

**CORROSION RATE AND ITS ESTIMATION**

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing and eddy current testing

**UNIT V** **10 Hours**

**CORROSION CONTROL METHODS**

Fundamentals of cathodic protection - types of cathodic protection(sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control

**FOR FURTHER READING**

Corrosion issues in supercritical water reactor (SCWR) systems

**Total: 45 Hours**

**Reference(s)**

1. Mouafak A. Zaher, "Introduction to Corrosion Engineering", CreateSpace Independent Publishing Platform, 2016.
2. E.McCafferty, "Introduction to Corrosion Science", Springer; 2010 Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, "Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering", 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, "Corrosion Engineering", Tata McGraw Hill, Singapore, 2008
5. David E.J. Talbot (Author), James D.R. Talbot, "Corrosion Science and Technology", Second Edition (Materials Science & Technology), CRC Press; 2nd Edition, 2007.
6. http://corrosion-doctors.org/Corrosion-History/Eight.htm

## 18GE0C2 ENERGY STORING DEVICES 3 0 0 3

**Course Objectives**

- Understand the concept, working of different types of batteries and analyze batteries used in electric vehicles
- Identify the types of fuel cells and to relate the factors of energy and environment
- Analyze various energy storage devices and fuel cells

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**Course Outcomes (COs)**

1. Explain the parameters required for operation of a cell to evaluate the capacity of energy storage devices
2. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications
3. Differentiate fuel cells based on its construction, production of current and applications
4. Compare different methods of storing hydrogen fuel and its environmental applications
5. Relate energy and environmental based on the importance and types of renewable energy for sustainable development

**Articulation Matrix**

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**UNIT I** **6 Hours**

**BASICS OF CELLS AND BATTERIES**

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid battery - charge efficiency- charge rate - charge retention - closed circuit voltage, open circuit voltage current density - cycle life - discharge rate-over charge-over discharge

**UNIT II** **10 Hours**

**BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES**

Primary batteries - zinc-carbon, magnesium, and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries - introduction, cell reactions, cell representations and applications - lead acid, nickel-cadmium and lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide, lithium anode cell, photogalvanic cells. Battery specifications for cars and automobiles

**UNIT III** **10 Hours**

**TYPES OF FUEL CELLS**

Importance and classification of fuel cells - description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate and direct methanol fuel cells

**UNIT IV** **10 Hours**

**HYDROGEN AS A FUEL**

Sources and production of hydrogen - electrolysis - photocatalytic water splitting - methods of hydrogen storage- high pressurized gas - liquid hydrogen type - metal hydride - hydrogen as engine fuel - features, application of hydrogen technologies in the future - limitations

**UNIT V** **9 Hours**

**ENERGY AND ENVIRONMENT**

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second, third and fourth generation solar cell - photobiochemical conversion cell

**Total: 45 Hours**

**Reference(s)**

1. M. Aulice Scibioh and B. Viswanathan, Fuel Cells: Principles and Applications, University Press, India, 2009
2. F. Barbir,PEM fuel cells: Theory and practice, Elsevier, Burlington, MA, Academic Press, 2013
3. M. R. Dell Ronald and A. J. David, Understanding Batteries, Royal Society of Chemistry, 2001
4. J. S. Newman and K. E. Thomas-Alyea, Electrochemical Systems, Wiley, Hoboken, NJ, 2012
5. Shripad T. Revankar, Pradip Majumdar, Fuel Cells: Principles, Design, and Analysis, CRC Press, 2016
6. Thomas B. Reddy, Linden's Handbook of Batteries, 4th Edition, McGraw Hill Professional, 2010

## 18GE0C3 POLYMER SCIENCE 3 0 0 3

**Course Objectives**

- Explain the properties of different polymers with its mechanism
- Select the appropriate polymerization techniques to synthesize the polymers and its processing
- Identify suitable polymers for various industrial applications

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**Course Outcomes (COs)**

1. Illustrate the types of mechanism of polymerization reactions and analyze the natural and synthetic polymers
2. Identify the suitable polymerization techniques to synthesize the high quality polymers
3. Characterize the polymers to identify the structural, thermal ,mechanical and electrical features for specific applications
4. Apply the polymer processing methods to design polymer products
5. Identify and analyze the polymers used in electronic and biomedical applications

**Articulation Matrix**

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**UNIT I** **10 Hours**

**POLYMERS AND ELASTOMERS**

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization - copolymerization - condensation polymerization (nylon-6,6) - ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene - butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides

**UNIT II** **8 Hours**

**POLYMERIZATION TECHNIQUES**

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation

**UNIT III** **8 Hours**

**CHARACTERIZATION AND TESTING**

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point. Test for electrical resistance, dielectric constant, dissipation factor, arc resistance and dielectric strength - water absorption

**UNIT IV** **9 Hours**

**POLYMER PROCESSING**

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion

**UNIT V** **10 Hours**

**SPECIALITY POLYMERS**

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers. Polymer for biomedical applications: artificial organs, controlled drug delivery, hemodialysis and hemofiltration

**FOR FURTHER READING**

Biodegradable polymers

**Total: 45 Hours**

**Reference(s)**

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, "Polymer Science", New Age International (P) Ltd., New Delhi, 2015
2. Joel R. Fried, "Polymer Science and Technology", Prentice Hall of India (P). Ltd., 2014

3. F. W. Billmeyer,"Text Book of Polymer Science", John Wiley & Sons, New York, 2007
4. Barbara H. Stuart, "Polymer Analysis", John Wiley & Sons, New York, 2008
5. George Odian , "Principles of Polymerization", John Wiley & Sons, New York, 2004
6. R. J. Young and P. A. Lovell, "Introduction to Polymers", CRC Press, New York, 2011

## 18GE0M1 GRAPH THEORY AND COMBINATORICS 3 0 0 3

**Course Objectives**

- This course comprehends the graphs as a modeling and analysis tool in computer science & Engineering
- It introduces the structures such as graphs & trees and techniques of counting and combinations, which are needed in number theory based computing and network security studies in Computer Science.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Recognize the basic ideas of Graph and its characteristics.
2. Assess the characteristics of trees and its properties.
3. Predict the coloring of graphs and its applications in the respective areas of engineering.
4. Compute the permutations and combinations in the engineering field.
5. Demonstrate the types of generating functions and their applications in engineering.

**Articulation Matrix**

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**UNIT I** **9 Hours**

**INTRODUCTION**

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

**UNIT II** **9 Hours**

**TREES, CONNECTIVITY**

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

**UNIT III** **9 Hours**

**MATRICES, COLOURING AND DIRECTED GRAPH**

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

**UNIT IV** **9 Hours**

**PERMUTATIONS**

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

**UNIT V** **9 Hours**

**GENERATING FUNCTIONS**

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - Non-homogeneous recurrence relations - Method of generating functions.

**Total: 45 Hours**

**Reference(s)**

1. Narsingh Deo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics And Its Applications, McGraw Hil, 2007
4. Clark J. & Holton D.A., A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J.L., Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L., Elements of Discrete Mathematics, McGraw Hill, 1985.

## 18GE0M2 ALGEBRA AND NUMBER THEORY 3 0 0 3

**Course Objectives**

- Understand the basic notions of groups, rings, fields which will then be used to solve related problems.
- Examine the key questions in the Theory of Numbers.
- Implement the integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Exemplify the concepts of groups and fields in the areas of Engineering.
2. Classify the different types of fields.
3. Organize the divisibility in number theory in various areas of Engineering.
4. Identify the solution of some kinds of equations.
5. Demonstrate the theorems in number theory.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
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**UNIT I** **9 Hours**

**FIELDS**

Group Theory - Rings and Polynomials - Fields.

**UNIT II** **9 Hours**

**FINITE FIELDS AND POLYNOMIALS**

Finite Fields - Irreducible Polynomials over Finite fields - Factorization of Polynomials over Finite Fields.

**UNIT III** **9 Hours**

**DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS**

Division algorithm- Base-b representations - number patterns - Prime and composite numbers - Fibonacci and Lucas numbers - Fermat numbers - GCD - Euclidean Algorithm - Fundamental theorem of Arithmetic - LCM.

**UNIT IV** **8 Hours**

**DIOPHANTINE EQUATIONS AND CONGRUENCES**

Linear Diophantine equations - Congruence s - Linear Congruence s - Applications: Divisibility tests - Modular Designs - Chinese remainder theorem - 2x2 linear systems.

**UNIT V** **10 Hours**

**CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS**

Wilson s theorem - Fermat s Little theorem - Euler s theorem - Euler s Phi functions - Tau and Sigma functions - Perfect numbers - Mersenne Primes - Mobius Function.

**Total: 45 Hours**

**Reference(s)**

1. Lidl.R., and Pilz. G., Applied Abstract Algebra, Springer-Verlag, New Delhi, 2nd Edition, 2006.
2. Thomas Koshy, Elementary Number Theory with Applications, Elsevier Publications, New Delhi, 2002.

3. San Ling and Chaoping Xing, Coding Theory: A first Course, Cambridge Publications, Cambridge, 2004.
4. Niven.I, Zuckerman.H.S., and Montgomery, H.L., An Introduction to Theory of Numbers, John Wiley and Sons, Singapore, 2004.

## 18GE0M3 MATHEMATICAL FINANCE AND QUEUEING THEORY

**3 0 0 3**

**Course Objectives**

- To provide the required fundamental concepts in probability and queueing models and apply these techniques in networks, image processing etc.
- Acquire skills in analyzing queueing models.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Identify the properties of stochastic process in finance
2. Interpret the concept and applications of Statistics in finance.
3. Demonstrate the basics of finance using the notions of statistics.
4. Assess the classifications and the properties of queues.
5. Implement the concepts of queue in open and closed networks.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
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**UNIT I** **9 Hours**

**APPLIED STOCHASTIC CALCULUS**

Brownian motion - Constructions - Non differentiability - Quadratic variation - Stochastic integration - Construction of Ito integral and properties ,the Ito formula - Feynman-Kac formula

**UNIT II** **9 Hours**

**STATISTICS**

Basic parameter estimation - Maximum likelihood estimation - Distributions - Regression techniques - Tests for normality - QQ plots - Hypothesis testing - Numerical examples in R.

**UNIT III** **9 Hours**

**CONTINUOUS-TIME FINANCE**

Black-Scholes-Merton model of stock prices as geometric Brownian motion, derivation of the Black-Scholes-Merton partial differential equation, the Black-Scholes formula and simple extensions of the model, self-financing strategies and model completeness, risk neutral measures, the fundamental theorems of asset pricing, continuous time optimal stopping and pricing of American options, forwards and futures in Black-Scholes-Merton model.

**UNIT IV** **9 Hours**

**QUEUEING THEORY**

Markovian queues - Birth and Death processes - Single and multiple server queueing models - Little s formula - Queues with finite waiting rooms - Finite source models.

**UNIT V** **9 Hours**

**NON-MARKOVIAN QUEUES AND QUEUEING NETWORKS**

M/G/1 queue - Pollaczek Khinchin formula - M/D/1 and M/EK/1 as special cases - Series queues - Open and closed Jackson networks.

**Total: 45 Hours**

**Reference(s)**

1. M. Capinski and T. Zastawniak, Mathematics for Finance: An Introduction to Financial Engineering, Springer, 2005.
2. S. Shreve, Stochastic Calculus for Finance, Vol. 1 and Vol. 2, Springer, 2004.
3. G. R. Grimmett and D. R. Stirzaker, Probability and Random Processes, 3rd Edition, Oxford University Press, 2001.
4. Taha, H.A., Operations Research, Pearson Education, Asia, 8th Edition, 2007.

## 21AE001 WIND TUNNEL TECHNIQUES 3 0 0 3

**Course Objectives**

- To understand the different types of wind tunnels.
- To interpret the basic concepts of measuring setup of forces and moments on models during the wind tunnel testing.
- To understand the application of various types of wind tunnels.
- To learn the basic measurement procedure involving wind tunnel testing.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**Course Outcomes (COs)**

1. Analyze the dimension of physical quantities using different methods.
2. Design and analyze different types of wind tunnel with respect to speed regions.
3. Apply the calibration procedure in wind tunnel based on speed, flow angularity and turbulence.
4. Compare the wind tunnel measurement techniques and their applications and limitations.
5. Check the flow around aerodynamic models using flow visualizations techniques.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **8 Hours**

**INTRODUCTION**

General features -Types of wind tunnel, Low speed wind tunnel - High speed wind tunnel - Effuser - diffuser-test section - driving unit - special purpose tunnels.

**UNIT II** **9 Hours**

**LOW SPEED WIND TUNNELS**

Components of low speed wind tunnel - convergent section - test section - divergent section - power plant- power losses - energy ratio - losses in cylindrical section -losses in convergent cone - honeycombs - guide vanes-losses due to open jet test section.

**UNIT III** **9 Hours**

**HIGH SPEED WIND TUNNEL**

Blow down type wind tunnels - Induction type tunnels - continuous supersonic wind tunnels - losses in supersonic wind tunnel - supersonic wind tunnel diffusers - effect of second throat.
CALIBRATION OF WIND TUNNEL
Test section speed setting - horizontal buoyancy - flow angularities - turbulence measurements - associated instrumentation - calibration of supersonic tunnels - Mach number determination - determination of test section noise.

**UNIT IV** **10 Hours**

**WIND TUNNEL MEASURING SETUP**

Pressure and velocity measurements - force measurements - three component and six component balances - internal balances.

**UNIT V** **9 Hours**

**FLOW VISUALIZATION**

Smoke and tuft grid techniques - Water flow visualization method - dye injection special techniques - optical methods of flow visualization.

**FOR FURTHER READING**

Study of different types testing model, Study of boundary layer wind tunnel, Importance of calibration and calibration methods, Pressure transducers.

**Total: 45 Hours**

**Reference(s)**

1. Rae, W.H. and Pope, A. "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984.
2. Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press, Taylor & Francis, 2006.
3. Antonio Viviani, Giuseppe Pezzella, "Aerodynamic and Aerothermodynamic Analysis of Space Mission Vehicles", Springer Aerospace Technology, 2015.
4. Pavian, Henry Christensen, "Experimental Aerodynamics", 1st edition, Pitman Publishing, 1940.
5. G P Russo, "Aerodynamic Measurements: From Physical Principles to Turnkey Instrumentation", Woodhead publishing, 1990.
6. Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids", CRC Press - Taylor & Francis, 2007.

## 21AE002 INDUSTRIAL AERODYNAMICS 3 0 0 3

**Course Objectives**

- To build up necessary background for understand the aerodynamic aspects of wind generators, automobiles, buildings etc.
- To understand the application of various aerodynamic aspects in vehicles and buildings etc.,
- To learn the aerodynamics important in recent industries.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**Course Outcomes (COs)**

1. Analyse wind characteristics and understand the historical development of wind turbine, its components and classifications
2. Apply the aerodynamic effects in road vehicle and analyse the various method of drag reduction
3. Analyse the aerodynamics of low rise buildings and high rise building for deign good ventilation.
4. Analyse the effect of Reynolds number on wake formation of bluff shapes.
5. Check the Special features of industrial and stationary gas turbines as compared to aircraft gas turbines.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **9 Hours**

**WIND ENERGY COLLECTORS**

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height. Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.

**UNIT II** **9 Hours**

**GROUND VEHICLE AERODYNAMICS**

Historical development of vehicle aerodynamics - flow phenomenon related to vehicles- flow separation and reattachment - resistance to vehicle motion, Power requirement and drag coefficients of automobiles - Problem based on drag coefficient, Drag reduction technique in road vehicle, Effects of cut back angle, Aerodynamics trains and hovercraft.

**UNIT III** **9 Hours**

**BUILDING AERODYNAMICS**

Pressure distribution on low rise buildings, Wind forces on buildings, Environmental winds in city blocks, Special problems of tall buildings, Building codes, Building ventilation and Architectural aerodynamics.

**UNIT IV** **9 Hours**

**FLOW INDUCED VIBRATIONS**

Effect of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Buffeting, Vortex Shedding, Galloping and flutter.

**UNIT V** **9 Hours**

**INDUSTRIAL GAS TURBINES**

Working of gas turbines, Special features of industrial and stationary gas turbines as compared to aircraft gas turbines.

**FOR FURTHER READING**

Wind mills, Wake formation, Flow over the building model, Application of industrial aerodynamics.

**Total: 45 Hours**

**Reference(s)**

1. T. YomiObidi, "Ground Vehicle Aerodynamics with Applications", SAE International,2014.
2. Lawson,"Building Aerodynamics", Cambridge University Press, 2010.
3. Tomomichi Nakamura, Shigehiko Kaneko, "Flow-Induced Vibrations: Classifications and Lessons from Practical Experiences", Second Edition, Academic Press, 2013.
4. V Ganesan,"Gas Turbines", Third Edition, McGraw Hill Education (India) Private Limited; 2010.
5. A. R. Jha, "Wind Turbine Technology", CRC Press, 2010.
6. Scorer, R.S., "Environmental Aerodynamics", Ellis Harwood Ltd., England, 1998.

## 21AE003 HELICOPTER AERODYNAMICS 3 0 0 3

**Course Objectives**

- To provide an introductory treatment of the aerodynamic theory of rotary - wing aircraft
- To study the fundamentals of rotor aerodynamics for rotorcraft in hovering flight, axial flight, and forward flight modes
- To perform blade element analysis, investigate rotating blade motion, and quantify basic helicopter performance

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**Course Outcomes (COs)**

1. Analyse the major helicopter components, characteristics and configuration
2. Apply and understand the major issues involved in forward flight rotor theory
3. Apply the momentum theory and blade element theory to helicopter rotor blade
4. Analyse the equilibrium condition of helicopter and Trim analysis
5. Estimate the special power requirements and ground effect machines

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
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**UNIT I** **9 Hours**

**INTRODUCTION**

Historical Development if Helicopters - Helicopter configurations based on torque reaction - Control Requirements - Types of Rotor Systems - Basic Power Requirements

**UNIT II** **9 Hours**

**INTRODUCTION TO HOVERING THEORY**

Momentum Theory. - Blade Element Theory - Combined Blade Element and Momentum theories for non uniform inflow calculation - Ideal Rotor Vs Optimum Rotor

**UNIT III** **9 Hours**

**VERTICAL FLIGHT AND FORWARD FLIGHT**

Various flow states of Rotor - Auto rotation in vertical Descent - Ground Flight - Momentum Theory - Variable Inflow Models - Blade Element Theory - Rotor Reference Planes - Hub Loads - Power Variation with forward speed - Rotor blade flapping motion: Simple Model

**UNIT IV** **9 Hours**

**HELICOPTER TRIM AND STABILITY**

Equilibrium condition of helicopter - Trim analysis - Basics of Helicopter Stability

**UNIT V** **9 Hours**

**GROUND EFFECT MACHINES**

Types - Hover height, lift augmentation and power calculations for plenum chamber and pheripheral Jet machine - Drag of hovercraft on land and water. Applications of Hovercraft

**FOR FURTHER READING**

Various configurations - propeller, rotor, ducted fan and jet lift - tilt wing and vectored thrust - performance of VTOL and STOL aircraft in hover, transition and forward motion

**Total: 45 Hours**

**Reference(s)**

1. Gessow, and Myers, G.C., "Aerodynamics of Helicopter", Macmillan & Co., N.Y., 1987.
2. Gupta, L., "Helicopter Engineering", Himalayan Books, 1996.
3. McCormick, B.W., "Aerodynamics of V/STOL Flight", Academic Press, 1987.
4. Johnson, W., "Helicopter Theory", Princeton University Press, 1980.
5. McCormick, B.W., "Aerodynamics, Aeronautics & Flight Mechanics", John Wiley, 1995.

7.

## 21AE004 WIND POWER ENGINEERING 3 0 0 3

**Course Objectives**

- To learn how wind is generated and possible ways of extracting the same.
- To estimate the resource potential.
- To learn the operation of a wind electric generator and wind turbine.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**Course Outcomes (COs)**

1. Analyse the historical development of wind turbine, its components and classifications
2. Understand the characteristics of winds and atmospheric boundary layers.
3. Analyze the methods to measure the performance of wind turbines using different theories.
4. Analyse the wind turbine and its sub system design required for the operation of wind turbine turbines.
5. Evaluate the environmental factors which infer the operation of wind farms and methods for sustainable operations.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **8 Hours**

**INTRODUCTION TO WIND ENERGY**

Background, Motivations, and Constraints, Historical perspective, Wind speed variation -Modern wind turbines, Components and geometry.

**UNIT II** **9 Hours**

**WIND CHARACTERISTICS AND RESOURCES**

General characteristics of the wind resource, Atmospheric boundary layer characteristics, Wind data analysis and resource estimation.

**UNIT III** **9 Hours**

**AERODYNAMICS OF WIND TURBINES**

Forces from wind, Lift and drag forces - Airfoils, 1-D Momentum theory, Ideal horizontal axis wind turbine with wake rotation, Blade element theory -General rotor blade shape performance prediction.

**UNIT IV** **9 Hours**

**WIND TURBINE DESIGN AND CONTROL**

Brief design overview - Introduction - Wind turbine control systems -Typical grid-connected turbine operation -Basic concepts of electric power- Power transformers.

**UNIT V** **10 Hours**

**ENVIRONMENTAL AND SITE ASPECTS**

Overview- Wind turbine siting - Installation and operation- Wind farms- Overview of wind energy economics-Electromagnetic interference-noise.

**FOR FURTHER READING**

Wind turbine energy production estimates using statistical techniques - Wind turbine rotor dynamics - Electrical machines. Ice forming on the blades, Land use impacts, Safety.

**Total: 45 Hours**

**Reference(s)**

1. Emil Simiu& Robert H Scanlan, "Wind effects on structures - Fundamentals and Applications to Design", John Wiley & Sons Inc New York, 2019.
2. Ahmad Hemami, "Wind Turbine Technology", Cengagelearning,Cananda, 2012.
3. Tom Lawson, "Building Aerodynamics", Imperial College Press London, 2001.
4. G P Russo, "Aerodynamic Measurements: From Physical Principles to Turnkey Instrumentation", Woodhead publishing, 2011.
5. N J Cook, "Design Guides to wind loading of buildings structures - Part I & II", Butterworths London, 1985.
6. "IS: 875 (1987) Part III Wind loads, Indian Standards for Building codes",1987.

## 21AE005 WIND TUNNEL INSTRUMENTATION AND MEASUREMENTS

**3 0 0 3**

**Course Objectives**

- To introduce the students to the practical elements of experimental aerodynamics and to develop an appreciation for how aerodynamic data are acquired.
- To provide the students with an opportunity to apply modern instrumentation and measurement techniques to the acquisition of aerodynamic data and understand the inherent limitations of each technique
- To develop a working knowledge of experimental test facilities, techniques and equipment commonly used in the field of experimental aerodynamics.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**Course Outcomes (COs)**

1. Analyse the experimental studies in fluid mechanics and apply different measurement techniques.
2. Analyse different types of wind tunnel with respect to speed regions and explain the calibration of wind tunnel based on speed, flow angularity and turbulence.
3. Check the flow around aerodynamic models using flow visualizations techniques
4. Compare the wind tunnel measurement techniques and their applications and limitations
5. Analyse the data acquisition systems and uncertainty situations using instruments

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **8 Hours**

**BASIC MEASUREMENTS IN FLUID MECHANICS**

Objective of experimental studies - Fluid mechanics measurements - Basic measuring instruments - Performance terms associated with measurement systems - Direct measurements - Analogue methods

- Model analysis - similarities - model law - Importance of model studies - problem based on models law

**UNIT II** **9 Hours**

**WIND TUNNEL MEASUREMENTS**

Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel - Instrumentation and calibration of wind tunnels - Turbulence- Wind tunnel balance - Principle and application and uses.

**UNIT III** **9 Hours**

**FLOW VISUALIZATION AND ANALOGUE METHODS**

Visualization techniques - Smoke tunnel - Hele-Shaw apparatus - Interferometer - Fringe-Displacement method - Shadowgraph - Schlieren system - Background Oriented Schlieren (BOS) System.

**UNIT IV** **9 Hours**

**PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS**

Pitot-Static tube characteristics - Velocity measurements - Hot-wire anemometry - Hot-film anemometry - Laser Doppler Velocimetry (LDV) - Particle Image Velocimetry (PIV) - Pressure measurement device - Manometers -Pressure Transducers - Electrical resistance thermometry- Thermo electric thermometry - pyrometry.

**UNIT V** **10 Hours**

**DATA ACQUISITION SYSTEMS AND UNCERTAINTY ANALYSIS**

Data acquisition and processing - Signal conditioning - Estimation of measurement errors - Uncertainty calculation

**FOR FURTHER READING**

Measurements in boundary layers. Balance calibration. Hydraulic analogy, Hydraulic jumps, Electrolytic tank. Pressure transducers, Temperature measurements. Uses of uncertainty analysis

**Total: 45 Hours**

**Reference(s)**

1. Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids", CRC Press - Taylor & Francis, 2007.
2. Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press, Taylor & Francis, 2006.
3. Pavian, Henry Christensen, "Experimental Aerodynamics", 1st edition, Pitman Publishing, 1940.
4. G P Russo, "Aerodynamic Measurements: From Physical Principles to Turnkey Instrumentation", Woodhead publishing, 1990.
5. Rae W.H., and Pope A., "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984.
6. Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.

## 21AE006 HIGH SPEED AERODYNAMICS 3 0 0 3

**Course Objectives**

- To understand the effect of compressibility at high-speeds and the ability to make intelligent design decisions.
- To analysis the dynamics in subsonic, transonic and supersonic flow regimes in both internal and external geometries.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**Course Outcomes (COs)**

1. Apply the basic concepts in aero-thermodynamic and fluid mechanics for describing various flow phenomenon.
2. Understand the wave formation in the supersonic flow field for determining the nature of shock and expansion wave.
3. Illustrate the wave formation on wedge shaped and concave corners for solving complex problems in supersonic vehicles and develop the fundamental equation for one-dimensional and quasi one- dimensional flow of compressible ideal gas.
4. Analyse the steady isentropic flow, flow with friction and flow with heat transfer for solving problems in flow through one-dimensional passage.
5. Analyse the different wind tunnel configurations utilized for subsonic and supersonic applications.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **9 Hours**

**INTRODUCTION TO COMPRESSIBLE FLOWS**

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.

**UNIT II**

**SHOCK AND EXPANSION WAVES**

Shocks and expansion waves: Development of governing equations for normal shock, stationary 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.

**UNIT III** **9 Hours**

**ONE DIMENSIONAL AND QUASI ONE DIMENSINAL FLOW**

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.

**UNIT IV** **9 Hours**

**APPLICATIONS OF COMPRESSIBLE FLOWS AND NUMERICAL TECHNIQUES**

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.

**UNIT V** **9 Hours**

**EXPERIMENTAL METHODS IN COMPRESSIBLE FLOWS**

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.

**Total: 45 Hours**

**Reference(s)**

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.
3. Ascher H. Shapiro, “The Dynamics and Thermodynamics of Compressible Fluid Flow” JohnWiley& Sons; Volume 1st Edition, 1977.
4. RadhakrishnanEthirajan, “Gas Dynamics”, John Wiley & Sons, 2nd Edition 2010.
5. H W Liepmann and A Roshko, “Elements of Gas Dynamics”, John Wiley & Sons, 4th Edition, 2003.
6. https://nptel.ac.in/courses/101103004/pdf/mod8.pdf
7. https://www.uvm.edu/~dhitt/me346/?Page=exams.html

## 21AE007 CRYOGENICS 3 0 0 3

**Course Objectives**

- To understand the behavior of materials at low temperatures
- To develop skills for designing cryogenic systems including refrigeration, storage and transfer of cryogens, and instrumentation.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**Course Outcomes (COs)**

1. Apply the basic concept to gather introductory knowledge of cryogenic Engineering
2. Analyse the various cycle used for the production of low temperature for different types of gases
3. Analyse the instruments, components and techniques used for the storage of cryogenic gases
4. Apply cryogenic concept for design of aerospace system
5. Analyse different safety procedures to be followed during the storage and handling of cryogenic gases

**Articulation Matrix**

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**UNIT I** **9 Hours**

**INTRODUCTION**

Historical Background - Introduction to cryogenic propellants - Liquid hydrogen, liquid helium, liquid nitrogen and liquid oxygen

**UNIT II** **9 Hours**

**PRODUCTION OF LOW TEMPERATURE**

Theory behind the production of low temperature - Expansion engine heat exchangers - Cascade process- Joule Thompson Effect - Magnetic effect - Ortho and H2

**UNIT III** **9 Hours**

**EFFICIENCY OF CRYOGENIC SYSTEMS**

Types of losses and efficiency of cycles - specific amount of cooling - The fraction liquefied - Cooling coefficient of performance - Thermodynamic efficiency.

**UNIT IV** **9 Hours**

**CYCLES OF CRYOGENIC PLANTS**

Classification of cryogenic cycles - The structure of cycles - Throttle expansion cycles - Expander cycles

**UNIT V** **9 Hours**

**CRYOGENIC IN AEROSPACE APPLICATIONS**

Cryogenic liquids in Rocket launching and space simulation Storage of cryogenic liquids - Effect of cryogenic liquids on properties of aerospace materials - Cryogenic loading problems - Zero gravity problems associated with cryogenic propellants - Phenomenon of tank collapse.

**FOR FURTHER READING**

Properties of the cryogenic propellants - Helium 4 and Helium 3- The energy balance Method- Thermodynamic analysis.

**Total: 45 Hours**

**Reference(s)**

1. MamataMukhopadhyay, "Fundamentals Of Cryogenic Engineering", PHI Learning, 2010
2. Haseldom, G., "Cryogenic Fundamentals", Academic Press, 2012
3. Barron, R. F., "Cryogenic Systems", Oxford University, 2010.
4. Timmerhaus, Flynn, "Cryogenics Process Engineering", Plenum Press, New York, 2012.
5. G.M Walker, "Cryocooler Part - 1 Fundamentals", Plenum Press, New York and London, 1983.
6. G.M Walker, "Cryocooler Part - 2", Plenum Press, New York and London, 1983.

## 21AE008 SPACE MECHANICS 3 0 0 3

**Course Objectives**

- To understand and use the concept of satellite motion to assess its trajectories
- To study the basic concepts of Orbital Mechanics with particular emphasis on interplanetary trajectories and satellite system
- To evaluate the working of the missile system and its trajectory

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**Course Outcomes (COs)**

1. Analyze the application of the basic concepts of space mechanics
2. Evaluate the trajectories of the satellite using the N-body concept
3. Analyze parameters to identify satellite injection, motion and determine the causes for perturbation
4. Evaluate terminologies and system to design and determine interplanetary trajectories
5. Analyze the working of ballistic missile and its design parameters

**Articulation Matrix**

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**UNIT I** **9 Hours**

**BASIC CONCEPTS**

The solar system - references frames and coordinate systems - the celestial sphere - the ecliptic - motion of vernal equinox - sidereal time - solar time - standard time.

**UNIT II** **9 Hours**

**THE GENERAL N-BODY PROBLEM**

The many body Problem - Lagrange - Jacobian Identity -The Circular Restricted Three Body Problem -Libration Points- Relative Motion in the N-body Problem -Two Body Problem - Satellite Orbits - Relations Between Position and Time.

**UNIT III** **9 Hours**

**SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS**

General aspects of satellite injections - satellite orbit transfer -various cases - orbit deviations due to injection errors - special and general perturbations - Cowells method - Encke- method - General perturbations approach.

**UNIT IV** **9 Hours**

**INTERPLANETARY TRAJECTORIES**

Two dimensional interplanetary trajectories -fast interplanetary trajectories - three dimensional interplanetary trajectories - launch if interplanetary spacecraft -trajectory about the target planet.

**UNIT V** **9 Hours**

**BALLISTIC MISSILE TRAJECTORIES AND MATERIALS**

The boost phase - the ballistic phase -trajectory geometry- optimal flights - time of flight - re-entry phase - the position of the impact point - influence coefficients.Space environment - peculiarities - effect of space environment on the selection of spacecraft material.

**FOR FURTHER READING**

The solar system - the celestial sphere - the ecliptic - motion of vernal equinox - sidereal time - solar time - standard time - classification of missiles - Aerodynamic heating - Materials used - Space environment effects on materials.

**Total: 45 Hours**

**Reference(s)**

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamic", W.H. Freeman & Co., 2012.
2. Sutton, G.P., "Rocket Propulsion Elements", John Wiley, 2019.
3. Howard D. Curtis., "Orbital Mechanics for Engineering Students", Elsevier, 2015.
4. Francis J Hale., "Introduction to Space Flight", Prentice Hal., 2013.

## 21AE009 HIGH TEMPERATURE GAS DYNAMICS 3 0 0 3

**Course Objectives**

- To provide the linear relationship between internal energy and temperature is inaccurate at high temperature, the cause being the population of internal molecular modes
- To Provide the aspects of Chemical reactions occurring in the gas phase and air, modeling as a multispecies mixture

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Attribute the knowledge of high temperature gas flows, equilibrium and non equilibrium conditions to analyse the chemical effects in real perfect gases
2. Interpret the basics of statistical thermodynamics and apply different parameters like hypersonic flows, Boltzmann distribution and Cartesian function for clear understading
3. Carryout the chemical equilibrium calculation of equilibrium composition of air to evaluate collision frequency, mean free path, velocity and seed distribution functions
4. Apply different governing equations for equilibrium and non equilibrium flows to analyse temperature, blunt body and oblique shock wave
5. Analyse high temperature radioactive heat transfer, absorbing and emitting properties due to different transport properties

**Articulation Matrix**

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**UNIT I** **9 Hours**

**INTRODUCTION**

Nature of high temperature flows - Chemical effects in air - Real perfect gases - Gibbs free energy and entropy by chemical and non-equilibrium - Chemically reacting mixtures and boundary layers

**UNIT II** **9 Hours**

**STATISTICAL THERMODYNAMICS**

Introduction to statistical thermodynamics - Relevance to hypersonic flow - Microscopic description of gases - Boltzman distribution - Cartesian function

**UNIT III** **9 Hours**

**KINETIC THEORY AND HYPERSONIC FLOWS**

Chemical equilibrium calculation of equilibrium composition of high temperature air - equilibrium properties of high temperature air - collision frequency and mean free path - velocity and speed distribution functions

**UNIT IV** **9 Hours**

**INVISCID HIGH TEMPERATURE FLOWS**

Equilibrium and non - equilibrium flows - governing equations for inviscid high temperature equilibrium flows - equilibrium normal and oblique shock wave flows - frozen and equilibrium flows - equilibrium conical and blunt body flows - governing equations for non equilibriuminviscid flows

**UNIT V** **9 Hours**

**TRANSPORT PROPERTIES IN HIGH TEMPERATURE GASES**

Transport coefficients - mechanisms of diffusion - total thermal conductivity - transport characteristics for high temperature air - radioactive transparent gases-radioactive transfer equation for transport, absorbing and emitting and absorbing gases.

**FOR FURTHER READING**

Strong and weak viscous interactions - hypersonic shock waves and boundary layer interactions - Estimation of hypersonic boundary layer transition

**Total: 45 Hours**

**Reference(s)**

1. John D. Anderson, Jr., "Hypersonic and High Temperature Gas Dynamics", McGraw-Hill Series, New York, 1996.
2. John D. Anderson, Jr., "Modern Compressible Flow with Historical perspective", McGraw-Hill Series, New York, 1996.
3. William H. Heiser and David T. Pratt, "Hypersonic Air breathing propulsion", AIAA Education Series.
4. John T. Bertin, "Hypersonic Aerothermodynamics", AIAA Inc., Washington, D.C.,1994

## 21AE010 COMBUSTION 3 0 0 3

**Course Objectives**

- To know the composition of various types of fuels and their properties
- To understand the pollution from combustion of fuels and controlling them.
- To understand the thermodynamic of combustion.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Explain the thermodynamics of combustion and analyse the composition of various types of fuels and their properties.
2. Discuss the fundamental physical and chemical principles of various combustion phenomena independent of an application
3. Impart various combustion problems by extending the earlier-gained knowledge of thermodynamics, fluid mechanics and heat/mass transfer.
4. Evaluate quantitative and qualitative estimates of characteristics of various combustion processes.
5. Analyse the high speed compressible flow combustion.

**Articulation Matrix**

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**UNIT I** **10 Hours**

**INTRODUCTION AND OVERVIEW OF CONCEPTS IN COMBUSTION**

A Roadmap to Various Combustion Phenomena, Thermo - Chemical equations - Hydrocarbon oxidation: Equivalence ratio, heats of formation, heats of reaction, and heats of combustion, premixed flames. Diffusion flames, Adiabatic flame temperature

**UNIT II** **10 Hours**

**CHEMICAL KINETICS AND FLAMES**

Thermodynamics, Thermo chemistry and Chemical Equilibrium, Measurement of burning velocity - Various methods - Effect of various parameters on burning velocity - Flame stability - Detonation - Deflagration - Rankine - Hugoniot curve. Radiation by flames.

**UNIT III** **11 Hours**

**COMBUSTION IN JET ENGINES**

Combustion in gas turbine combustion chambers - Re-circulation - Combustion efficiency - Factors affecting combustion efficiency - Fuels used for gas turbine combustion chambers - Combustion stability. Flame holder types and Flame stabilization Aerodynamics - Numerical problems.

**UNIT IV** **9 Hours**

**COMBUSTION PHENOMENA AND APPLICATIONS**

Combustion of gases: NOx Emission Mechanism and Control, Combustion of liquids: CO emissions and control, Combustion of solids: Coal and biomass paralysis, Combustion of solids: char oxidation. Combustion of solids: SOx emissions and control.

**UNIT V** **5 Hours**

**SUPERSONIC COMBUSTION**

Introduction - Supersonic combustion controlled by mixing, diffusion and heat convection - Analysis of reaction and mixing processes. Supersonic burning with detonation shocks.

**FOR FURTHER READING**

Chemical Equilibrium - Chemically Reacting flows - Calorically and thermally perfect gas - Hypersonic Intake - Different types of Coal.

**Total: 45 Hours**

**Reference(s)**

1. Arthur Henry Lefebvre, Dilip R. Ballal, "Gas Turbine Combustion: Alternative Fuels and Emissions", Taylor & Francis Group, 2012.
2. Turns, S.R., "An Introduction to Combustion Concepts and Applications", McGraw Hill International Editions, New Delhi, 2013.
3. Sharma, S.P., and Chandra Mohan, "Fuels and Combustion", Tata McGraw Hill Publishing Co., Ltd., New Delhi 2012.
4. Beer, J.M. and Chigier, N.A., "Combustion Aerodynamics", Applied Science Publishers Ltd., London, 2013.
5. Chowdhury, R., "Applied Engineering Thermodynamics", Khanna Publishers, New Delhi, 2015.
6. http://nptel.ac.in/courses/101104014/

## 21AE011 ADVANCED PROPULSION SYSTEM

**Course Objectives**

- To familiarize on advanced air breathing propulsion systems
- To understand the air augmented rockets and scramjets
- To introduce the various technical details and operating principles of nuclear and electric propulsion.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Analyse the thermodynamic cycle of air breathing engine.
2. Analyse the operating parameters and energy transfer parameters in diffuser region.
3. Analyse the working principle of scramjet engine and performance of combustor.
4. Apply the nuclear propulsion based on nozzle and engine control.
5. Analyse the electric and ion propulsion system.

**Articulation Matrix**

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**UNIT I** **9 Hours**

**THERMODYNAMIC CYCLE ANALYSIS OF AIR-BREATHING ENGINE**

Air breathing propulsion systems like Turbojet, turboprop, ducted fan, Ramjet and Air augmented rockets – Thermodynamic cycles – Jet propulsion – Combustion process in jet engines – inlet charging process – Subcritical, Critical and Supercritical charging.

**UNIT II** **9 Hours**

**RAMJETS AND AIR AUGMENTED ROCKETS**

Principle operation of ramjet and rocket - Preliminary performance calculations – Diffuser design with and without spike, Supersonic inlets – combustor and nozzle design – integral Ram rocket.

**UNIT III** **9 Hours**

**SCRAMJET PROPULSION SYSTEM**

Fundamental considerations of hypersonic air breathing vehicles – Preliminary concepts in engine airframe integration – calculation of propulsion flow path – flow path integration – Various types of supersonic combustors – fundamental requirements of supersonic combustors – Mixing of fuel jets in supersonic cross flow – performance estimation of supersonic combustors..

**UNIT IV** **9 Hours**

**NUCLEAR PROPULSION**

Nuclear rocket engine design and performance – nuclear rocket reactors – nuclear rocket nozzles – nuclear rocket engine control – radioisotope propulsion – basic thruster configurations – thruster technology – heat source development – nozzle development – nozzle performance of radioisotope propulsion systems..

**UNIT V** **9 Hours**

**ELECTRIC AND ION PROPULSION**

Basic concepts in electric propulsion – power requirements and rocket efficiency – classification of thrusters – electrostatic thrusters – plasma thruster of the art and future trends – Fundamentals of ion propulsion – performance analysis – ion rocket engine.

**FOR FURTHER READING**

Advanced jet engine cycles: Variable cycle engines - Factors limiting ramjet end scramjet engine - Types of fuels and their properties.

**Total: 45 Hours**

**Reference(s)**

1. G.P. Sutton, “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York,1998.
2. William H. Heiser and David T. Pratt, Hypersonic Airbreathing propulsion, AIAA Education Series, 2001.
3. Fortescue and Stark, Spacecraft Systems Engineering, 1999.
4. Cumpsty, Jet propulsion, Cambridge University Press, 2003.

## 21AE012 ROCKETS AND MISSILES 3 0 0 3

**Course Objectives**

- To introduce basic concepts of design and trajectory estimation of rocket and missiles.
- To describe the principles and working of vehicle, airframe components, staging and control, material used and propulsion systems in rockets and missiles.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Understand various propulsion systems and its issues of rockets and missiles.
2. Understand about various airframe components and its aerodynamic characteristics.
3. Analyse rocket motions in free space and gravitational field under constant thrust case and constant specific thrust case.
4. Understand about various thrust vector control methods, advantages of staging a rocket and stage separation techniques.
5. Understand about aerodynamic heating issues and material/techniques used to overcome that.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **9 Hours**

**PROPULSION SYSTEMS**

Ignition system in rockets – types of igniters – igniter design considerations – design consideration of liquid rocket combustion chamber, injector propellant feed lines, valves, propellant tanks outlet and helium pressurized and turbine feed systems – propellant slash and propellant hammer – elimination of geysering effect in missiles.

**UNIT II** **9 Hours**

**AERODYNAMICS OF ROCKETS AND MISSILES**

Airframe components of rockets and missiles – forces acting on a missile while passing through atmosphere – classification of missiles – methods of describing aerodynamic forces and moments – lateral aerodynamic moment – lateral damping moment and longitudinal moment of a rocket – lift and drag forces – drag estimation – body upwash and downwash in missiles – rocket dispersion – numerical problems.

**UNIT III** **9 Hours**

**ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD**

One dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields – description of vertical, inclined and gravity turn trajectories – determination of range and altitude simple approximations to burnout velocity.

**UNIT IV** **9 Hours**

**STAGING AND CONTROL OF ROCKETS AND MISSILES**

Rocket vector control – methods – thrust determination – SITVC – multistaging of rockets – vehicle optimization – stage separation dynamics – separation techniques.

**UNIT V** **9 Hours**

**AERO THERMO HEATING AND MATERIALS**

Heat flux and heat transfer, selection of materials – special requirements of materials to perform under adverse conditions.

**FOR FURTHER READING**

Combustion system of solid rockets – Stability and Controllability - Thrust vector controls - Ejection of various stages of rockets - Ablative materials used in rockets and missiles.

**Total: 45 Hours**

**Reference(s)**

1. Sutton, G.P., et al., Rocket Propulsion Elements, John Wiley & Sons Inc., New York, 1993.
2. Mathur, M., and Sharma, R.P., Gas Turbines and Jet and Rocket Propulsion, Standard Publishers, New Delhi 1998.
3. Cornelisse, J.W., Rocket Propulsion and Space Dynamics, J.W., Freeman & Co. Ltd., London, 1982.
4. Parket, E.R., Materials for Missiles and Spacecraft, McGraw-Hill Book Co. Inc., 1982.
5. Vinayak and Srinivasan, Aircraft materials, 2008.

## 21AE013 THEORY OF ELASTICITY 3 0 0 3

**Course Objectives**

- To understand the theoretical concepts of material behavior with particular emphasis on their elastic property.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**Course Outcomes (COs)**

1. Analyse the concept of theory of elasticity and SoM theory including strain/displacement and Hooke"s law relationships.
2. Evaluate the structural parameters using theory of elasticity approach.
3. Apply Plane stress and Plane strain concepts to solve the two dimensional problems.
4. Derive theory of elasticity equations in polar coordinates.
5. Apply theory of elasticity approach to solve torsional problems.

**Articulation Matrix**

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**UNIT I** **7 Hours**

**INTRODUCTION TO THEORY OF ELASTICITY**

Continuum mechanics- introduction-theory of elasticity- Assumption-differences between elementary theory and theory of elasticity-Review of stress-strain-displacement relations- Compressibility of material, bulk modulus, Shear modulus

**UNIT II** **10 Hours**

**EQUATIONS OF ELASTICITY**

Compatibility equations for stresses and strains, Principal stresses and principal strains, Mohr circle, Saint Venant principle-Airy stress function, Bi-harmonic equations.

**UNIT III** **10 Hours**

**PLANE STRESS AND PLANE STRAIN PROBLEMS**

Equations of equilibrium for plane stress and plane strain problems-Polynomial solutions, Simple two- dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams, etc.

**UNIT IV** **9 Hours**

**POLAR COORDINATES**

Equations of equilibrium, Strain displacement relations, Stress - strain relations, Axi-symmetric problems, Kirsch, Michell and Boussinesque problems.

**UNIT V** **9 Hours**

**TORSION**

Naviers theory, St. Venants theory, Prandtls theory on torsion, The semi- inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections.

**FOR FURTHER READING**

Theory of plasticity, Prandtls membrane analogy-sand heap analogy- stresses in closed rings.

**Total: 45 Hours**

**Reference(s)**

1. Dr P N Chandramouli "Continuum Mechanics", Yes Dee Publishing Pvt Ltd, 2014.
2. Timoshenko, S., and Goodier, T.N., "Theory of Elasticity", Tata McGraw Hill, 2010.
3. Enrico Volterra& J.H. Caines, "Advanced Strength of Materials", Prentice Hall New Jersey, 1991.
4. Wing, C.T., "Applied Elasticity", McGraw-Hill Co., New York, 1993.
5. Atkin, R. J., & Fox, N.,"An Introduction to the theory of Elasticity" Dover publication, 2005.
6. http://nptel.ac.in/courses/105108070/

6.

## 21AE014 EXPERIMENTAL STRESS ANALYSIS 3 0 0 3

**Course Objectives**

- To introduce the basic aspects of experimental stress analysis that includes exhaustive treatment of the most versatile techniques like photoelasticity and strain gauges
- To know the fundamental aspects of different non destructive testing techniques

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Demonstrate the basic understanding of measuring parameters of instruments and explain the experimental methods for stress analysis.
2. Explain the classification and working principles of major types of strain gauges with its merits, demerits and application
3. Analyze the photo-elastic techniques used for stress analysis along with compensation techniques.
4. Evaluate the major photo elastic coatings and brittle coatings with industrial applications.
5. Apply the major Non destructive testing techniques to identify the defect in machine components.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | 1 | | 1 | | | | | | | | | | |
| 2 | 1 | 3 | 1 | | 2 | | | | | | | | | | |
| 3 | 1 | 2 | 3 | 2 | 3 | | | | | | | | | | |
| 4 | 1 | 2 | 3 | 2 | 3 | | | | | | | | | | |
| 5 | 1 | 1 | 3 | 3 | - | | | | | | | | | | |

**UNIT I** **8 Hours**

**MEASUREMENTS**

Principles of measurements, accuracy, sensitivity and range of measurements - Stress analysis - Analytical, Numerical and Experimental approaches - Direct information provided by various

experimental methods - Brief description, Visual appreciation of field information - Listing of major problems of different complexity.

**UNIT II** **10 Hours**

**STRAIN GAUGES**

Introduction to strain gauges - Strain sensitivity of strain gauge - Bridge sensitivity - Rosette Analysis - Performance of strain gauge system, calibration and temperature compensation - Mechanical, optical, acoustical and electrical extensometers - Strain gauge alloys, carries and adhesives

**UNIT III** **9 Hours**

**TRANSMISSION PHOTOELASTICITY**

Introduction to Transmission Photoelasticity - Ordinary and Extraordinary Rays - Stress-optic Law - Plane and circular polariscope - Jones Calculus - Tardys Method of Compensation - Calibration of Photo elastic materials fringe thinning methodologies - Fringe Ordering in Photoelasticity - Photo elastic materials.

**UNIT IV** **9 Hours**

**PHOTOELASTIC COATINGS AND BRITTLE COATINGS**

Introduction to Photoelastic coatings - Correction Factors for Photoelastic Coatings Coating Materials - Selection of Coating Thickness - Calibration of Photoelastic Coatings - Introduction to Brittle Coatings - Analysis of Brittle Coatings - Application of coatings

**UNIT V** **9 Hours**

**NON DESTRUCTIVE TESTING**

Fundamentals of NDT - Radiography, Ultrasonic and Magnetic particle inspection - Fluorescent penetrant technique - Eddy current testing - Acoustic emission technique - Fundamentals of brittle coating methods - Introduction to moir techniques - Holography, ultrasonic c- scan and thermograph.

**FOR FURTHER READING**

Three dimensional photo elasticity - Stress freezing, Slicing and Application to a complex problem - Integrated photo elasticity - Principle of optical equivalence - Introduction to digital photo elasticity.

**Total: 45 Hours**

**Reference(s)**

1. K. Ramesh, "e-Book on Experimental Stress Analysis", IIT Madras, 2009.
2. K. Ramesh, "Digital Photoelasticity, Advanced Techniques and Applications", Springer, 2000.
3. W.N. Sharpe (Ed.), "Springer Handbook of Experimental Solid Mechanics", Springer, 2008.
4. U C Jindal, "Experimental Stress Analysis", 1st edition, Pearson, 2012.
5. AllesandroFreddi, Giorgio Olmi, Luca Cristofolini, "Experimental Stress Analysis for Materials and Structures", Springer, 2015.
6. Srinivas, "Stress Analysis and Experimental Techniques An Introduction", Alpha Science Int'l Ltd, 2011.

## 21AE015 FATIGUE AND FRACTURE MECHANICS 3 0 0 3

**Course Objectives**

- To learn about large variety of fracture mechanisms and fracture modes associated with failure
- Have a fundamental understanding of various regimes of fatigue crack growth and life estimation

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Predict material failure for the combination of applied stress
2. Identify and exemplify the basic fatigue mechanisms and apply that knowledge to failure analysis
3. Predict the fatigue life cycle of a component used in aircraft
4. Apply stress analysis to calculate the crack driving force in linear and nonlinear materials and formulate appropriate fracture criteria for stationary and growing cracks
5. Evaluate well defined fracture mechanics problems for both linear and nonlinear materials subjected to both monotonic and cyclic loading

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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| 2 | 2 | 3 | 1 | 1 | 1 | | | | | | | | | | |
| 3 | 1 | 1 | 1 | 3 | 1 | | | | | | | | | | |
| 4 | 1 | 2 | 2 | 3 | 1 | | | | | | | | | | |
| 5 | 1 | 2 | 3 | 2 | 2 | | | | | | | | | | |

**UNIT I** **9 Hours**

**FATIGUE OF STRUCTURES**

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.

**UNIT II** **8 Hours**

**PHYSICAL ASPECTS OF FATIGUE**

Phase in fatigue life - Crack initiation - Crack growth - Final fracture - Dislocations - Fatigue fracture surfaces

**UNIT III** **9 Hours**

**STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR**

Low cycle and high cycle fatigue - Coffin - Manson's relation - Transition life - Cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques -Cumulative damage - Miner's theory.

**UNIT IV** **10 Hours**

**OVERVIEW OF ENGINEERING FRACTURE MECHANICS**

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.

**UNIT V** **9 Hours**

**CRACK INITIATION AND LIFE ESTIMATION**

Lacuna of fatigue test - Crack growth curve - Paris law - Sigmoidal curve: Region I, Region II and Region III - Mean stress influence and environmental effects on crack growth rate - Crack closure - Crack growth modules.

**FOR FURTHER READING**

Safe life and fail-safe design philosophies - Importance of fracture mechanics in aerospace structures

**Total: 45 Hours**

**Reference(s)**

1. Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw Hill, New Delhi, India, 2009.
2. K. R.Y. Simha, "Fracture Mechanics for Modern Engineering Design", Universities Press (India) Limited, 2001
3. T.L. Anderson, "Fracture Mechanics - Fundamentals and Applications", 3rd Edition, Taylor and Francis Group, 2005.
4. Ali Fatemi, "Metal Fatigue in Engineering", 2nd edition, John Wiley and sons, inc., 2000.
5. K. Ramesh, e-Book on "Engineering Fracture Mechanics", IIT Madras, 2007.
6. Gross, Dietmar, Seelig and Thomas, "Fracture Mechanics with an Introduction to Micromechanics", ISBN 978-3-319-71090-7, Springer, 2018.

## 21AE016 STRUCTURAL DYNAMICS

**3 0 0 3**

**Course Objectives**

- To know the methods and principles of vibration analysis and vibration measuring instruments.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**Course Outcomes (COs)**

1. Apply Newtons law and Energy methods to determine the parameters like natural frequency, time period of a mechanical vibrating system.
2. Estimate the important parameters of different vibrating system conditions and explain the methods of vibration measurement and its control.
3. Determine the natural frequencies of multi degrees of freedom system using different methods of analysis.
4. Obtain a governing equation for a vibration of continuous systems and to solve using approximate methods.
5. Analyze the different aero elastic problems in aircraft and civil structures and explain its prevention methods.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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| 3 | 1 | 2 | | 1 | | | | | | | | | 1 | | |
| 4 | 1 | 2 | | 1 | | | | | | | | | 1 | | |
| 5 | 3 | 1 | | 1 | | | | | | | | | 1 | | |

**UNIT I** **9 Hours**

**SINGLE DEGREE OF FREEDOM SYSTEMS**

Simple harmonic motion-addition-Terminologies - Newtons Law - D Alemberts principle-Energy Methods for free vibration.

**UNIT II** **9 Hours**

**DAMPED, FORCED VIBRATIONS OF 1 DOF SYSTEM**

Damped vibrations - Forced Vibrations, with and without damping-support excitation- Vibration measuring instruments.

**UNIT III** **9 Hours**

**MULTI DEGREES OF FREEDOM SYSTEMS**

Two degrees of freedom systems - Static and Dynamic couplings vibration absorber-Principal co-ordinates, Principal modes and orthogonal condition - Eigen value problems - Hamilton"s principle-Lagrangean equation and application.

**UNIT IV** **9 Hours**

**CONTINUOUS SYSTEMS AND APPROXIMATE METHODS**

Vibration of elastic bodies - Rayleigh method- Holzer Method-Stodolas method- Matrix iteration method.

**UNIT V** **9 Hours**

**ELEMENTS OF AEROELASTICITY**

Concepts- Coupling - Aeroelastic instabilities and their prevention- Basic ideas on wing divergence, loss and reversal of aileron control- Flutter and its prevention.

**Total: 45 Hours**

**Reference(s)**

1. ThammaiahGowda, D.V.Girish, T.Jagadeesha "Mechanical vibrations", McGraw Hill Education, 2012.
2. Fung Y.C., "An Introduction to the Theory of Aeroelasticity" Dover Publications Inc.,2008.
3. Timoshenko S., "Vibration Problems in Engineering" John Wiley and Sons, New York, 1993.
4. Singiresu S. Rao "Mechanical Vibrations" 5th edition, Prentice Hall, 2010.
5. http://nptel.ac.in/courses/112103111/
6. http://nptel.ac.in/courses/112103112/

## 21AE017 AEROSPACE MATERIALS 3 0 0 3

**Course Objectives**

- To get insights into the basic aspects of material science.
- To provide basic idea on the mechanical behaviour of materials.
- To impart knowledge on the macro mechanics of composite materials,
- To gain knowledge on the analysis and manufacturing methods of composite materials.
- To learn about the sandwich construction

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

**Course Outcomes (COs)**

1. Be able to investigate the physical and mechanical behaviour of different materials.
2. Have exposure on dislocation theories and their importance.
3. Have general knowledge of the properties of different aerospace materials
4. Be able to apply failure theories appropriately.
5. Be able to select good materials for a specific aerospace application.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
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| 5 | 1 | | 3 | | | 3 | | | | | | | | | |

**UNIT I** **9 Hours**

**MATERIAL SCIENCE**

Crystallography of metals & metallic alloys – Imperfections – Dislocations in Different Crystal Systems – Effect on plasticity – Strengthening Mechanisms Due to Interaction of Dislocations with Interfaces – Other Strengthening Methods – Dislocation Generation Mechanisms

**UNIT II** **8 Hours**

**MECHANICAL BEHAVIOUR**

Stress-strain curve and mechanical behaviour of materials – linear elasticity and plasticity – failure of ductile and brittle materials – use of failure theories – maximum normal stress and maximum shear stress failure theories – importance of the octahedral stress failure theory – failure theories based on strain energy – cyclic loading and fatigue of materials – the S-N curve

**UNIT II** **11 Hours**

**METALLIC ALLOYS**

Metals and alloys used for different aerospace applications – Properties of conventional and advanced aerospace alloys – Effect of alloying elements – Summary of conventional and stateof-the-art manufacturing processes – Types of heat treatment and their effect – other processing parameters – Materials for aerospace application – Design requirements & standards.

**UNIT IV** **9 Hours**

**HIGH TEMPERATURE MATERIALS**

Carbon-Carbon Composites and Ceramic Materials For High Temperature Aerospace Application – Manufacturing Technologies & Controlling Parameters – Mechanical and Thermal Properties of These Material Systems – Thermal Protection Material System for a Re-Entry Vehicle – Use of Superalloys – Metal Matrix Composites &Cermets – Properties and Applications – Mechanical and Thermal Fatigue

**UNIT V** **8 Hours**

**SMART MATERIALS**

Introduction to smart materials-shape memory effects-shape memory alloys-shape memory polymers-electro-rheological fluids-energy harvesting materials-self healing polymers

**FOR FURTHER READING**

Graphite-based composite, Fiber metal laminates, Hybrid composites.

**Reference(s)**

1. Adrian Mouritz, “Introduction to Aerospace Materials”, Woodhead Publishing, 1st edition, 2012.

2. Jones. R M, “Mechanics of Composite Materials”, 2nd Edition, CRC Press, Taylor & Francis Group, 1998.

3. Prasad, N. Eswara, Wanhill, RJH, “Aerospace Materials and Material TechnologiesVolume 1: Aerospace Materials”, Springer Singapore, 2017.

4. Sam Zhang &Dongliang Zhao, “Aerospace Materials Handbook”, CRC Press, Taylor & Francis Group, 2012.

5. Brain culshaw, smart structures and materials, Artech house, 2000.

**21AE018 AERO ELASTICITY** **3 0 0 3**

**COURSE OBJECTIVE**

- To study the dynamic behaviour of different aircraft components and the interaction among the aerodynamic, elastic and inertia forces
- To understand the theoretical concepts of material behavior with particular emphasis on their elastic property.

**PROGRAMME OUTCOMES (POS)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
m. Utilize the knowledge of aeronautical engineering in innovative, dynamic and challenging environment for design and development of new products.
n. Impart professional skills through simulation, language skills and general purpose CAE packages to solve practical problems of components in design and analysis to meet the airworthiness requirements for flight vehicles.

**COURSE OUTCOMES:**

1. Understand the concepts of structural stress , vibration and elastic forces acting in the aero structure
2. Apply the concept to identify the aero elastic problems
3. Analyse the stability and instability due to aeroelastic effects
4. Analyse the interaction between aerodynamic forces and elastic forces in static aeroelasticity case.
5. Analyse the interactions among aerodynamic, elastic, and inertial forces in dynamic aeroelasticity case.

**ARTICULATION MATRIX**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
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| 2 | 3 | 2 | 2 | 1 | | | | | | | | | 2 | 2 | |
| 3 | 2 | 3 | 2 | | | | | | | | | | 2 | | |
| 4 | 3 | 2 | 2 | 1 | | | | | | | | | | | |
| 5 | 2 | 2 | 3 | 1 | | | | | | | | | | | |

**UNIT I** **8 Hours**
**INTRODUCTION-AERO ELASTICITY PHENOMENA**

Vibration of beams due to coupling between bending and torsion – The aero-elastic triangle of forces – Stability versus response problems – Aeroelasticity in Aircraft Design – Vortex induced vibration – Introduction to aero servo elasticity.

**UNIT II** **9 Hours**

**ELEMENTS OF AEROELASTICITY**

Concepts – Coupling – Aero elastic instabilities and their prevention – Basic ideas on wing divergence, Aeroelastic problems – Collar's triangle of forces – loss and reversal of aileron control – Critical aileron reversal speed – Aileron efficiency -Semi rigid theory and successive approximations – Lift distributions – Rigid and elastic wings – Flutter and its prevention.

**UNIT III** **9 Hours**

**AEROELASTIC FLUTTER**

Physical Interpretation of the Classical Flutter - Modal Damping and Modal Frequency- Concepts of Stability, Stability Boundary and Instability - Calculation of the Flutter Speed via P-Method - Concept of Coalescence of Modal Frequencies - Two-Degree-of-Freedom Flutter Model - Engineering Solutions for Flutter - Review on the Structural Damping and Introduction to the K-Method - Concept of Dummy Structural Damping - P-K Method - Concepts of Violent Flutter, Moderate Flutter and Mild Flutter- Prediction of the Divergence Speed with a Flutter Analysis - Comparison Between the P Method and K Method , G method

**UNIT IV** **9 Hours**

**STATIC AEROELASTICITY**

Simple two dimensional idealisations - Strip theory - Integral equation of the second kind - Exact solutions for simple rectangular wings - "Semirigid" assumption and approximate solutions - Generalised coordinates - Successive approximations - Numerical approximations using matrix equations - 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.

**UNIT V** **10 Hours**

**DYNAMIC AEROELASTICITY**

Non-dimensional parameters - Stiffness criteria - Dynamic mass balancing - Dimensional similarity. Flutter analysis - Two dimensional thin airfoils in steady incompressible flow - Quasisteady 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

**Total hours = 45Hours**

## References:

1. Bisplinghoff., R.L. Ashley, H., and Halfman, R.L, "Aeroelasticity" Addison Wesley Publishing Co., Inc. II ed. 1996.
2. Broadbent, E.G., Elementary Theory of Aeroelasticity, Bunhill Publications Ltd, 1986.
3. Blevins R.D, "Flow induced vibrations", Krieger Pub Co; 2 Reprint editions, 2001.
4. Scanlan, R.H. and Rosenbaum, R., Introduction to the Study of Aircraft Vibration and Flutter, Macmillan Co., N.Y., 1991.
5. Y.C. Fung, "An Introduction to the Theory of Aeroelasticity", John Wiley & Sons Inc., New York, 2008.
6. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, "Aeroelasticity", II Edition Addison Wesley Publishing Co., Inc., 1996.

## 21AE019 PRINCIPLES OF NAVIGATION 3 0 0 3

**Course Objectives**

- To understand phenomenon of position determination using modern navigation systems.
- To analyze the methods of utilizing navigation systems to direct the aircraft.

**Programme Outcomes (POs)**

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

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

m. Utilize the knowledge of aeronautical engineering in innovative, dynamic and challenging environment for design and development of new products.

n. Impart professional skills through simulation, language skills and general purpose CAE packages to solve practical problems of components in design and analysis to meet the airworthiness requirements for flight vehicles.

**Course Outcomes (COs)**

1. Explain the principles of instrumentation engineering to guide the aircraft.
2. Analyze the operational characteristics of radio navigation system.
3. Interpret the principle applications of inertial navigation system.
4. Analyze the performance of advanced radio navigation systems and its accuracy.
5. Explain the modern navigation system implemented in aircrafts.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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| 3 | | 3 | | | | 2 | | | | | | | 2 | 2 | |
| 4 | | 2 | | | | 3 | | | | | | | 2 | 2 | |
| 5 | | 2 | | | | 3 | | | | | | | 2 | 2 | |

**UNIT I** **9 Hours**

**INTRODUCTION TO AIRCRAFT NAVIGATION**

Basics of Navigation - Axis of Navigation - Categories of Navigation: Pilotage Method - Celestial Navigation - Method of Dead Reckoning Navigation - Basic T-instruments.

**UNIT II** **9 Hours**

**RADIO NAVIGATION**

Evolution of Radio Navigation - principles of radio transmission and reception- Classifications of radio navigation - Hyperbolic Navigation system: LORAN - DECCA - OMEGA - Concpet of coupled VOR and DME system.

**UNIT III** **9 Hours**

**INERTIAL NAVIGATION SYSTEM**

Basic principle - Advantages and Disadvantages - Components of INS - Coriolis Effect - Euler angles and Quaternion method - Functional block of INS - Strap-down and stable platform - Sculling error.

**UNIT IV** **9 Hours**

**ADVANCED NAVIGATION SYSTEMS**

Signal characteristics of Non-directional Beacons -Instrument Landing system: Radiation pattern - Azimuth and Elevation geometry of Microwave Landing system - Radio altimeters.

**UNIT V** **9 Hours**

**SATELLITE AND HYBRID NAVIGATION SYSTEM**

Segment of satellite - radio navigation system - Range Equations - Principles of Global position system and position determination - structure of wide area and local area augmentation systems - Types of Errors.

**FOR FURTHER READING**

Case study: A380 and Boeing 787 Navigation and Communication systems.

**Total: 45 Hours**

**Reference(s)**

1. David Wyatt, "Mike Tooley, Aircraft Communications and Navigation Systems", Butterworth Heinemann, 2011.
2. David Titterton, John L. Weston, "Strapdown Inertial Navigation Technology", 2nd Edition, IEE Publishers, London, 2004.
3. James wolper, "Understanding Mathematics for Aircraft Navigation", Latest edition, McGraw-Hill, New Delhi, 2001.
4. Myron and Fried, "Avionics Navigation Systems", second edition, Wiley India Publishers, New Delhi, 2010.

## 21AE020 GUIDANCE OF MISSILES 3 0 0 3

**Course Objectives**

- To introduce the basic concepts of designing missile system and its components.
- The course is intended to build up necessary features for guiding and controlling the missile trajectories.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Explain the classification, components, their function and trajectory dynamics of missiles.
2. Analyze the aerodynamics of missiles and missile testing methods in wind tunnel and flight testing.
3. Classify the different missile propulsion system with its merits and demerits and its flight performance at different flight regimes.
4. Analyze the different missile trajectories and estimating the performance parameters.
5. Explain the working of different missile systems and its sub systems with help of case studies.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **9 Hours**

**MISSILE SYSTEMS**

Introduction - Development of Missile systems - classifications - missile system elements, missile ground systems - radars technology- launchers, coordinate frames, basics of trajectory dynamics.

**UNIT II** **9 Hours**

**MISSILE AERODYNAMICS**

Missile aerodynamics- design methodology, aerodynamic prediction method, aerodynamic loads & performance analysis, wind tunnel and flight testing of missile models and missile prototypes.

**UNIT III** **9 Hours**

**PROPULSION UNIT**

Principles of jet propulsion and rocketry, nozzle theory and performance parameters of solid rockets and ramjet and compound jet engines - evaluation of flight performance - forces acting on vehicle - basic relations of motion.

**UNIT IV** **9 Hours**

**MISSILE TRAJECTORY CONTROL**

Types of trajectories-Vertical, inclined and gravity turn trajectories -Estimation of performance parameters -determination of range and altitude- numerical computation of ballistic trajectories-Applications.

**UNIT V** **9 Hours**

**MISSILE SYSTEMS AND SUBSYSTEMS**

Digital Electronic Control Unit -Launcher electronic unit- Gyroscopic systems-Safety and arming devices-servo integration with control surface-Thermal beacon and Xenon beacon-Integrated guided missiles - Case studies.

**FOR FURTHER READING**

Digital Electronic Control Unit - Launcher electronic unit- Gyroscopic systems-Safety and arming devices-servo integration with control surface-Thermal beacon and Xenon beacon-Integrated guided missiles - Case studies.

**Total: 45 Hours**

**Reference(s)**

1. George M.Siouris, "Missile Guidance and Control Systems", Latest Edition, Springer publishers, 2004
2. S.N. Balakrishnan, A. Tsourdos, B.A. White, "Advances in Missile Guidance, Control, and Estimation", CRC Press, 2012.
3. lbert J. Sobey and Alfred M. Suggs, "Control of Aircraft and Missile Power plants: An Introduction to the Analysis and Design of Engine Control Systems", John Wiley & Sons, New York, 1963.
4. John H. Blakelock, "Automatic Control of Aircraft and Missiles", John Wiley & Sons, 18-Jan-1991.

## 21AE021 AIR TRAFFIC CONTROL AND AERODROME DESIGN

**3 0 0 3**

**Course Objectives**

- To understand the services and the divisional responsibilities of Air Traffic control unit.
- To attribute the design characteristics and the operations of Aerodrome Unit.
- To understand the navigational and visual aids mounted in the Aerodrome area.

**Programme Outcomes (POs)**

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
m. Utilize the knowledge of aeronautical engineering in innovative, dynamic and challenging environment for design and development of new products.
n. Impart professional skills through simulation, language skills and general purpose CAE packages to solve practical problems of components in design and analysis to meet the airworthiness requirements for flight vehicles.

**Course Outcomes (COs)**

1. Explain the objectives and services of to perform the air traffic control operation.
2. Analyze the influences of air rules followed in Air Traffic Control operation.
3. Explain the RADAR concept applicable in Air Traffic operation.
4. Analyze the design parameters of Aerodrome and Airport.
5. Interpret the visual aids mounted at the Air Traffic control area.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **9 Hours**

**INTRODUCTION**

Objectives and Services unit - Air Traffic Control Tower - Ground Control Unit - Air control Unit - Flight Data and Clearance control Unit - Approach and Terminal Control - Structure of Air Traffic control Unit

**UNIT II** **9 Hours**

**AIR TRAFFIC RULES AND AIRSPACES**

Visual and Instrument Meteorological conditions - Visual Flight Rules - Instruments Flight Rules - Special Visual Flight rules - Uncontrolled and Controlled Airspace - Classifications of Airspaces based on VFR and IFR - Flight plan and Position Report

**UNIT III** **9 Hours**

**AIR TRAFFIC CONTROL RADAR AND SEPARATION**

ATC RADAR frequency and coverage area - Air Traffic Control RADAR beacon system - Primary and Secondary surveillance RADAR - Concept of separation - Assignment of cruise level minimum flight altitude.

**UNIT IV** **9 Hours**

**AERODROME DESIGN STANDARDS AND OPERATIONS**

Classifications: Aerodrome, Airport and Airfield - Aerodrome Data - Aerodrome reference code, elevation, temperature and reference point - Length, width and distance between runways - Instrument Approach Runway system - Aerodrome Beacons.

**UNIT V** **9 Hours**

**VISUAL AIDS FOR AREA**

Basics of Visual aids - wind direction indicator - landing direction indicator - Location and characteristics of signal area - Visual Markings - Lighting systems - operation visual Approach Slope Indicator.

**FOR FURTHER READING**

Airport Ground Handling and Support Equipments - Airport Hangar Maintenance.

**Total: 45 Hours**

**Reference(s)**

1. Virendrakumar and Sathish Chandra, "Airport Planning and Design", Galgotia publications Pvt Ltd, New Delhi, 2012.
2. "Aeronautical Information Publication (India)", Vol. I & II, the English book store, 17-1,Connaught Circus, New Delhi, 2006.
3. M.S Nolan, "Fundamentals Air Traffic Control", Latest Edition, Yesdee Publishers, 2010.
4. Seth B. Young, Alexander T. Wells, "Airport Planning and Management" McGraw-Hill Education, New Delhi, 2011.

**21AE022 UAV SYSTEMS 3 0 0 3**

**Course Objectives**

- To understand the evolution and the basic structure of unmanned aerial vehicles.
- To analyze the avionic systems integration and its applications.
- To understand the method of operating unmanned vehicles in a desired trajectory.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
m. Utilize the knowledge of aeronautical engineering in innovative, dynamic and challenging environment for design and development of new products.
n. Impart professional skills through simulation, language skills and general purpose CAE packages to solve practical problems of components in design and analysis to meet the airworthiness requirements for flight vehicles.

**Course Outcomes (COs)**

1. Explain the fundamental ideology about unmanned and micro air vehicles.
2. Analyze the structural components used in unmanned systems.
3. Interpret the selection process of hardware and software units of unmanned systems.
4. Explain the modern avionics systems used for the UAV models.
5. Apply guidance and trajectory control algorithm to navigate the unmanned system.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **9 Hours**

**INTRODUCTION TO UAV AND MAV**

Basic terminology: DRONES - Historical Development -Classifications - Components for UAV and MAV Prototypes - Functional Operations.

**UNIT II** **9 Hours**

**AIRFRAME DESIGN**

Fixed and Rotor wing configurations - Flapping wing model - Types of Fuselage structures - Selection of Airfoil - Empennage configurations -Flight control surfaces - Blimp wing.

**UNIT III** **9 Hours**

**HARDWARE AND SOFTWARE SUPPORT**

Specifications and Characteristics of Motors and Batteries - Selection of Propellers -Autopilot system and operations- servos and actuators - Open source, DO178C and ARP4754A software design standards.

**UNIT IV** **9 Hours**

**UAV AVIONICS**

Mission control computer - Fully Autonomous take-off and landing system - Onboard accelerometers - Types of sensors and data transmission - Telemetry and Tracking system - Integrated Global positioning system - Light weight full motion and Angle video system.

**UNIT V** **9 Hours**

**CONTROL AND GUIDANCE**

Path planning algorithm - waypoint trajectory guidance method - Obstacles avoidance Techniques - Functional block of lateral and longitudinal guidance - Structure of Ground control network system - Flight Test.

**FOR FURTHER READING**

Applications - Case studies on UAVs and MAVs: Rustom and Predator hawk.

**Total: 45 Hours**

**Reference(s)**

1. MirosawAdamski, "Power units and power supply systems in UAV", New Edition, Taylor and Francis Group publishers, 2014.
2. Reg Austin, "Unmanned Air Systems: UAV Design, Development and Deployment"First Edition, Wiley Publishers, 2015.
3. Skafidas, "Microcontroller Systems for a UAV", KTH, TRITA-FYS 2002:51 ISSN 0280-316X. 34, 2002.
4. Droneprep, "Unmanned Aircraft Systems Logbook for Drone Pilots & Operators", Create Space Independent Publishing Platform, Latest Edition, 2015.

## 21AE023 AERODYNAMICS OF UAV 3 0 0 3

**Course Objectives**

- To understand the fundamental principles of aerodynamics and flight stability for applications in unmanned arial vehicle (UAV).
- To analysis the foundation in modeling and optimization, and the computation of UAV flight stability.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**Course Outcomes (COs)**

1. Apply the basic concepts in aero-thermodynamic and fluid mechanics for describing various flow phenomenon.
2. Understand the wave formation in the supersonic flow field for determining the nature of shock and expansion wave.
3. Illustrate the wave formation on wedge shaped and concave corners for solving complex problems in supersonic vehicles and develop the fundamental equation for one-dimensional and quasi one- dimensional flow of compressible ideal gas.
4. Analyse the steady isentropic flow, flow with friction and flow with heat transfer for solving problems in flow through one-dimensional passage.
5. Analyse the different wind tunnel configurations utilized for subsonic and supersonic applications.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **9 Hours**

**FUNDAMENTALS OF AERODYNAMICS**

Historical perspective; Forces and moments; Centre of pressure; Aerodynamic centre; Inviscid/viscous flow; Incompressible/compressible flow; Bernoulli's Equation; d'Alembert's Paradox; Kutta-Joukowski Theorem; Circulation; Laminar and turbulent boundary layers.

**UNIT II**

**AIRFOILS FOR UAVS**

Symmetric and cambered airfoils; Airfoil nomenclature; Airfoil numbering system; Modern low-speed airfoils; Natural laminar flow (NLF) airfoils; Reflexed airfoils; Concave pressure recovery; High-lift design philosophy; Selected research papers; Examples and practical applications.

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**UNIT III** **9 Hours**

**AIRFOIL THEORY**

Classical Thin-airfoil Theory; Vortex sheet; Prandtl's Classical Lifting-line Theory; Elliptical lift distribution; Numerical non-linear lifting-line method; Finite-wing Theory; Vortexpanel Numerical Method; Numerical modeling demonstration.

**UNIT IV** **9 Hours**

**ROTORCRAFT AERODYNAMICS.**

Helicopter UAVs; Rotor thrust; Rotor drag, Coning angle; Disc loading; Helicopter flight principles; Ground effect; Translational lift; Autorotation; Vortex ring state; Blade & blade tip design; Rotational airflow; Blade tip speed; Retreating blade stall; Blade flapping; Blade sailing; High-inertia blades; Tip sweepback; Anti-torque rotor design; Applied examples.

**UNIT V** **9 Hours**

**AUTOMATED FLIGHT STABILITY**

Static stability; Dynamic stability; Longitudinal stability and control; Neutral point; Static margin; Elevator effectiveness; Lateral stability and control; Directional stability and control; Stability derivatives; Pitching, rolling and yawing rate; Inertial and aerodynamic damping; Canard; Forward wing sweep; Stability augmentation.

**Total: 45 Hours**

**Reference(s)**

1. Andey Lennon, " Basics of R/C Model Aircraft Design" Model airplane news puplication,
2. John Baichtal, Building your own drones: A Beginners' Guide to Drones, UAVs, and ROVs.
3. J. D. Anderson, "Fundamentals of Aerodynamics", 5th Edition, McGraw Hill Education India Private Limited, 2010.
4. E. L. Houghton, "Aerodynamics for Engineering students", 6th edition, Elsevier, 2012.
5. EthirajanRathakrishnan, "Theoretical Aerodynamics", 1st Edition, Wiley Publications, 2013.
6. L. J. Clancey, "Aerodynamics", Shroff Publications, 2006.
7. http://nptel.ac.in/courses/101105059/

## 21AE024 SATELLITE TECHNOLOGY 3 0 0 3

**Course Objectives**

- To acquired foundation in orbital mechanics and launch vehicles for the satellites.
- To provide the fundamentals to design the satellite systems.
- To understand the various multiple access techniques for satellite communication systems and earth station technologies.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
m. Utilize the knowledge of aeronautical engineering in innovative, dynamic and challenging environment for design and development of new products.

**Course Outcomes (COs)**

1. Understand the function of spacecraft subsystems.
2. Apply orbital mechanics formulas and solutions to spacecraft mission design.
3. To provide knowledge on orbital transfer and satellite trajectories.
4. To acquire the functionalities of subsystems utilized for satellites.
5. To understand the concepts of satellite navigation and GPS

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
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| 5 | 3 | 2 | | | | 1 | | | | | | | 2 | 2 | |

**UNIT I** **9 Hours**

**INTRODUCTION TO ORBITS AND SATELLITES**

Elements and mechanics of Orbits – launch vehicles – satellites - components and functions - Applications.

**UNIT II** **9 Hours**

**ORBITAL EQUATIONS AND DYNAMICS**

Kepler laws – Solution to two-body problem – conics and relations orbital elements – orbit determination – Lambert problem – satellite tracking - Relations between Position and Time.

**UNIT III** **9 Hours**

**SATELLITE ORBITAL TRANSFER AND INTERPLANETARY TRAJECTORIES**

Satellite orbit transfer: Direct Transfer and Hohmann Transfer and their relative advantages and disadvantages - Orbital Plane changes - Numerical Problems
Two dimensional interplanetary trajectories - fast interplanetary trajectories - trajectory about the target planet.

**UNIT IV** **9 Hours**

**SATELLITE SUBSYSTEMS**

Attitude and Orbit Control System, Telemetry, Tracking, Command and Monitoring, Power Systems, Communication Subsystems, Satellite Antennas

**UNIT V** **9 Hours**

**SATELLITE NAVIGATION**

Global Positioning Systems - Radio and Satellite Navigation, GPS Position Location principles, GPS Receivers, GPS C/A code accuracy, Differential GPS, IRNSS and GLONASS.

**FOR FURTHER READING**

Applications - Case studies on future challenges in aerospace engineering.

**Total: 45 Hours**

**Reference(s)**

1. Curtis, H. D., Orbital Mechanics for Engineering Students, 2nd ed., Elsevier (2009).
2. Chobotov, V. A., Orbital Mechanics, 3rd ed., AIAA Edu. Series (2002).
3. Tewari, A., Atmospheric and Space Flight Dynamics: Modeling and Simulation with MATLAB and Simulink, Birkhuser (2007).
4. Satellite Communications- Timothy Pratt, Charles Bostian and Jeremy Allnutt, WSE, Wiley Publications, 2nd Edition, 2003, John Wiley & Sons.

## 21AE025 NDT FOR AERONAUTICAL APPLICATIONS

**3 0 0 3**

**Course Objectives**

- To study and understand the various Non Destructive Evaluation and Testing methods
- To provide knowledge on selecting suitable non-destructive testing methods for inspecting aerospace components.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Illustrate the basic principles, techniques, equipment, application and limitations of NDT methods
2. Find the defects in the aircraft components using liquid penetrant and magnetic particle testing
3. Carryout thermography and eddy current testing to identify the defects in aircraft components
4. Predict the defects in the aircraft components using ultrasonic and acoustic emission testing
5. Carryout radiography testing to identify the defects in aircraft components

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **7 Hours**

**OVERVIEW OF NDT**

NDT Versus Mechanical testing - Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation - Relative merits and limitations -

Various physical characteristics of materials and their applications in NDT - Visual inspection - Unaided and aided.

**UNIT II** **8 Hours**

**SURFACE NDE METHODS**

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods - Testing Procedure - Magnetic Particle Testing- Theory of magnetism, inspection materials - Magnetisation methods - Interpretation and evaluation - Principles and methods of demagnetization - Residual magnetism.

**UNIT III** **10 Hours**

**THERMOGRAPHY AND EDDY CURRENT TESTING (ET)**

Thermography- Principles - Contact and non contact inspection methods - Advantages and limitation - Instrumentations and methods, applications - Eddy Current Testing - Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements- Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

**UNIT IV** **10 Hours**

**ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE)**

Ultrasonic Testing - Principle, Transducers, transmission and pulse-echo method - straight beam and angle beam - instrumentation, data representation, A/Scan, B-scan, C-scan - Acoustic Emission Technique - Principle, AE parameters, Applications.

**UNIT V** **10 Hours**

**RADIOGRAPHY (RT)**

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 - Interpretation / Evaluation - Fluoroscopy - Xero-Radiography, Computed Radiography, Computed Tomography.

**FOR FURTHER READING**

Phased array ultrasonics time of flight diffractions -Automated and remote ultrasonic testing - Acoustic pulse reflectometry - Alternative current field method - Case studies on NDT techniques used in aircrafts.

**FOR FURTHER READING**

Phased array ultrasonics time of flight diffractions -Automated and remote ultrasonic testing - Acoustic pulse reflectometry - Alternative current field method - Case studies on NDT techniques used in aircrafts.

**Total: 45 Hours**

**Reference(s)**

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.
3. ASM Metals Handbook, V-17, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Volume 17, Metals Park, Ohio, USA, 2000.
4. Charles, J. Hellier, "Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.

## 21AE026 HELICOPTER MAINTENACE 3 0 0 3

**Course Objectives**

- To provide the Applicant with a strong focus on the practical skills required to ensure safe performance of maintenance, inspections and routine work.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**Course Outcomes (COs)**

1. Understand the basic directions,ground handling procedure and construction methods of helicopter
2. Elaborate the maintenance procedure of main rotor systems and its components
3. Summarize the working and maintenance procedure of helicopter transmission system.
4. Analyse the working of helicopter propulsion system and tail rotor system and its maintenance procedure.
5. Apply the purpose equipment for aircraft and its maintenance

**Articulation Matrix**

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**UNIT I** **9 Hours**

**HELICOPTER FUNDAMENTALS**

Basic directions -ground handling, bearing -gears construction -Construction of fuselage and tail Structures

**UNIT II** **9 Hours**

**MAIN ROTOR SYSTEM**

Head maintenance - blade alignment - static main rotor balance - vibration - tracking - span wise dynamic balance - blade sweeping -electronic balancing -dampener maintenance - counter weight adjustment - auto rotation adjustments - mast & flight control rotor - mast- stabilizer, dampeners - swash plate flight control systems collective - cyclic - push pull tubes -torque tubes- bell cranks - mixer box -gradient unit control boosts -maintenance & inspection control rigging

**UNIT III** **9 Hours**

**MAIN ROTOR TRANSMISSIONS**

Engine transmission coupling- drive shaft - maintenance clutch- freewheeling units -spray clutch-roller unit - torque meter - rotor brake -maintenance of these components -vibrations - mounting systems- transmissions

**UNIT IV** **9 Hours**

**POWER PLANTS AND TAIL ROTORS**

Fixed wing power plant modifications - installation - different type of power plant maintenance. Tail rotor system - servicing tail rotor track - system rigging

**UNIT V** **9 Hours**

**AIRFRAMES AND RELATED SYSTEMS**

Rotary wing Fuselage structural construction - Tubular, sheet metal- Bonded Fuselage maintenance-Airframe Systems - Stress and loads on Airframe, Wheel and skid Gear,visibility., Special purpose equipment

**FOR FURTHER READING**

Emergency landing system. Checking Orientation of Blades- ground effect- Landing gear types with various surface regions

**Total: 45 Hours**

**Reference(s)**

1. Powers, Rod. 2017/2018ASVABFor Dummies with Online Practice. John Wiley & Sons, 2018.
2. Jeppesen, "Helicopter Maintenance", Jeppesons and Sons Inc., 2000.
3. Wang, Jinsong, ed. Proceedings of the First Symposium on Aviation Maintenance and Management-Volume II. Vol. 297. Springer Science & Business Media, 2014.
4. U.S department of Transportation, FAA, Airframe and power plant mechanics, 2008.
5. U.S Department of Transportation , FAA - Basic helicopter handbook - 2013.

## 21AE027 AERO ENGINE REPAIR AND MAINTENANCE

**3 0 0 3**

**Course Objectives**

- To understand the basic concepts of the maintenance and repair of both piston and jet aero engines and the procedures followed for an overhaul of aero engines
- To acquire the knowledge of the inspection and overhaul of both piston and jet engines

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**Course Outcomes (COs)**

1. Understand the working principle of the piston engine and its components
2. Carry out the troubleshooting procedures for engine components
3. Analysis of symptom failure in, different engine system.
4. Outline the maintenance procedure for jet engines
5. Understand the troubleshooting procedures for aerospace engine components

**Articulation Matrix**

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**UNIT I** **9 Hours**

**PISTON ENGINES**

Carburation and Fuel injection systems - Ignition system components - spark plug detail - Engine operating conditions at various altitudes - Induction, Exhaust, and cooling system - Inspection and maintenance -troubleshooting - engine components - Daily and routine checks - Compression testing of cylinders - Special inspection schedules - Checks and inspection procedures

**UNIT II** **9 Hours**

**JET ENGINES**

Bearings and seals - Inlets - compressors- turbines-exhaust section - Details of control, starting around running and operating procedures - Inspection and Maintenance- permissible limits of damage and repair criteria - internal inspection - compressor washing- field balancing of compressor fans- Component & Systems maintenance procedures - instruments for online maintenance - Foreign Object Damage(FOD) - Blade damage

**UNIT III** **9 Hours**

**PROPELLERS**

Propeller theory - operation, construction assembly and installation - Pitch change mechanism- Propeller axially system- Damage and repair criteria - General Inspection procedures - Checks on constant speed propellers - Pitch setting, Propeller Balancing, Blade cuffs, Governor/Propeller operating conditions - Damage and repair criteria.

**UNIT IV** **9 Hours**

**TESTING AND INSPECTION**

Symptoms of failure - Fault diagnostics - Rectification during testing equipments for overhaul: Tools and types of equipment - requirements for overhauling - Tools for inspection - Tools for safety and for visual inspection - Equipment for replacement of parts and their repair. Engine testing and procedures and schedule preparation - Online maintenance.

**UNIT V** **9 Hours**

**OVERHAULING**

Engine Overhaul - Overhaul procedures - Cleaning of components - Repairs schedules for overhaul - Balancing of Gas turbine components. Trouble Shooting: Procedures for trouble shooting - Condition monitoring of the engine on ground and at altitude - engine health monitoring and corrective methods.

**FOR FURTHER READING**

Starting procedure of engines-Engine maintenance time chart- Bird Hitting damage control-Engine Fire Protection system

**Total: 45 Hours**

**Reference(s)**

1. Thomas Wild, "Aircraft Power plants", 9th edition TATA McGraw Hill,New Delhi, 2018.
2. Ahmed F. El-Sayed, Aircraft Propulsion and Gas Turbine Engine, 2nd Edition, 2017.
3. Dale Crane,"Aviation Maintenance Technician - Powerplants", 2nd Edition,Aviation Supplies & Academics, Incorporated, 2011.
4. United Technologies Pratt and Whitney, "The Aircraft Gas turbine engine and its Operation", The English Store, New Delhi, 2005.
5. "Federal Aviation Administration , Aviation Maintenance Technician Handbook-Powerplant", Volumes 1 and 2, Newcastle, WA: Aviation Supplies & Academics, 2012.

## 21AE028 AIRFRAME MAINTENANCE AND REPAIR 3 0 0 3

**Course Objectives**

- To make the students to understand the Airframe components and the tools used to maintain the components. Defect investigation, methods to carry out investigation and the detailed maintenance and practice procedures.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Students will be able to understand the general maintenance process that is used for maintaining the aircraft structural components in welding shop .
2. Analysis of various aircraft structural components
3. Understanding the procedure and concept of jacking, rigging, etc
4. Analysis of different safety practices.
5. Carryout the troubleshooting procedures for aircraft maintenance

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
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| 5 | 2 | | | | | | | | | | | | | | |

**UNIT I** **8 Hours**

**MAINTENANCE OF AIRCRAFT STRUCTURAL COMPONENTS**

Equipments used in welding shop and their maintenance - Ensuring quality welds - Welding jigs and fixtures - Soldering and brazing laser welding. Sheet metal repair and maintenance: Selection of materials; Repair schemes; Fabrication of replacement patches; Tools - power/hand; Repair techniques; Peening - Close tolerance fasteners; Sealing compounds; forming/shaping; Calculation of weight of completed repair; Effect of weight - change on surrounding structure.

**UNIT II** **9 Hours**

**PLASTICS AND COMPOSITES IN AIRCRAFT**

Review of types of plastics used in airplanes maintenance and repair of plastic components repair of cracks, holes etc., various repair schemes scopes. Inspection and repair of composite components special precautions autoclaves. Inspection of damage classification repair or replacement sheet metal inspection N.D.T. Testing riveted repair design, damage investigation

**UNIT III** **9 Hours**

**AIRCRAFT JACKING, ASSEMBLY AND RIGGING**

Airplane jacking and weighing and C.G. Location.Balancing of control surfaces inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor.

**UNIT IV** **10 Hours**

**REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM**

Trouble shooting and maintenance practices service and inspection.inspection and maintenance of landing gear systems. inspection and maintenance of air-conditioning and pressurization system, water and waste system. Installation and maintenance of instruments handling testing inspection. Inspection and maintenance of auxiliary systems fire protection systems ice protection system rain removal system position and warning system auxiliary power units (APUs).

**UNIT V** **9 Hours**

**SAFETY PRACTICES**

Hazardous materials storage and handling, aircraft furnishing practices equipment's. Trouble shooting - theory and practices

**FOR FURTHER READING**

Reciprocating Engine overhaul procedure- turbine Engine maintenance -trouble shooting and procedure of turbojet and turbo Prop Engines- Fuel System for rocket engines.

**Total: 45 Hours**

**Reference(s)**

1. Kroes, Watkins, Delp, "Aircraft Maintenance and Repair", Tata McGraw-Hill, New Delhi, 2010
2. L. McKinley and R. D. Bent, "Aircraft Maintenance & Repair", Tata McGraw-Hill, 2010.
3. General Hand Books of Airframe and Powerplant Mechanics, U. S. Dept. of Transportation, Federal Aviation Administration, the English Book Store, New Delhi 1995.
4. Larry Reithmeir, "Aircraft Repair Manual", Palamar Books, Marquette, 1992.
5. Brim D.J.andBogges H.E., "Aircraft Maintenance", Pitman Publishing.

## 21AE029 AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES

**3 0 0 3**

**Course Objectives**

- To study the basic concepts of the maintenance and repair of both piston and jet aero engines and the procedures followed for overhaul of aero engines
- To update inventory management system and maintaining aircraft components for alignment, cleanliness, wear and tear, and clearance

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Course Outcomes (COs)**

1. Understand the safety precautions during aircraft maintenance and starting procedure of an aircraft engines.
2. Analyze the ground servicing procedure of an aircraft sub systems
3. Analyze the maintenance safety procedures and precautions.
4. Understand the Inspections methods and aircraft documents requirements for aircraft maintenance
5. Analyze the aircraft hardwares and tools

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 2 | | | 2 | 3 | 2 | 2 | 1 | | | | | | |
| 2 | | 1 | | | 2 | 1 | 3 | 2 | 2 | | | | | | |
| 3 | | | | | 2 | 2 | 3 | 2 | 1 | | | | | | |
| 4 | | | | | 1 | 1 | 3 | 2 | 1 | | | | | | |

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| 5 | 3 | 1 | 2 | | | | | | | | | | | | |

**UNIT I** **8 Hours**

**AIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENT**

Mooring, jacking, leveling and towing operations preparation equipment precautions engine starting procedures piston engine, turboprops and turbojets engine fire extinguishing

**UNIT II** **9 Hours**

**GROUND SERVICING OF VARIOUS SUB SYSTEMS**

Air conditioning and pressurization - oxygen and oil systems - ground units and their maintenance

**UNIT III** **8 Hours**

**MAINTENANCE OF SAFETY**

Basic Safety equipments in aircraft- Shop safety - environmental cleanliness - precautions

**UNIT IV** **9 Hours**

**INSPECTION**

Process - purpose - types - inspection intervals - techniques - checklist - special inspection - publications, bulletins, various manuals - FAR air worthiness directives - type certificate data sheets - data specifications

**UNIT V** **11 Hours**

**AIRCRAFT HARDWARE, SYSTEMS AND PROCESSES**

Hand tools - precision instruments - special tools and equipments in an airplane maintenance shop - identification terminology - specification and correct use of various aircraft hardware - American and British systems of specifications - threads, gears, bearings, etc. - drills, tapes & reamers. - Identification of all types of fluid line fittings. Materials, metallic and non-metallic.

**FOR FURTHER READING**

Reciprocating Engine overhaul procedure- turbine Engine maintenance -troubleshooting and procedure of turbojet and turbo Prop Engines- Fuel System for rocket engines

**Total: 45 Hours**

**Reference(s)**

1. Lloyd Dingle, Michael H Tooley, "Aircraft Engineering Principles (Taylor & Francis Aerospace and Aviation Engineering)", 2nd Edition, Kindle Edition, 2014
2. Thomas Wild, "Aircraft Power plants", 9th edition TATA McGraw Hill,New Delhi, 2018
3. Kroes Watkins Delp, "Aircraft Maintenance and Repair" , 4th Edition, McGraw-Hill, New York 2012
4. He Ren, Xi Chen, Yong Chen,"Reliability Based Aircraft Maintenance Optimization and Applications (Aerospace Engineering)", Academic Press; 1st edition 2017
5. J. L. McKinley and R. D. Bent, "Aircraft Maintenance & Repair", Tata McGraw-Hill, 2010.
6. Treager, S., "Gas Turbine Technology", Tata McGraw-Hill, 2008.

## 21AE030 AIRLINE AND AIRPORT MANAGEMENT 3 0 0 3

**Course Objectives**

- To understand the operational flow of airlines and air transportation maintenance.
- To understand the structure and management levels of aviation sectors.
- To attribute the financial influences those are structuring the airlines and airport operations.

**Programme Outcomes (POs)**

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

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

m. Utilize the knowledge of aeronautical engineering in innovative, dynamic and challenging environment for design and development of new products.

n. Impart professional skills through simulation, language skills and general purpose CAE packages to solve practical problems of components in design and analysis to meet the airworthiness requirements for flight vehicles.

**Course Outcomes (COs)**

1. Interpret the roles and functions of Airlines and Airport Industry
2. Explain the economic flow in functioning Airline Sectors
3. Explain the principles of management theories for Airport operations
4. Analyse the scheduling methods to control the flight plan process of airlines
5. Analyse the factors influencings the design of fleet

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
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| 2 | | 3 | | | | 2 | | | | | | | 2 | 2 | |
| 3 | | 1 | | | | 3 | | | | | | | 2 | 3 | |
| 4 | | 2 | | | | 3 | | | | | | | 2 | 2 | |
| 5 | | 2 | | | | 3 | | | | | | | 2 | 2 | |

**UNIT I** **9 Hours**

**INTRODUCTION**

Historical Development of Aviation and Air Transportation - Global Air Transport Authority: Overview - Roles of International Air Transport Association and Interntaional Civil Aviation Organization - Airline Management System - Organization Levels and functions.

**UNIT II** **9 Hours**

**AIRLINE ECONOMICS**

Airline Economics - Forecasting - general factors considered for Airlines economic Analysis - Margin Growth - Forecasting Approach of Indian Airline Economics - Airline Revenue and Gross Domestic Product - Operating cost of Airlines - Load Factor - Passenger fare and tariffs - influence of

geographical, economic & political factors on routes and route selection

**UNIT III** **9 Hours**

**AIRPORT OPERATIONAL STRUCTURE**

Airport structures and sectors - Divisional responsibilities - Organizational Levels of Airport of Airport management system - Airport Authority of India: Organizational Structure - Functional policies and Objectives - Overview of DGCA.

**UNIT IV** **9 Hours**

**PRINCIPLES OF AIRLINES SCHEDULING**

Flight operations and crew scheduling - ground operations and facility - limitations, Equipment Maintenance scheduling - Principles of Airlines Scheduling - Types of Airline scheduling -Point to Point Scheduling - Hub and Spoke Scheduling - Preparation of Flight Plan.

**UNIT V** **9 Hours**

**FLEET PLANNING AND DESIGN**

Introduction: Airline Fleet - Fleet Planning and Aircraft evaluation Process - Factors considered for Fleet planning - Fleet size -Fleet structure - Fleet Rationalism - Fleet commonality - Fleet cost planning - capital acquisition - valuation & depreciation - budgeting- Air crew Evalution.

**FOR FURTHER READING**

Aircraft Traffic control- Significance- Roles- Emergency landing - Communication ATC, PilotsBlack Box investigation.

**Total: 45 Hours**

**Reference(s)**

1. Fedric J.H., "Airport Management", 2000.
2. C.H. Friend, "Aircraft Maintenance Management", 2000.
3. Alexander T Wells, "Air Transportation", Wadsworth Publishing Company, California, 1993.
4. "Indian Aircraft manual" - DGCA Publications.

## 21AE031 PYTHON FOR AEROSPACE ENGINEERING

**3 0 0 3**

**Course Objectives**

- To understand the basics of python with control flow statements
- To gain knowledge about the different data types and control flow statements
- To impart knowledge about the functions, modules, files and exception

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Implement simple python programs using strings and operators
2. Develop python programs using control flow statements
3. Design applications using list, sets, tuples and dictionaries in python
4. Apply the concepts of functions and modules in python programming
5. Develop python programs using files and exception

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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| 3 | 1 | 2 | 3 | | - | | | | | | | | | | |
| 4 | 2 | 1 | 3 | | - | | | | | | | | | | |
| 5 | 2 | 1 | 3 | | - | | | | | | | | | | |

**UNIT I** **9 Hours**

**INTRODUCTION**

Basics of python - Variables: Assigning Values to Variables, Multiple Assignment - Strings - Types of Operator: Arithmetic Operators, Comparison Operators, Assignment Operators, Logical Operators, Identity Operators

**UNIT II** **9 Hours**

**STATEMENTS**

Control Statements: if, if-else, nested if-else - Looping Statements: for, while, nested loop - Loop control statements: break, continue, and pass.

**UNIT III** **9 Hours**

**DATA TYPES**

List: Accessing Values in Lists, Updating Lists, Delete List Elements, Basic List Operations, Indexing, Slicing, and Matrixes - Tuple: Accessing Values in Tuples, Updating Tuples, Delete Tuple Elements, Basic Tuple Operations, Indexing, Slicing, and Matrixes - Dictionary: Accessing Values in Dictionary, Updating Dictionary, Delete Dictionary Elements Built-in Dictionary Functions & Methods

**UNIT IV** **9 Hours**

**FUNCTION AND MODULES**

Function: Defining a Function, Calling a Function, Pass by reference vs value, Anonymous Functions -Module: import Statement, from import Statement, Namespaces and Scoping.

**UNIT V** **9 Hours**

**FILES AND EXCEPTION**

Files: Reading and Writing-Format Operators-Filenames and paths - Exception: Handling an exception, User-Defined Exceptions

**FOR FURTHER READING**

Classes and Objects, Database Access.

**Total: 45 Hours**

**Reference(s)**

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/ Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python - Revised and updated for Python 3.2", Network Theory Ltd., 2014.
3. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus", Wiley India Edition, 2015.
4. John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press , 2017.

## 21AE032 AIRCRAFT DESIGN 3 0 0 3

**Course Objectives**

- To understand and develop the basic concept of aircraft design in detail.
- To apply the knowledge of flight mechanics, aerodynamics, propulsion and structures in design.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Understand the aircraft design process, and merits of different airplane layouts.
2. Create comparative data sheet and estimate various components weights.
3. Apply the knowledge of aerodynamics and propulsion in selecting suitable geometry and propulsion system for an aircraft.
4. Estimate performance, stability and controllability of the aircraft.
5. Design structural members to carry various loads on the complete aircraft.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **9 Hours**

**INTRODUCTION**

Introduction to Aircraft Design Process - State of art in airplane design, Classification of airplanes based on purpose and configuration - Merits of different airplane layouts, Design requirement based on manufacturability, maintenance and operational costs.

**UNIT II** **9 Hours**

**CONCEPTUAL DESIGN PROCEDURE**

Mission Requirements, Data collection and 3-view drawings, Weight estimation - Crew weight, Payload weight, Empty weight, Fuel weight and Mission segment weights - Development of procedures for evaluation of aircraft component weights. Selection of wing loading and thrust loading.

**UNIT III** **9 Hours**

**POWER PLANT AND GEOMETRY SELECTION**

Power plant choices available - Comparative merits - Selection of Power plant - Considerations for Engine location. Wing, Horizontal tail and Vertical tail geometry design - Aerofoil selection, Sweep angle, Aspect ratio, Taper ratio, Wash in & Wash out, Incidence and dihedral angle - Airworthiness requirements. Fuselage geometry design.

**UNIT IV** **9 Hours**

**PERFORMANCE AND STABILITY ESTIMATIONS**

Drag Estimation - Drag Polar - Performance Estimation. Determination of center of gravity location - Control Selection - Longitudinal, lateral and directional stability and controllability estimations.

**UNIT V** **9 Hours**

**STRUCTURAL DESIGN**

V-n diagram, Gust envelope - Estimation of various loads on complete aircraft - Fuselage Design - Wing Design - Empennage design - Landing gear design - Undercarriages, controls, connections and joints - Material selection.

**FOR FURTHER READING**

Materials for modern aircraft, Methods of analysis, testing and fabrication

**Total: 45 Hours**

**Reference(s)**

1. D.P. Raymer, "Aircraft Design: A conceptual Approach", Fifth Edition, AIAA Series, 2012.
2. Denis Howe, "Aircraft Conceptual Design Synthesis", John Wiley & Sons, Ltd, 2000.
3. E.F. Bruhn, "Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., U.S.A., 1980.
4. DarrolStinton, "The Design of the Airplane", Second Edition, Blackwell Science U.K, 2001.
5. H.N.Kota, "Integrated design approach to Design fly by wire Lecture notes", Interline Pub. Bangalore, 1992.
6. Daniel Raymer, "Dan Raymer"s Simplified Aircraft Design for Homebuilders", Design Dimension Press, 2002.

## 21AE033 COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

**Course Objectives**

- To give an introduction to computational fluid dynamics (CFD), modelling technology for thermo-fluid related applications
- To give also an proper background for the intelligent and appropriate use of commercial CFD packages

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**Course Outcomes (COs)**

1. Develop the suitable governing Partial Differential Equation for the given
2. Create the discretization process for the stability of the numerical solution
3. Develop the flow over an airfoil using vortex panel method
4. Apply the mathematical concepts of different methodologies, theories and approaches.
5. Derive the best algorithm for the pressure velocity coupling using grid generation

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
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| 3 | 3 | | 2 | 2 | 1 | | | | | | | | | | |
| 4 | 3 | | 2 | 2 | 1 | | | | | | | | | | |
| 5 | 2 | | 2 | | 1 | | | | | | | | | | |

**UNIT I** **9 Hours**

**INTRODUCTION OF GOVERNING PDE**

Conservation equations in both differential and integral form. Classification of PDE: elliptic, parabolic, and hyperbolic. Method of finite differences, Consistency and order of accuracy, Discretization of convective and diffusive PDE. Explicit and Implicit strategies

**UNIT II** **9 Hours**

**DISCRETIZATION**

Boundary layer equations and methods of solution, implicit time dependent methods for inviscid and viscous compressible flows concept of numerical dissipation stability properties of explicit and implicit methods conservative upwind Discretization for hyperbolic systems further advantages of upwind differencing

**UNIT III** **9 Hours**

**PANEL METHODS AND TURBULENCE MODELS**

Introduction -source panel method -vortex panel method -applications - Turbulence and its length scales, Law of the wall, Reynolds decomposition and RANS, Mixing length theory, Zero-,one-,two-equation turbulence models

**UNIT IV** **9 Hours**

**FINITE VOLUME TECHNIQUES**

Finite volume techniques - Cell Centered formulation - Lax Wendoroff Time stepping- Runge - kutta time stepping - multi - stage time stepping - accuracy - cell vertex formulation - multistage time stepping - FDM -like finite volume techniques - Central and up-wind type Discretization

**UNIT V** **9 Hours**

**SOLUTION ALGORITHMS FOR PRESSURE VELOCITY COUPLING IN STEADY FLOWS AND UNSTRUCTURED GRIDS**

Introduction - Staggered grid - Momentum Equations - The SIMPLE algorithm - Assembly of a complete method - SIMPLER algorithm, SIMPLEC algorithm, PISO algorithm - General comments on SIMPLE, SIMPLER, SIMPLEC and PISO - Advancing Front Triangulation, Voronoi Diagram and Delaunay Triangulation.

**FOR FURTHER READING**

Inlet, Outlet and Wall Boundary Conditions, Constant Pressure Boundary Condition, Symmetry Boundary Condition, Periodic or cyclic boundary condition - Potential Pitfalls - Simple Chemical Reacting System (SCRS), Eddy break-up of model of combustion, Laminar flame-let model

**Total: 45 Hours**

**Reference(s)**

1. H.K. Versteeg and W.Malalasekera, "An Introduction to Computational Fluid Dynamics", Pearson Education, 2007.
2. Klaus A. Hoffmann, Steve T. Chiang, "Computational Fluid Dynamics , Engineering Education System", 4th edition.
3. David C. Wilcox, "Turbulence modeling for CFD", D C W Industries, 3rd edition.
4. John D. Anderson, "Computational Fluid Dynamics", McGraw-Hill Higher Education, 6th edition.
5. Dale A. Anderson, John C. Tannehill and Richard H. Pletcher, "Computational Fluid Mechanics and Heat Transfer", CRC Press, 3rd edition.
6. John F. Wendt (Editor), "Computational Fluid Dynamics An Introduction", Springer Verlag, Berlin, 2008.

## 21AE034GRID GENERATION TECHNIQUES 3 0 0 3

**Course Objectives**

- To introduce the concepts of grid generation required for Computational Fluid Dynamics applications.
- To give also an proper background for the intelligent and appropriate use of grid generation packages

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**Course Outcomes (COs)**

1. Develop the suitable grid type for the given model.
2. Analyse the different grid generation methods and select the right method for the model.
3. Develop structured grid with necessary conditions for the given model.
4. Apply the grid generation concepts of different methodologies, theories and approaches available for unstructured grid generation.
5. Apply the best suited grid generation method for the given model and domain.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 3 | | 2 | | 1 | 3 | | | | | | | | | |
| 3 | 3 | | 2 | 2 | 1 | | | | | | | | | | |
| 4 | 3 | | 2 | 2 | 1 | | | | | | | | | | |
| 5 | 2 | | 2 | | 1 | | | | | | | | | | |

**UNIT I** **9 Hours**

**INTRODUCTION TO GRID GENERATION**

Historical aspects of the various grids - need for grid generation, Definition and types of grid, Transformation of equation, Matrices and Jacobians, Stretched Grids, Elliptic Grids, Adaptive grids. QUICK and SIMPLE algorithms.

**UNIT II** **9 Hours**

**GRID TYPES**

Body fitted grids in complex geometries, orthogonal grids, mapping functions, staggered/collocated and structured/unstructured, various methods of grid generations (Algebraic, Transfinite, Poisson equation methods).

**UNIT III** **9 Hours**

**STRUCTURED GRIDS**

Structured Grids – Types -essential features, structured Grid generation techniques- algebraic and numerical methods, conformal transformation for structured grid Generation - Grid quality and adaptive methods of structured grids.

**UNIT IV** **9 Hours**

**UNSTRUCTURED GRID**

Unstructured grid generation techniques – Delaunay triangulation - Voronoi diagram, advancing front method - surface grid generation, multi-block grid generation, and mesh less methods Grid quality and adaptive methods of unstructured grids.

**UNIT V** **9 Hours**

**GRID GENERATION IN CFD**

Introduction - Structured Grid/Mesh Generation (2D-Quad/3D-Hex) - Mapped Meshing - Sweeping Meshing - Un-structured Grid/Mesh Generation(2D-Tri/3D-Tet) - Creation of Density box, Domain and its types, Prism mesh Generation, Mesh Quality checks, Mesh export.

**Total: 60 Hours**

**Reference(s)**

1. Vladimir D. Liseikin, “Grid Generation Methods”, Scientific Computation, Springer, 2017.
2. Joe F. Thompson, Bharat K. Soni, Nigel P. Weatherill, “Handbook of Grid Generation”, CRC Press, 1998.
3. M Farrashkhalvat, J P Miles, “Basic Structured Grid Generation With an Introduction to Unstructured Grid Generation”, 2003.
4. Rubén Sevilla, “Mesh Generation and Adaptation - Cutting-Edge Techniques”, 2022.
5. Klaus A. Hoffmann, Steve T. Chiang, "Computational Fluid Dynamics , Engineering Education System", 4th edition.
6. David C. Wilcox, "Turbulence modeling for CFD", D C W Industries, 3rd edition.
7. John D. Anderson, "Computational Fluid Dynamics", McGraw-Hill Higher Education, 6th edition.
8. John F. Wendt (Editor), "Computational Fluid Dynamics An Introduction", Springer Verlag, Berlin, 2008.

**21AE035 COMPUTER-AIDED DESIGN & ANALYSIS 3 0 0 3**

**COURSE OBJECTIVES:**

- To impart the knowledge of CAD systems and the importance of graphics transformation
- To impart basic knowledge on Computer Aided Design methods and procedures
- To introduce the fundamentals of solid modelling
- To impart the knowledge on basics of simulation modelling.
- To familiarize the concept of modelling complex system

**PROGRAMME OUTCOMES (POS)**

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

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

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

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

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

**COURSE OUTCOMES:**

1. Explain the working of CAD systems with the application of graphic transformations.
2. Apply the graphics aids and manipulation for scene creation
3. Create an assembly with their hierarchical relationship
4. Recognize about the simulation modelling concepts with examples.
5. Explain the modelling complex system with simulation language

**ARTICULATION MATRIX**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
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**UNIT I** **8 Hours**

**OVERVIEW OF CAD SYSTEMS AND IMPORTANCE OF GRAPHICS**

Overview of computer aided design (CAD) systems-Definition, Product cycle of CAD, CAD applications, Conventional and CAD processes, -requirements of hardware and software for CAD. Graphics transformations - Importance and Functions of graphics in software packages, generative, cognitive and image processing graphics.Transport of graphics data, graphic standards, generation of graphic primitives, display and viewing.

**UNIT-II**

**PART DESIGN REPRESENTATION** **9 Hours**

Design Drafting - Dimensioning - Conventional tolerance - Geometric tolerance - CAD - input / output devices -topology - Geometric transformation - Perspective transformation - Data structure - Geometric modelling for process planning - GT layout, GT coding - OPTIZ system - MICLASS system- CODE system.

**UNIT-III**

**ASSEMBLY MODELING** **10 Hours**

Mechanical Assembly: Introduction- top down &bottom up modelling, approaches, collaborative design, part modelling & representation, Hierarchical relationships, mating conditions. Generation of Assembling Sequences - Precedence Diagram, Liaison sequence analysis, Precedence Graph, Assembly analysis - Interference checking.

**UNIT-IV**

**INTRODUCTION TO SIMULATION MODELLING** **9 Hours**

Definition, nature of simulation, advantages, disadvantages, limitations, areas of application, systems and system environment, components of a system, discrete and continuous systems. Model of a system, types of models, discrete-event system simulation, steps in a simulation study. Simulation examples – Queuing systems, inventory systems

**UNIT-V**

**MODELLING COMPLEX SYSTEM** **10 Hours**

Introduction - list processing in simulation - a simple simulation language: Simlib - single-server queuing simulation with Simlib - time-shared computer model - multiteller bank with jockeying - job-shop model - efficient event-list manipulation.

**Total: 45 Hours**

**Reference(s)**

1. Ibrahim Zeid, CAD/CAM Theory and Practice, McGrawHillInc., New Delhi, 2014.
2. Donald Hearn and M PaulineBaker,"Computer Graphics", Prentice Hall, 2001
3. Nanua Singh, Systems Approach to Computer Integrated Design and Manufacturing, John Wiley & Sons, 2008.
4. P.N.Rao, Computer Aided Manufacturing, Tata McGraw Hill Publishing Company, 2010.
5. Jerry Banks, John S, Carson, II, Barry L Nelson and David M Nicol, Discrete-Event System Simulation, Prentice Hall of India Pvt. Ltd., 2009.
6. Averill M Law, Simulation Modeling and Analysis, Tata McGraw Hill Companies Inc, 2014.

## 21AE036 AI & ML IN AERONAUTICAL ENGINEERING

**3 0 0 3**

**Course Objectives**

- To impart artificial intelligence principles, techniques and its history
- To assess the applicability, strengths, and weaknesses of the basic knowledge representation,problem solving, and learning methods in solving engineering problems.
- To introduce students to the basic concepts and techniques of Machine Learning.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

**Course Outcomes (COs)**

1. Evaluate Artificial Intelligence (AI) methods and describe their foundations.
2. Apply basic principles of AI in solutions that require problem solving, inference, perception,
3. knowledge representation and learning.3: Provide solution for classification and regression approaches in real-world applications.
4. Recognize the characteristics of machine learning that makes it useful to solve real-world problems.
5. Understand cutting edge technologies related to machine learning applications.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
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**UNIT I** **9 Hours**

**ARTIFICIAL INTELLIGENCE**

History of Artificial Intelligence – Comparison with machine learning and Data Scienece supervised learning – unsupervised learning – semi-supervised learning – reinforced learning – data science – Artificial Intelligence and deep learning in Engineering – Need for AIML in Aerospace applications -

**UNIT II** **8 Hours**

**MACHINE LEARNING**

Introduction - Well-posed learning problems, designing a learning system, Perspectives and issues in

machine learning Concept learning and the general to specific ordering – introduction, a concept learning task, concept learning as search, find-S: finding a maximally specific hypothesis, version spaces and the candidate elimination algorithm, remarks on version spaces and candidate elimination, inductive bias.

**UNIT III** **9 Hours**

**CLASSIFICATION & REGRESSION**

Regression-Random forest algorithm (RFA) – Decision tree – binary decision tress, pruning – Bayesian network, applications – Support vector Machine algorithm (SVR) – deep learning concepts – Artificial Neural networks (ANN) – training data, hidden layers, and predicted output – Application of classification and regression algorithms in Aerospace Industry

**UNIT IV** **9 Hours**

**DEVELOPMENT OF ML MODEL**

Problem Identification- Clustering-Regression-Steps In Ml Modelling- Data Analysis-B Model Selection- Testing & Training –Prediction

**UNIT V** **8 Hours**

**Applications**

Human Machine Interaction – Predictive maintenance- Fault detection – Dynamic system Order reduction – Umage classification- Process Optimization- Inspection

**Total: 45 Hours**

**Reference(s)**

1. M Ric, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw Hill
2. Ma Peter Flach, ―Machine Learning: The Art and Science of Algorithms that Make Sense of Data‖, First Edition, Cambridge University Press, 2012.chine Learning – Tom M. Mitchell, - MGH
3. Arnold Sterenharz, TetianaShmelova, YuliyaSikirda, "Artificial Intelligence Applications in the Aviation and Aerospace Industries-IGI Global, 2019
4. Aboul Ella Hassanien, Ashraf Darwish, Hesham El-Askary, "Machine Learning and Data Mining in Aerospace Technology, Springer International Publishing, 2019

## 21AE037 CIVIL AVIATION REQUIREMENTS 3 0 0 3

**Course Objectives**

- To understand the necessary background for understanding the civil air rule and regulations which are being followed by Directorate General of Civil Aviation.
- To analyze the policies and certification procedures framed under civil aviation regularities.

**Programme Outcomes (POs)**

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
m. Utilize the knowledge of aeronautical engineering in innovative, dynamic and challenging environment for design and development of new products.
n. Impart professional skills through simulation, language skills and general purpose CAE packages to solve practical problems of components in design and analysis to meet the airworthiness requirements for flight vehicles.

**Course Outcomes (COs)**

1. Explain the scope and provisions of framing civil aviation rules for airlines operations.
2. Apply the reliability methods for aircraft maintenance operation.
3. Explain the procedure of issue and renewal for aircraft registration process.
4. Analyze the importance/influence of Aircraft Maintenance Engineering Certification.
5. Analyze the physical aids and primary documents carried during the aircraft operation.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
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**UNIT I** **9 Hours**

**AIRWORTHINESS**

Responsibilities of operators - owners- procedure of CAR issue, amendments - objectives and targets of airworthiness directorate - airworthiness regulations and safety oversight of engineering activities of operators. C.A.R. Series - "B" Issue Approval of Cockpit Check List - Minimum Equipment list - Preparation and use of cockpit checklist and emergency list.

**UNIT II** **9 Hours**

**C.A.R. SERIES C: DEFECT RECORDING, MONITORING, INVESTIGATION AND REPORTING**

Defect recording, reporting, investigation, rectification and analysis -Reporting and rectification of defects observed on aircraft -Analytical study of in-flight readings & recordings-Maintenance control by reliability method.

C.A.R. Series D: Reliability and Aircraft Maintenance Programmes Reliability Programmes (engines) -aircraft maintenance programme & their approval; On condition maintenance of reciprocating engines; TBO revision programme; -Fixing routine maintenance periods and component TBOs.

**UNIT III** **9 Hours**

**C.A.R. SERIES E: APPROVAL OF ORGANISATIONS**

Approval of organizations in categories A,B,C,D,E,F,&G - Requirements of infrastructure at stations other than parent base :
C.A.R. Series F - Air Worthiness and Continued Air Worthiness. Procedure relating to registration of aircraft; Procedure for issue / revalidation of type certificate of aircraft and its engines / propeller; issue/revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness

**UNIT IV** **9 Hours**

**C.A.R. SERIES: L - M**

Procedure and Issue of AME License - classification and experience requirements, Mandatory Modifications /Inspections.

**UNIT V** **9 Hours**

**C.A.R. SERIES T AND X**

Flight testing of aircraft for issue of C of A - Registration Markings of aircraft -Weight and balance control of an aircraft - Provision of first aid kits & Physician-s kit in an aircraft -Use furnishing materials in an aircraft - Aircraft log books -Document to be carried on board on Indian registered aircraft - Procedure for issue of tax permit - Procedure for issue of type approval of aircraft components and equipments including instruments.

**FOR FURTHER READING**

Approval of Dangerous Goods Training -Programme-Guidelines and Procedure for Dangerous Goods Inspections

**Total: 45 Hours**

**Reference(s)**

1. "Aeronautical Information Circulars (relating to Airworthiness) from DGCA 7 AAI", 2000 and 2006.
2. "Aircraft Manual (India)", Volume Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.
3. Advisory Circulars from DGCA 2003 & 2015
4. "Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness)" - Published by DGCA, The English Book Store, 17- 1,Connaught Circus, New Delhi 2000.

## 21AE038 CORROSION OF AEROSPACE MATERIALS

**3 0 0 3**

**Course Objectives**

- Understand the major factors affecting the corrosion in aircraft and apply suitable corrosion control technique
- Evaluate the impact of corrosion on aircraft structures and components by conducting corrosion test and by implementing monitoring system

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Understand the major factors affecting the corrosion in aircraft and to create the Pourbaix diagrams of Fe, Al and Mg
2. Apply suitable prevention technique to eradicate the eight forms of corrosion
3. Understand the special forms of corrosion and apply suitable corrosion control based on oxidation rate laws of design rules
4. Evaluate the impact of corrosion on aircraft structures and components by implementing monitoring system
5. Understand the corrosion prone areas in aircraft and apply suitable corrosion protection technique

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **7 Hours**

**INTRODUCTION TO CORROSION**

Importance of corrosion and its prevention - examples of corrosion in aircrafts - factors affecting corrosion in aircrafts - environmental and metallurgical factors -Faraday's experiment - passivation - units of corrosion rate - mdd and mpy - Pourbaix diagrams of Fe, Al and Mg.

**UNIT II** **11 Hours**

**FORMS OF CORROSION**

8 forms of corrosion and their prevention - uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion cracking - cathodic and anodic protection.

**UNIT III** **9 Hours**

**SPECIAL FORMS OF CORROSION**

Hydrogen damage - corrosion fatigue - filliform corrosion - fretting corrosion - microbes induced corrosion - high temperature oxidation, corrosion scale formation, Pilling-Bedworth ratio, 4 oxidation rate laws design rules for corrosion control.

**UNIT IV** **8 Hours**

**CORROSION MONITORING**

Corrosion monitoring - weight loss method, electrical resistance method, electrochemical polarization methods - Tafel extrapolation, linear polarization impedance technique - susceptibility tests - tests for intergranular susceptibility and stress corrosion.

**UNIT V** **10 Hours**

**CORROSION AND PREVENTION TECHNIQUES IN AIRCRAFT**

Corrosion prone areas in aircrafts - corrosion of ferrous metals - corrosion of non-ferrous metals - Al, Mg, Ti - corrosion of dissimilar metals - carbon steel and aluminum alloy joint, stainless steel and aluminum alloy joint - intergranular corrosion of fasteners - corrosion protection - Cadmium plating, Chromium plating, Chromatizing, Galvanizing - preventive maintenance - aircraft cleaning.

**FOR FURTHER READING**

Corrosion of fuel tanks, corrosion of battery compartments, corrosion by industrial pollutants and airborne salts, role of paints to protect corrosion.

**Total: 45 Hours**

**Reference(s)**

1. Mars G. Fontana, "Corrosion Engineering", Tata McGraw Hill, Singapore, 2008.
2. Zaki Ahmad, "Principles of Corrosion Engineering and Corrosion Control", Elsevier Science and Technology Books, 2006.
3. R. WinstoneRevie and Herbert H. Uhlig, "Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering", John Wiley & Science, 2008.
4. ASM Hand Book, Vol. 13, "Corrosion", ASM International, 2005.
5. Pierre R. Roberge, "Hand Book of Corrosion Engineering", McGraw Hill, New York, 2000.
6. Denny A. Jones, "Principles and Prevention of Corrosion", Prentice Hall Inc., 2004.

## 21AE039 CRISIS MANAGEMENT IN AIRCRAFT INDUSTRY

**3 0 0 3**

**Course Objectives**

- To understand the case studies of various causes, characteristics of crisis.
- To understand the management techniques already in vogue and apply them to the solutions of crisis problems.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**Course Outcomes (COs)**

1. Understand the basics of Crisis management in the aeronautical industry
2. Compare the different types of crisis and various types of methods
3. Carryout the steps followed during the emergency situation in the aviation industry
4. Outline the DGCA, IATA rules and regulations for airports
5. Analyse the various aircrafts accidents in aviation.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **8 Hours**

**INTRODUCTION TO CRISIS MANAGEMEN**

Crisis management; Crisis management basics; Establishing a crisis management team; The role of the crisis manager; Organizational crisis and communication; Crisis checklist needs.

**UNIT II** **9 Hours**

**TYPOLOGIES AND STAGES OF CRISIS MANAGEMENT**

Crisis typologies - Coombs typology; Characteristics of the crises; Consequences; Modeling crises; Crisis communication; Strategic communication Pre-crisis - Existing in pre-crisis phase, preparing for the worst; Post-crisis

**UNIT III** **9 Hours**

**CRISIS MANAGEMENT AT AIRPORTS**

Psychology of crisis management decisions; Emergency response scenarios; Contingency plans; Damage control; Various Crisis at Airport -SOP for Bomb Threat -Mitigating Hijack Crisis Situation-Response to Acts of Unlawful Interference: Developing Plans

**UNIT IV** **10 Hours**

**WORLD AIRLINES AND AIRPORTS , WORLD AVIATION BODIES**

Airports -Civil, Military Training-Domestic/International -Passenger/Cargo Terminals -World Airlines-World"s Major Airports IATA / ICAO-National Aviation Authorities & Role of State and Central Governments Airports Authority of India - The National Transportation Board, Director General of Civil Aviation

**UNIT V** **9 Hours**

**CRISIS IN AIRCRAFT INDUSTRY -CASE STUDIES**

American airlines flight 191; Delta airlines flight 191; Trans world airlines flight 800; Pan American World Airways flight 103; US Air flight 427; Value jet flight 592; Malaysian Airlines MH370-Ethiopian Airlines flight 302

**FOR FURTHER READING**

Planning and Design Considerations for Security at Airports Annex 17: SARPs (Standard and Recommended Practices) -Access Control and Alarm Monitoring Mechanisms, Security Screening Infrastructure and Procedures -In Flight Safety & Security

**Total: 45 Hours**

**Reference(s)**

1. 1. Cusick, Stephen K., Antonio I. Cortes, and Clarence C. Rodrigues. Commercial aviation safety. McGraw-Hill Education, 2017
2. 2. GephartJr, Robert P., C. Chet Miller, and Karin Svedberg Helgesson, eds. The Routledge Companion to Risk, Crisis and Emergency Management. Routledge, 2018
3. 3. Eriksson, Johan. Threat Politics: New Perspectives on Security, Risk and Crisis Management: New Perspectives on Security, Risk and Crisis Management. Routledge, 2017
4. 4. Price, Jeffrey, and Jeffrey Forrest. Practical aviation security: predicting and preventing future threats. Butterworth-Heinemann, 2016
5. 5. Information Resources Management Association. Crisis Management: Concepts, Methodologies, Tools and Applications. IGI Global, 2013.

## 21AE040 BOUNDARY LAYER THEORY 3 0 0 3

**Course Objectives**

- To familiarize the basic concepts and equations of viscous flow.
- To acquire the knowledge of laminar boundary layer and its equations
- To understand the turbulence, instrumentation and measurements.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

6. Apply the basic concepts and equations of viscous flow.
7. Analyse the viscous flow equation through the duct.
8. Analyse the displacement, momentum and energy thickness on integral analysis.
9. Analyse the boundary layer equation on flat plate for heat transfer.
10. Analyse the turbulent flow and its measurement methods.

**Articulation Matrix**

| CO No | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
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**UNIT I** **9 Hours**

**INTRODUCTION**

Preliminary Concepts Some examples of viscous flow phenomena: – aerofoil, cylinder, circular pipe. Boundary conditions for viscous flow problems.The kinematics properties of viscous flow. Fundamental Equations of Viscous Flow Conservation of mass, momentum and energy equations. Mathematical characterization of basic equations.Dimensionless parameters in viscous flow.

**UNIT II** **9 Hours**

**VISCOUS FLOW EQUATIONS**

Classification of solutions.Couette flow, stability of Couette flow.Poiseuille steady flow through duct. Unsteady duct flow between plates with bottom injection and top suction. Plane stagnation flow-differential equation free of parameters.

**UNIT III** **9 Hours**

**LAMINAR BOUNDARY LAYER**

Laminar boundary layer equations.Flat plate Integral analysis.Displacement thickness, Momentum and Energy thicknesses for two dimensional flows; Shape factor.Some insight into boundary layer approximations.Discussion of Navier Stokes equations.Concept of thermal boundary layer.

**UNIT IV** **9 Hours**

**LAMINAR BOUNDARY LAYER EQUATIONS**

Dimensionless variables.Laminar boundary layer equations.Similarity solutions for steady two-dimensional flow.Blasius solution for flat- plate flow, wall shear stress.Flat plate heat transfer for constant wall temperature.Some examples of Falkner-Skan potential flows.Reynolds analogy as a function of pressure gradient.

**UNIT V** **9 Hours**

**TURBULENT FLOW**

Turbulent flow in pipes and channels. Free turbulence: – jets, wakes and mixing layers. Instrumentation and Measurements: Hot wire and Hot film anemometer for turbulence measurements. Schlieren methods for flow visualization. Pressure probes, Interferometer and Smoke method.

**FOR FURTHER READING**

Boundary layer control, approximation methods, turbulence modeling.

**Total: 45 Hours**

**Reference(s)**

5. An Introduction to Fluid Dynamics, G. K. Batchelor, Cambridge University Press, 2010.
6. Viscous Fluid Flow, F. M. White, McGraw Hill, USA, 1974.
7. Fluid Mechanics, F. M. White, , McGraw Hill, USA, 1979.
8. Fundamentals of Aerodynamics, John D. Anderson, , McGraw Hill, USA, 2007.
9. Foundations of Aerodynamics, Kuethe and Chow, John Wiley & Sons Inc., 1976

## 21AE041 VEHICLE AERODYNAMICS 3 0 0 3

**Course Objectives**

- To understand the impact of aerodynamic forces and moments on performance of vehicle
- To acquire fundamental and applied understanding of air flows, vehicle aerodynamics and control
- To develop design skills necessary for the aerodynamic design of road vehicles

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**Course Outcomes (COs)**

1. Analyze the internal and external flow in the vehicle.
2. Analyze the flow separation of bluff body to reduce the drag forces
3. Analyze the vehicle shape and size to make a good aerodynamic design.
4. Evaluate the aerodynamic force and moments on vehicle body.
5. Demonstrate wind tunnel techniques to test the aerodynamic design.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
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**UNIT I** **9 Hours**

**INTRODUCTION**

Importance of vehicle aerodynamics, fluid mechanics related to vehicles - external and internal flow problem, resistance to vehicle motion, performance, fuel consumption, engine cooling requirement, air flow to passenger compartment, duct for air conditioning, cooling of transverse engine and rear engine.

**UNIT II** **10 Hours**

**AERODYNAMIC DRAG**

Vehicle as a bluff body - flow field around car, drag force - types of drag force. Analysis of aerodynamic drag - drag coefficient. Strategies for aerodynamic development - low drag profiles.

**UNIT III** **9 Hours**

**SHAPE OPTIMIZATION OF VEHICLES**

Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back. Dust flow patterns at the rear, effects of gap configuration and effect of fasteners.

**UNIT IV** **9 Hours**

**VEHICLE HANDLING**

Origin of forces and moments on a vehicle, lateral stability problems, methods to calculate forces and moments. Vehicle dynamics under side winds, the effects of forces and moments, characteristics of forces and moments, dirt accumulation on the vehicle, wind noise, drag reduction in commercial vehicles.

**UNIT V** **8 Hours**

**WIND TUNNELS FOR AUTOMOTIVE AERODYNAMICS**

Introduction, principle of wind tunnel technology, limitation of simulation, stress with scale models, full scale wind tunnels, measurement techniques, equipment and transducers, road testing methods, numerical methods.

**Total: 45 Hours**

**Reference(s)**

1. Wolf-Heinrich Hucho, Aerodynamics for Road Vehicles, 4th Edition, Warrendale, PA: SAE International, 2014
2. J. Katz, Race car aerodynamics - Designing for speed, Cambridge, MA, Bentley Publishers, 2014 Pope .A, Low Speed Wind Tunnel Testing, New York, John Wiley &Sons2014.
3. YomiObidi, Theory and Applications of Aerodynamics for Ground Vehicles, Warrendale, PA: SAE International, 2014
4. R.H. Barnard, Road Vehicle Aerodynamic Design, 2nd edition, St Albans: MechAero Publishing, 2001.
5. Introduction of Aerodynamics https://nptel.ac.in/courses/101105059/

## 21AE042 ADVANCED VEHICLE ENGINEERING 3 0 0 3

**Course Objectives**

- To provide the basic understanding of the dynamics of vehicle systems, developments and procedure to the design of vehicle.
- To envision the aerodynamic characteristics and the fundamental aspects of the aerodynamic design of a vehicle.
- To assess the aspects of vehicle design with particular emphasis on modal dynamics and vehicle safety.

**Programme Outcomes (POs)**

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

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

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

m. Utilize the knowledge of aeronautical engineering in innovative, dynamic and challenging environment for design and development of new products.

**Course Outcomes (COs)**

1. To provide the knowledge on future requirements for advanced vehicle systems.
2. To understand the methodology for vehicles signals identification.
3. To provide knowledge on vehicle aerodynamics.
4. To impart the necessity of reducing acoustics, vibration and harshness of a vehicles.
5. To understand the safety engineering in the vehicle design process.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 2 | 3 | | | | 1 | | | | | | | 2 | 2 | |
| 3 | 3 | 2 | | | | 1 | | | | | | | 2 | 2 | |
| 4 | 3 | 2 | | | | 1 | | | | | | | 3 | 2 | |
| 5 | 3 | 2 | | | | 1 | | | | | | | 2 | 2 | |

**UNIT I** **9 Hours**

**VEHICLE DYNAMICS**

Kinematics of Vehicle model - Longitudinal dynamics - Lateral dynamics - Vertical dynamics - Power transmissions – modal simulation.

**UNIT II** **9 Hours**

**DYNAMICS OF SIGNALS**

Time domain signals - Statistical parameters - advanced data acquisition techniques - estimation of the frequency response function - experimental techniques for the identification of vehicles operational parameters

**UNIT III** **9 Hours**

**VEHICLE AERODYNAMICS**

Aerodynamic parameters and Measurements - Definition of set-ups, aerodynamic maps, vehicle configurations – Force components – Lift, drag, load and balancing mechanism - wing polars - rebalance techniques.

**UNIT IV** **9 Hours**

**APPLIED VEHICLE DYNAMICS**

Acoustics phenomenon measurement and analysis - acoustic insulation test - introduction to experimental vibration modal analysis - vibratory characteristics of wing and rotating parts - introduction to closed loop vibration tests - dynamic stiffness estimation.

**UNIT IV** **9 Hours**

**SAFETY ENGINEERING**

Concept of defective product – design and manufacturing effect - harmonized aviation standards - Crashworthiness and Airworthiness - Vehicle's safety and manufacturer liability – Fatigue risk management - ICAO laws and regulations.

**FOR FURTHER READING**

Applications - Case studies on modern commercial and Fighter aircrafts.

**Total: 45 Hours**

**Reference(s)**

1. WH Hucho, editor. Aerodynamics of Road Vehicles. SAE international, Warrendale USA, 4th edition, 1998.
2. RH Barnard. Road vehicle aerodynamic design. MechAero Publishing, St. Albans, England, 2nd edition, 2001.
3. M.Guiggiani , The science of Vehicle Dynamics, 2nd edition , 2014.
4. Noise and Vibration Analysis: Signal Analysis and Experimental Procedures, Anders Brandt, ISBN: 9780470746448.

## 21AE042 ADVANCED VEHICLE ENGINEERING 3 0 0 3

**Course Objectives**

- To provide the basic understanding of the dynamics of vehicle systems, developments and procedure to the design of vehicle.
- To envision the aerodynamic characteristics and the fundamental aspects of the aerodynamic design of a vehicle.
- To assess the aspects of vehicle design with particular emphasis on modal dynamics and vehicle safety.

**Programme Outcomes (POs)**

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

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

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

m. Utilize the knowledge of aeronautical engineering in innovative, dynamic and challenging environment for design and development of new products.

**Course Outcomes (COs)**

1. To provide the knowledge on future requirements for advanced vehicle systems.
2. To understand the methodology for vehicles signals identification.
3. To provide knowledge on vehicle aerodynamics.
4. To impart the necessity of reducing acoustics, vibration and harshness of a vehicles.
5. To understand the safety engineering in the vehicle design process.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | 2 | 3 | | | | 1 | | | | | | | 2 | 2 | |
| 3 | 3 | 2 | | | | 1 | | | | | | | 2 | 2 | |
| 4 | 3 | 2 | | | | 1 | | | | | | | 3 | 2 | |
| 5 | 3 | 2 | | | | 1 | | | | | | | 2 | 2 | |

**UNIT I** **9 Hours**

**VEHICLE DYNAMICS**

Kinematics of Vehicle model - Longitudinal dynamics - Lateral dynamics - Vertical dynamics - Power transmissions – modal simulation.

**UNIT II** **9 Hours**

**DYNAMICS OF SIGNALS**

Time domain signals - Statistical parameters - advanced data acquisition techniques - estimation of the frequency response function - experimental techniques for the identification of vehicles operational parameters

**UNIT III** **9 Hours**

**VEHICLE AERODYNAMICS**

Aerodynamic parameters and Measurements - Definition of set-ups, aerodynamic maps, vehicle configurations – Force components – Lift, drag, load and balancing mechanism - wing polars - rebalance techniques.

**UNIT IV** **9 Hours**

**APPLIED VEHICLE DYNAMICS**

Acoustics phenomenon measurement and analysis - acoustic insulation test - introduction to experimental vibration modal analysis - vibratory characteristics of wing and rotating parts - introduction to closed loop vibration tests - dynamic stiffness estimation.

**UNIT IV** **9 Hours**

**SAFETY ENGINEERING**

Concept of defective product – design and manufacturing effect - harmonized aviation standards - Crashworthiness and Airworthiness - Vehicle's safety and manufacturer liability – Fatigue risk management - ICAO laws and regulations.

**FOR FURTHER READING**

Applications - Case studies on modern commercial and Fighter aircrafts.

**Total: 45 Hours**

**Reference(s)**

1. WH Hucho, editor. Aerodynamics of Road Vehicles. SAE international, Warrendale USA, 4th edition, 1998.
2. RH Barnard. Road vehicle aerodynamic design. MechAero Publishing, St. Albans, England, 2nd edition, 2001.
3. M.Guiggiani , The science of Vehicle Dynamics, 2nd edition , 2014.
4. Noise and Vibration Analysis: Signal Analysis and Experimental Procedures, Anders Brandt, ISBN: 9780470746448.

**18GE0E1 ENTREPRENEURSHIP DEVELOPMENT I 3 0 0 3**

**Course Objectives**

- Study of this subject provides an understanding of the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc

**Programme Outcomes (POs)**

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Course Outcomes (COs)**

1. Able to gain Knowledge about entrepreneurship, motivation and business.
2. Able to develop small scale industries in different field.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2 | | | | | | 3 | | 2 | 1 | | | | | | |
| 3 | | | | | | 2 | 3 | | | | | | | | |
| 4 | | | | | | 3 | 1 | 3 | 1 | | | | | | |
| 5 | | | | | | 1 | | 2 | 3 | | | | | | |

**UNIT I** **9 Hours**

**BASICS OF ENTREPRENEURSHIP**

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

**UNIT II** **9 Hours**

**GENERATION OF IDEAS**

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

**UNIT III** **9 Hours**

**LEGAL ASPECTS OF BUSINESS**

Contract act-Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments- promissory note, bills and cheques,

partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

**UNIT IV** **9 Hours**

**BUSINESS FINANCE**

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

**UNIT V** **9 Hours**

**OPERATIONS MANAGEMENT**

Importance- functions-deciding on the production system- facility decisions: plant location, plant layout (cases), capacity requirement planning- inventory management (cases)-lean manufacturing, Six sigma.

**Total: 45 Hours**

**Reference(s)**

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006

## 18GE0E2 ENTREPRENEURSHIP DEVELOPMENT II 3 0 0 3

**Course Objectives**

- Evolve the marketing mix for promoting the product / services
- Handle the human resources and taxation
- Understand Government industrial policies / support provided and prepare a business plan

**Programme Outcomes (POs)**

f. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Course Outcomes (COs)**

1. Increase in awareness of the entrepreneurship Development for engineering decisions.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | 1 | 3 | 1 | 3 | | | | | | |
| 2 | | | | | | 3 | | 2 | 1 | | | | | | |
| 3 | | | | | | 2 | 3 | | | | | | | | |
| 4 | | | | | | 3 | 1 | 3 | 1 | | | | | | |
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**UNIT I** **9 Hours**

**MARKETING MANAGEMENT**

Marketing environment,Segmentation, Targeting and positioning, Formulating marketing strategies,Marketing research, marketing plan, marketing mix (cases)

**UNIT II** **9 Hours**

**HUMAN RESOURCE MANAGEMENT**

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

**UNIT III** **9 Hours**

**BUSINESS TAXATION**

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases).Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases

**UNIT IV** **9 Hours**

**GOVERNMENT SUPPORT**

Industrial policy of Central and State Government, National Institute-NIESBUD, IIE, EDI. State Level Institutions-TIIC, CED, MSME, Financial Institutions

**UNIT V** **9 Hours**

**BUSINESS PLAN PREPARATION**

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

**Total: 45 Hours**

**Reference(s)**

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi: 2003
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill: 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi: 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.
6. http://niesbud.nic.in/agencies.html

## 21OGE01 PRINCIPLES OF MANAGEMENT 3 0 0 3

**Course Objectives**

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- Learn the application of the theories in an organization.
- Analyze the position of self and company goals towards business.

**Course Outcomes (COs)**

1. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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**UNIT I** **9 Hours**

**INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS**

Definition of Management Science or Art Manager Vs Entrepreneur-types of managers - Managerial roles and skills Evolution of Management Scientific, Human Relations, System and Contingency approaches Types of Business organization - Sole proprietorship, partnership, Company - public and private sector enterprises - Organization culture and Environment Current Trends and issues in Management.

**UNIT II** **9 Hours**

**PLANNING**

Nature and purpose of planning - Planning process - Types of planning - Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

**UNIT III** **9 Hours**

**ORGANISING**

Nature and purpose – Formal and informal organization - Organization chart - Organization Structure Types - Line and staff authority – Departmentalization - Delegation of authority - Centralization and

decentralization - Job Design - Human Resource – Management - HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning and management

**UNIT IV** **9 Hours**

**DIRECTING**

Foundations of individual and group behaviour – Motivation - Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership - types and theories of leadership – Communication - Process of communication - Barrier in communication Effective communication - Communication and IT.

**UNIT V** **9 Hours**

**CONTROLLING**

System and process of controlling - Budgetary and non - Budgetary control techniques - Use of Computers and IT in Management control - Productivity problems and management - Control and Performance-Direct and preventive control - Reporting.

**Total: 45 Hours**

**Reference(s)**


1. Robbins S, Management, (13th ed.), Pearson Education, New Delhi, 2017.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education, 7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007.
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008.

## 21OGE02 ENTREPRENEURSHIP DEVELOPMENT I 3 0 0 3

**Course Objectives**

- Learn the basics and scope of the Entrepreneurship
- Understand the generation of ideas of the Entrepreneurship
- Evolve the legal aspects of the business
- Learn to analyze the various business finance
- Learn the basics of the Operations Management

**Course Outcomes (COs)**

1. Analyze the role of entrepreneurship in economic development.
2. Explain the types of ideas that to be used for entrepreneurship development.
3. Examine the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Analyse the different modes of operation management.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 3 | | | | | | 1 | 2 | | 2 | | | | | | |
| 4 | | | | | | 1 | 2 | | 2 | | | | | | |
| 5 | | | | | | 1 | 2 | | 2 | | | | | | |

**UNIT I** **9 Hours**

**BASICS OF ENTREPRENEURSHIP**

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

**UNIT II** **9 Hours**

**GENERATION OF IDEAS**

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

**UNIT III** **9 Hours**

**LEGAL ASPECTS OF BUSINESS**

Contract act - Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments - promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

**UNIT IV** **9 Hours**

**BUSINESS FINANCE**

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

**UNIT V** **9 Hours**

**OPERATIONS MANAGEMENT**

Importance - functions - deciding on the production system - facility decisions: plant location, plant layout (cases), capacity requirement planning - inventory management (cases) - lean manufacturing, Six sigma.

**Total: 45 Hours**

**Reference(s)**


1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business

## 21OGE03 ENTREPRENEURSHIP DEVELOPMENT II 3 0 0 3

**Course Objectives**

- Evolve the marketing mix for promotion the product / services
- Handle the human resources and taxation
- Learn to analyze the taxation
- Understand the Government industrial policies and supports
- Preparation of a business plan

**Course Outcomes (COs)**

1. Examine the strategies and plans in marketing management.
2. Analyse the cases involved in human resource management.
3. Classify the direct and indirect taxes in business.
4. Analyze the supports given by government for improving the business.
5. Examine the various steps involved in preparing the business plan.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | 1 | 2 | | 2 | | | | | | |
| 2 | | | | | | 1 | 2 | | 2 | | | | | | |
| 3 | | | | | | 1 | 2 | | 2 | | | | | | |
| 4 | | | | | | 1 | 2 | | 2 | | | | | | |
| 5 | | | | | | 1 | 2 | | 2 | | | | | | |

**UNIT I** **9 Hours**

**MARKETING MANAGEMENT**

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies, Marketing research, marketing plan, marketing mix (cases)

**UNIT II** **9 Hours**

**HUMAN RESOURCE MANAGEMENT**

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

**UNIT III** **9 Hours**

**BUSINESS TAXATION**

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases

**UNIT IV** **9 Hours**

**GOVERNMENT SUPPORT**

Industrial policy of Central and State Government, National Institute-NIESBUD, IIE, EDI. State Level Institutions - TIIC, CED, MSME, Financial Institutions

**UNIT V** **9 Hours**

**BUSINESS PLAN PREPARATION**

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

**Total: 45 Hours**

**Reference(s)**


1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi: 2003
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill: 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi: 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.
6. http://niesbud.nic.in/agencies.html

## 21OAE01 NON-DESTRUCTIVE TESTING 3 0 0 3

**Course Objectives**

- To study and understand the various Non Destructive Evaluation and Testing methods
- To provide knowledge on selecting suitable non-destructive testing methods for inspecting machine components and structures.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**Course Outcomes (COs)**

1. Illustrate the basic principles, techniques, equipment, application and limitations of NDT methods
2. Find the defects in the aircraft components using liquid penetrant and magnetic particle testing
3. Carryout thermography and eddy current testing to identify the defects in aircraft components
4. Predict the defects in the aircraft components using ultrasonic and acoustic emission testing
5. Carryout radiography testing to identify the defects in machine components and structures

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 1 | 2 | 2 | | | | | | | | | | |
| 2 | 2 | 2 | 1 | 2 | 2 | | | | | | | | | | |
| 3 | 2 | 2 | 1 | 2 | 3 | | | | | | | | | | |
| 4 | 2 | 2 | 1 | 2 | 3 | | | | | | | | | | |
| 5 | 2 | 2 | 1 | 2 | 3 | | | | | | | | | | |

**UNIT I** **7 Hours**

**OVERVIEW OF NDT**

NDT Versus Mechanical testing - Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation - Relative merits and limitations -Various physical characteristics of materials and their applications in NDT - Visual inspection - Unaided and aided

**UNIT II** **8 Hours**

**SURFACE NDE METHODS**

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods - Testing Procedure - Magnetic Particle Testing- Theory of magnetism, inspection materials - Magnetisation methods - Interpretation and evaluation - Principles and methods of demagnetization - Residual magnetism

**UNIT III** **10 Hours**

**THERMOGRAPHY AND EDDY CURRENT TESTING (ET)**

Thermography- Principles - Contact and non contact inspection methods - Advantages and limitation - Instrumentations and methods, applications - Eddy Current Testing - Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements- Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

**UNIT IV** **10 Hours**

**ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE)**

Ultrasonic Testing - Principle, Transducers, transmission and pulse-echo method - straight beam and angle beam - instrumentation, data representation, A/Scan, B-scan, C-scan - Acoustic Emission Technique - Principle, AE parameters, Applications

**UNIT V** **10 Hours**

**RADIOGRAPHY (RT)**

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 - Interpretation / Evaluation - Fluoroscopy - Xero-Radiography, Computed Radiography, Computed Tomography

**FOR FURTHER READING**

Phased array ultrasonics time of flight diffractions -Automated and remote ultrasonic testing - Acoustic pulse reflectometry - Alternative current field method - Case studies on NDT techniques used in aircrafts

**Total: 45 Hours**

**Reference(s)**

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010
3. ASM Metals Handbook, V-17, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Volume 17, Metals Park, Ohio, USA, 2000.
4. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005
5. Charles, J. Hellier, "Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.

## 21OAE02 SMART MATERIALS 3 0 0 3

**Course Objectives**

- To impart the knowledge about the importance and applications of smart materials in Aero sector.
- To provide knowledge on synthesis/manufacturing/development of smart materials.

**Programme Outcomes (POs)**

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

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

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

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

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

**Course Outcomes (COs)**

1. Understand the classification of composite material based on their reinforcement, matrices and structure
2. Analyse the mechanical, electrical and optical properties of carbon nanotubes and understand its potential areas of application in aero sector.
3. Understand the concept of piezoelectric effect and major techniques to manufacture piezoelectric material
4. Create shape memory effect and understand its potential areas of application in aero sector.
5. Analyse the characterization of ER and MR fluids and understanding the major techniques to manufacture ER and MR fluids.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 1 | 1 | 1 | | | | | | | | | | |
| 2 | 3 | 1 | 1 | 1 | 2 | | | | | | | | | | |
| 3 | 3 | 2 | 1 | 1 | 2 | | | | | | | | | | |
| 4 | 3 | 1 | 1 | 1 | 2 | | | | | | | | | | |
| 5 | 3 | 1 | 1 | 1 | 2 | | | | | | | | | | |

**UNIT I** **11 Hours**

**COMPOSITE MATERIALS**

Introduction to composites - constituents of composites - classification of composites - types of matrix - types of reinforcements - hybrid and green composites- manufacturing methods of composites - properties and applications of composites - composite coatings.

**UNIT II** **9 Hours**

**CARBON NANOTUBES (CNTS)**

Introduction to CNTs - Fullerenes - types of CNTs (single walled, multi-walled etc.,) - synthesis and assembly of CNTs - C60, C80 and C240 nanostructures - mechanical, electrical and optical properties of CNTs - applications of CNTs.

**UNIT III** **9 Hours**

**PIEZOELECTRIC MATERIALS (PZT)**

Introduction to PZT materials - concept of piezoelectric effect - di-electric hysteresis - piezoelectric constants - PZT materials and manufacturing techniques - PZT transducers - PZT applications.

**UNIT IV** **9 Hours**

**SHAPE MEMORY ALLOYS (SMA)**

Introduction to SMA - shape memory effect - metallurgical phenomenon of SMA - viscoelastic behavior of SMA - temperature assisted shape memory effect - magnetic shape memory effect - examples of SMA and manufacturing - applications of SMA.

**UNIT V** **7 Hours**

**ELECTRORHEOLOGICAL (ER) AND MAGNETORHEOLOGICAL (MR) FLUIDS**

Introduction to ER and MR fluids - concept of rheology - manufacturing of ER and MR fluids - characterization of ER and MR fluids - applications of Er and MR fluids.

**FOR FURTHER READING**

Functionally graded materials (FGM), nano-composites, bulk-metallic glasses (BMG), phase change materials (PCM), graphene, super-hard materials, magnetostrictive materials.

**Total: 45 Hours**

**Reference(s)**

1. Michael J. O-Connell, "Carbon Nanotubes: Properties and Applications", CRC/Taylor & Francis, New York, USA, 2006.
2. P. Gauenzi, "Smart Structures", Wiley, West Sussex, UK, 2009.
3. M.V. Gandhi and B.S. Thompson, "Smart Materials and Structures", Chapman and Hall, London, UK, 1992.
4. E.F. Crawley, "Intelligent Structures for Aerospace: A Technology Overview and Assessment", AIAA 33 (8), 1994, pp.1689-1699.
5. K.K. Chawla, "Composite Materials Science and Engineering", Springer, New York, 2008.

## 21OAE03 FUNDAMENTALS OF AIRCRAFT ENGINEERING

**3 0 0 3**

**Course Objectives**

- To introduce the basic concepts of Aeronautical engineering and the current developments in the field.
- To know the basic principles on which the development of aerodynamics, structures and propulsion systems.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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

**Course Outcomes (COs)**

1. Understand the classification and working principles of different types of flight vehicles and its components.
2. Apply the aerodynamic principles for various aircraft configurations.
3. Analyse the reason behind using different aircraft structural elements and Avionics instruments used in aircraft construction.
4. Understand the working of air breathing and non-air breathing propulsion systems.
5. Apply the knowledge of flight instruments for the construction of advanced flight vehicles.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | | | | | | | | | | | | | |
| 2 | | 2 | 2 | | | | | | | | | | | | |
| 3 | 3 | 2 | | | | | | | | | | | | | |
| 4 | 2 | | 2 | | | | | | | | | | | | |
| 5 | 2 | 3 | | | | | | | | | | | | | |

**UNIT I** **7 Hours**

**AIRCRAFT CONFIGURATIONS**

Classification of flight vehicles, airplanes and Helicopters-working principles- Components of an airplane and their functions.

**UNIT II** **8 Hours**

**INTRODUCTION TO AERODYNAMICS**

International Standard Atmosphere, Temperature, pressure and altitude relationships- lift, drag and moment-Basic characteristics of airfoils-NACA classification-introduction to compressible flows- aircraft axis- aircraft manoeuvres.

**UNIT III** **11 Hours**

**AIRCRAFT STRUCTURES AND AVIONIC SYSTEMS**

General types of construction, Monocoque, semi-monocoque and geodesic construction, typical wing and fuselage structure. Need for Avionics in civil and military aircraft and space systems types of displays-salient features and applications of Data buses- Flight control systems - Radar electronic warfare.

**UNIT IV** **10 Hours**

**AIRCRAFT AND ROCKET PROPULSION**

Working principles of piston, turboprop and jet engines, -propellers- types- limitations-Comparative merits, principles of operation of rocket, types of rockets and typical applications.

**UNIT V** **9 Hours**

**AIRCRAFTS INSTRUMENTS AND ADVANCED FLIGHT VEHICLES**

Pitot based instruments-Navigation instruments-communication instruments-Engine Instruments. Introduction to UAVs and MAVs-Types and applications, Maintenance, safety and operations.

**FOR FURTHER READING**

Historical developments in aviation - Staging of rockets, space mission, re-entry vehicles, life support systems for manned space missions, Fuel cells. Indian space programmes-NASA space programmes-aircraft certifying agencies and their function.

**Total: 45 Hours**

**Reference(s)**

1. John D. Anderson, "Introduction to Flight", McGraw-Hill Higher Education; 7th edition, 2011.
2. Austin R., "Unmanned Aircraft Systems", AIAA Education Series, 2010.
3. John Cutler & Jeremy Liber, "Understanding Aircraft Structures", 4th edition, Sheridan House Inc, 2006.
4. George P. Sutton and Oscar Biblarz, "Rocket Propulsion Elements", 7th edition, John Wiley & Sons, Inc., New York, 2001.
5. Kermode A C, "Flight without Formulae", 5th edition, Pearson Education Pvt. Ltd, 2000.
6. Spitzer, C.R., "Digital Avionic Systems", Third Edition, CRC Press, 2017.

## 18AE0XA WIND TURBINE DESIGN AND TESTING 0 0 0 1

**Course Objectives**

- To understand the design and development of wind turbine blades and its systems
- To provide adequate knowledge of testing procedure involved in wind turbine

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Explain the flow physics involved the wind turbine systems and the testing methods
2. Design and develop a wind turbine systems as per the industry standards

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | | | | | | | | | | | | | |
| 2 | 1 | 3 | | | | | | | | | | | | | |

**Total: 0 Hours**

**Reference(s)**

1. Martin O. L. Hansen, "Aerodynamics of Wind Turbines" 2nd Edition, Earth Scan Publications, 2013.
2. Wei Tong, "Wind Power Generation and Wind Turbine Design" WIT Press, 2010.
3. David Wood, "Small Wind Turbines: Analysis, Design, and Application", Springer Publications, 2011.

## 18AE0XB REAL TIME INDUSTRIAL APPLICATIONS IN CFD 0 0 0 1

**Course Objectives**

- To understand the flow physics involved in the airflow over and through the bodies.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Explain the physics involved in the internal and external fluid flow over the aircrafts and other land based vehicles

2. Conduct experiments using commercial CFD packages for solving the fluid flow problem involved in the industry

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | | | | | | | | | | | | | |
| 2 | 2 | 2 | | | | | | | | | | | | | |

**Total: 0 Hours**

**Reference(s)**

1. H. Versteeg, W. Malalasekera, "An Introduction to Computational Fluid Dynamics: The Finite Volume Method" 2nd Edition, Pearson Publications, 1995.
2. John Anderson, "Computational Fluid Dynamics", Mc-Graw Hill Publications, 2012.
3. John Wendt, "Computational Fluid Dynamics: An Introduction (Von Karman Institute Book)", Springer Publications, 2009.

## 18AE0XC FAILURE ANALYSIS OF ADVANCED COMPOSITES

**0 0 0 1**

**Course Objectives**

- To understand the importance of failure analysis and the methods used for failure analysis in composite structures.
- To conduct a case studies for the failure analysis of a composites.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Explain the importance and the methods of failure analysis of a advanced composites.
2. Describe the fatigue and fracture mechanics for composite structures.
3. Conduct case studies for the for the failure analysis of a composite structures.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 3 | | | | | | | | | | | | | |
| 2 | 1 | 3 | | | | | | | | | | | | | |
| 3 | 2 | 2 | | | | | | | | | | | | | |

**Total: 0 Hours**

**Reference(s)**

1. Dr Emile Greenhalgh,"Failure Analysis and Fractography of Polymer Composites", Woodhead Publishing,1st edition,2009.

2. E. E. Gdoutos, K. Pilakoutas, C. A. Rodopoulos, "Failure Analysis of Industrial Composite Materials", McGraw Hill Professional, 2000.

## 18AE0XD TECHNICAL DOCUMENTATION FOR AEROSPACE ENGINEERING SERVICES

**0 0 0 1**

**Course Objectives**

- To build up necessary background on Aviation Technical Publications.
- To import knowledge on various Aviation documentation types and formats.
- To enhance the knowledge on Advanced Aircraft Engine Technologies

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Explain the importance of Technical Publications in Aerospace industry
2. Explain the advanced Double Spool and Triple spool Technology, Quality Metrics and Service Bulletins

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | | | | | | | | | | | | | |
| 2 | 3 | 2 | | | | | | | | | | | | | |

**Total: 0 Hours**

**Reference(s)**

1. Aircraft Manual (India) Volume, Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi. Advisory Circulars from DGCA 2003.

## 18AE0XE INTRODUCTION TO AEROSPACE NAVIGATION

**0 0 0 1**

**Course Objectives**

- To understand the Navigation Principles, Dead Reckoning and Position Fixing.

**Programme Outcomes (POs)**

a. Engineering Knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Explain the basic principles of aerospace navigation.
2. Appreciate and understand the various navigation position fixing aids and inertial sensors generally integrated in aircraft.

**Articulation Matrix**

| CO No | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 2 | | | | | | | | | | | | | |
| 2 | 2 | 3 | | | | | | | | | | | | | |

**Total: 0 Hours**

**Reference(s)**

1. Myron Kayton and Walter R. Fried, "Avionics Navigation Systems", 2nd Edition, John Wiley and Sons, 1997.
2. George M Siouris, "Aerospace Avionics Systems - A Modern Synthesis", Academic Press, 1993.

**18GE0XA ETYMOLOGY 1 0 0 1**

**Course Objectives**

- To increase vocabulary and enhance use, knowledge, and understanding of the English language
- To stimulate an appreciation for the English language, including how it developed, how new wordsenter the language, and how it continues to be dynamic
- To demonstrate the importance of a broad-based vocabulary for effective oral and written communication

**Course Outcomes (COs)**

1. Examine prefixes, roots, and suffixes of Latin, Greek, Germanic, and Anglo-Saxon origin.
2. Explore the historical aspects of language, including the infusion of Indo-European languages, semantic changes, and the influence of world events

**CONVENTIONS**

Acronyms, Abbreviations, Initialises, Jargon Neologisms - Idiomatic Expressions, Euphemisms Spoonerisms Malapropisms ; Mondegreens - Words Derived from Latin - Words Derived from Greek - Words Derived from - Germanic/Anglo-Saxon - Abstract word Acronym - Affix Analogy - Antonym Apheresis - Blend word Assimilation - Colloquial language Clipped word

**WORD ANALYSIS**

Concrete word Derivative - Dialect Diminutive suffix - Dissimilation Doublet - Etymology Euphemism - Figurative word Homonym - Hybrid word Inflection - Informal language Infusion - Jargon Linguistics - Loan words Metathesis ; Modify - Philology Onomatopoeia - Romance language Prefix - Semantics - Root-base word - Suffix Slang - Word component Synonym

**Total: 15 Hours**

**Reference(s)**

1. Norman, Lewis. Word Power Made Easy,Goyal Publisher. Edition 2.2014.
2. C T Onions. The Oxford Dictionary of English Etymology.Volume 11, Issue 1.70, Wynford Drive, Don Mills, Ont.Oxford University Press.1965.
3. Nurnberg W, Maxwell and Rosenblum, Morris, How to build a better Vocabulary, Completely Revised and Updated, Popular Library.1961

**18GE0XB GENERAL PSYCOLOGY 1 0 0 1**

**Course Objectives**

- To provide a basic understanding of psychology
- Defining Psychology and the subject matter of psychology
- To provide an awareness of various methods and branches of psychology
- To explain social and work psychology of people and the need for mental health

**Course Outcomes (COs)**

1. Understand the basics of human behavior in the workplace and society at large
2. Understand the different fields of psychology and its uses
3. Deal people effectively in their personal and social life

**GENERAL PSYCOLOGY**

Psychology - Introduction - Mind body relationship - Methods and Scope of Psychology Motivation-Types of Needs- Motivational Cycle- Intelligence: Concept of Intelligence and IQ- measurement - Social psychology: individual behavior and group behavior - Group dynamics- group formation-social influence-social cognition, stereotypes- prejudice- discrimination - Definitions, formation of attitude, factors of attitude formation-change of attitude

**Total: 15 Hours**

**Reference(s)**

1. Atkinson & Atkinson, Introduction to Psychology, 6th Ed McGraw-Hill Publications. 1975
2. Mishra, B. K, Psychology: The study of human behavior, 2nd Ed New Delhi: Prentice Hall of

India Learning Pvt. Ltd. 2016
3. Baron, R.A., Branscombe. N.R, Social Psychology, 14th Ed. New Delhi; Pearson Education.
4. Morgan, C.T., King, R.A., Weisz, J.R., & Schopler, J. Introduction to Psychology, 7th Ed. New Delhi: Tata McGraw Hill. 1993

**18GE0XC NEURO BEHAVIOURAL SCIENCE 1 0 0 1**

**Course Objectives**
- To provide an introduction to the Cognitive Neuro Science of languages
- To provide an understanding of the Cognitive processes

**Course Outcomes (COs)**
1. Identify the psychological problems that will impact mental health
2. Value ethical conduct in professional and personal life
3. Recognize the need for rationale and evidence in decision-making

**NEURO BEHAVIOURAL SCIENCE**

Introduction to physiology - Anatomy - Neuro Biology - Psycho Neuro Science Behaviour and Hormones - Behaviour Modifications - Relaxation Therapy - Psycho Education for minds

**Total: 15 Hours**

**Reference(s)**

1. Beck, Robert. Handbook of Physiology. Vol I. Oxford University Press March 15,1996
2. Horon C Philip. Sexology and Mind. Academic Press. 1993
3. Blatteis M.Clark and Melvin J. Fregly. Handbook of Physiology Sect 4, Oxford University Press. March 15, 1996

**18GE0XD VISUAL MEDIA AND FILM MAKING 1 0 0 1**

**Course Objectives**
- To acquire fundamental knowledge on development of film making as an art, and video production
- To provide students a basic understanding of the techniques and nuances of visual medium
- To inculcate an ability to plan and produce a short film

**Course Outcomes (COs)**
1. Understand the significance and techniques of visual medium
2. Analyse and produce visual clippings

**ART OF FILMMAKING**

History of Cinema (Origin and Narrative) Cinema as a visual medium -Significance of Editing Styles of Editing Editing as a methodology (Hollywood s Invisible Editing) Technical Aspects of Editing (Final Cut Pro (FCP), AVID and Premire Pro) - Basics of video production (pre-production to post-production) Different types of shots and angles Film style and Narrative (Italian Neo-realism, Avant Garde, Russain Formalism, Alternative Cinema etc.,) Regional Cinema to National Cinema Basics of Script Writing (Double and Single Column) Basics ofVideo

**Total: 15 Hours**

**Reference(s)**

1. Monaco, James, How to Read a Film: Movies, Media, and Beyond. Auckland: OUP, 2009
2. Belavadi, Vasuki, Video Production. India: OUP, 2013

## 18GE0XE YOGA FOR HUMAN EXCELLENCE 1 0 0 1

**Course Objectives**

- To know about the history and schools of yoga
- To know the difference between supreme consciousness and individual consciousness
- To apply the knowledge by the way of practice and introspection

**Course Outcomes (COs)**

1. Understand the historical aspects and schools of yoga
2. Ensure their physical & mental wellness through yoga practice
3. Develop the power to concentrate and have stress free mind

**YOGA FOR HUMAN EXCELLENCE**

What is Yoga , History of Yoga - Yoga in todays scenario- Schools of Yoga - Eight Limbs of Yoga - Sathvic, Rajasic, Tamasic Foods and Thoughts - Science of Yoga Loosening Exercises - Yogasanas & Benefits - Super Brain Yoga - Surya Namaskar Standing Asanas - Sitting Asanas - Prone Asanas - Supine Asanas – MudrasRelaxation Pranayama - Meditation

**Total: 15 Hours**

**Reference(s)**

1. Vethathiri Publications, Yoga Practices-2, Erode, 2012
2. Iyengar B.K.S. Yoga: Wisdom & Practice, B.K.S. Iyengar, 2009
3. Ramesh Partani, The Complete Secret, Ru Education, 2013
4. http://www.sarvyoga.com/
5. http://www.wikihow.com/Do-Superbrain-Yoga

## 18GE0XF VEDIC MATHEMATICS 1 0 0 1

**Course Objectives**

- To improve their calculation speed, analytical thinking and numerical skills

**Course Outcomes (COs)**

1. Solve problems creatively in mathematics and its applications

**VEDIC MATHEMATICS**

Addition- Subtraction- System of Multiplication- Squaring numbers- Cube roots- Square roots- Solution of simultaneous equations- Solutions of Quadratic equations

**Total: 15 Hours**

**Reference(s)**

1. Dhaval Bathia, Vedic Mathematics, JAICO Publishing House, 29th Edition, Mumbai, 2014
2. Jagadguru Swami Sri Bharathi Krsna Tirthaji Maharaja, Vedic Mathematics, Motilal Banarsidass Publishers Private Limited, New Delhi, 1997

## 18GE0XG HEALTH AND FITNESS 1 0 0 1

**Course Objectives**

- To understand the fundamental concepts about physical fitness & its types, training and assessment of physical fitness

**Course Outcomes (COs)**

1. Acquire the knowledge and training of the individual physical, mental and social concepts
2. Understand the fundamental concepts of yogic practice and physical fitness
3. To acquire the knowledge about nutrition and health consciousness

**FITNESS:** Meaning & Definition, Need & importance of Physical fitness Types Physical fitness -

Exercise, Training and Conditioning and it is important

**YOGA AND MEDITATION:** Meaning and definition; Principles of practicing; Basic Asana and it important, Pranayama and Meditation - Relaxation Techniques

**NUTRITION AND BALANCE DIET:** Nutrition and Balance Diet: Needs and Important, Significant of Nutritional Food - Tips for balance diet. Common Diseases fo

r IT professionals: Common diseases

– cause, prevention First aid for common sports injuries.

**Total: 15 Hours**

**Reference(s)**

1. Anderson, Bob., Pearl, Bill.,&Burke, Edmund R., (2001). Getting in Shape Workout Programs for Men&Women. Mumbai: Jaico Publishing House
2. Baechle, Thomas. R, & Earle, Roger. W., (2000). Essentials of Strength Training and Conditioning. Champaign: Human Kinetics
3. Iyengar, BKS., (2003). The Art of Yoga. New Delhi: Harper Collins Publishers
4. Singh, Hardayal, (1995). Science of Sports training. New Delhi: D.V.S. Publications
5. Begum, Raheena. M., (2002). A Textbook of Foods, Nutrition and Dietetics. New Delhi: Sterling Publishers Private Limited

## 18GE0XH CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING

**1 0 0 1**

**Course Objectives**

• To understand the importance of safe methods of treating solid wastes generated through various human activities

• To appreciate the skills / devices / practices associated with the compact proceedures of biodegradation of unwanted solid residues

**Course Outcomes (COs)**

1. Understand the role of recycling of garbage leading to the sustenance of our health and environment.
2. Recognize the organic farming practices and production of healthy food products.
3. Prepare and maintain tips for small scale compost units and thereby becoming more environmentally conscious

**VERMICOMPOSTING TECHNOLOGY**

Ecological roles and economic importance of earthworms - need for earthworm culture, scope and importance of vermiculture , limiting factors - types of worm culturing and the relative benefits Small scale and commercial methods: process & advantages , Vermicomposting equipments, devices, Design and maintenance of vermi bed - Products from vermiculture (matter & humus cycle), vermicastings in organic farming/horticulture - Marketing the products of vermiculture quality control, market research, marketing techniques , Applied vermiculture: use of urban solids & farm/ industrial residues for vermicomposting - Constraints of vermiculture and its future perspectives Artificial Earthworm as a standalone biodegradation assembly.

**Total: 15 Hours**

**Reference(s)**

1. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.4
2. Vermiculture Technology; Earthworms, Organic Wastes and Environmental Management, 2011, Edited by Clive A Edwards, Norman Q Arancon & Rhonda Sherman, CRC Press
3. www.organicgrowingwithworms.com.au
4. New York Times , Scientists Hope to Cultivate and Immune System for Crops

## 18GE0XI BLOG WRITING

**1 0 0 1**

**Course Objectives:**

- To sharpen and improve writing skills, including draft writing, voice, and format.
- To develop general and global knowledge.

- To experiment with non-written forms of online communications, including images, audio and video.
- To be able to add content to your website without the assistance of a web designer.

**Course Outcome (COs):**

1 Students will be able to:
2 Understand the flow of language in natural manner.
3 Understand the elements of a blog and be able to use them effectively.
4 Find a niche for a long-term blog.
5 Gain insight into the strategies, methods and writing of successful bloggers.
6 Develop their creativity thinking.

**Unit I** **7 Hours**

**Concept**: What is blog writing- Types of blog posts—personal experience, opinion, reviews, advice, news/updates. Focusing your blog—concept, audience, uniqueness, posts. Company blogs. **Structure:** Types of structure—inverted pyramid, feature article, list, story, other options. Creating effective openings. Planning a post.

**Unit II** **8 Hours**

**Voice**: Defining and achieving voice. Exploring various voices. Stylistic tips—rhythm, verbs, interesting words, senses, emphasis. Smartness and sarcasm. **Reliability** - accuracy, provability, specificity. Transparency about payments. Sample Blogs and Activities

**Total: 15 hours**

**References:**

1. The Elements of Blogging: Expanding the Conversation of Journalism, by Mark Leccese and Jerry Lanson. (Taylor & Francis, 2015) ISBN: 978-1-13-802154-9. $29.95 paperback.
2. *Blogging Heroes,* by Michael Banks. Choose 15 of the 30 interviews/profile segments to read, be sure to include the segments on Chris Anderson and Brian Lam.

## 16GE0XJ INTERPERSONAL SKILLS

**1 0 0 1**

**Course Objectives:**

- To communicate and work effectively, both individually and in groups
- To be able to understand and manage one's own and other's emotions
- To define and solve problems by making decisions about the best course of action

**Course Outcome (COs):**

1. Express themselves clearly and confidently
2. Listen to others completely and with empathy
3. Assert an opinion without diminishing other's opinion
4. Be responsible and timely with a willingness to collaborate
5. Develop innate personality traits to handle certain social situations

**Unit I**

Conversational Skills – Active Listening – Team working – Empathy – Emotional Intelligence

**Unit II**

Conflict Resolution and Mediation skills – Decision-making and Problem Solving – Negotiation and Persuasion skills

**Total: 15 hours**

**References:**

1. Stephen P. Robbins, Phillip L. Hunsaker, Training in Interpersonal Skills, Pearson, 2015
2. Robert B. Cialdini, Influence: The Psychology of Persuasion, Harper Business; Revised Edition, 2006

## 18GE0XK COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT

**1 0 0 1**

**Course Objectives**

- understand the basic concepts of National Service Scheme and its activity
- identify the needs and problems of the community and involve them in problem solving
- develop competence required for group living and acquire leadership qualities

**Course Outcomes (COs)**

1. understand the community in which they work and render their service
2. develop among themselves a sense of social and civic responsibility

Introduction and Basic Concepts of NSS: History-philosophy-aims & objectives of NSS- Emblem, flag, motto, song, badge- Organizational structure – roles and responsibilities functionaries. NSS Programmes and Activities: Concept of regular activities, special camping, DayCamps-Basisofadoption of village/slums-Methodology of conducting Survey -Financial pattern ofthescheme - Coordination withdifferent agencies-Maintenance oftheDiary. Community Mobilization: Mapping of community stakeholders-Designing the message in the context of the problem and the culture of the community-Identifying methods of mobilization-Youth-adult partnership.Health, Hygiene & Sanitation: Definition, needs and scope of health education- Food and Nutrition - Safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan). Entrepreneurship Development: Definition & Meaning - Qualities of good entrepreneur - Steps/ways in opening an enterprise -Role of financial and support service Institutions.

**Total : 15 Hours**

**Reference(s)**

1. A Hand book on National Service Scheme, Anna University, Chennai, 2012
2. http://nss.nic.in/intro.asp
3. Delgado-Gaitán and Concha, The Power of Community: Mobilizing for Family and SchoolingNew York: Rowman& Littlefield Publishing, Inc. 2001

## 18GE0XL NATIONAL CADET CORPS 1 0 0 1

**Course Objectives**

- To understand the importance of NCC and its organization.
- To realize the skills in the applications of drill and weapon training.
- To analyze the factors in National unity
- To identify the utility of smart materials in engineering applications.

**Course Outcomes (COs)**

1. Recall the motto and aim of NCC.
2. Implement synergy in disaster management.
3. Execute an example patriotic leader to serve nation.

**NCC ORGANIZATION**

National Cadet Corps: Aim and Objectives - Administrative and Organizational pattern - NCC flag and NCC song - Duties, Responsibilities and Conduct by NCC Cadets - Badges of ranks in NCC and Armed forces- Types of NCC camps - Eligibility conditions for writing B and C certificate examinations. Cadet welfare society and Career opportunities for NCC cadets.

**DRILL AND WEAPON TRAINING**

Drill: Aims of drill - Types of drill - Foot drill, Arms drill and Ceremonial drill. Word of commands, Guard of honour. Weapon training - Rifles used in NCC: Parts and Characteristics of 0.22‖ and INSAS – Stripping, Assembling and Cleaning of weapons.

**NATIONAL INTEGRATION AND SOCIAL AWARENESS**

National Integration: Introduction - Constitution of India- Importance and Necessity - Factors affecting National integration - Role of NCC in National integration. Social service and its need - Rural development programs - NGO’s role and Contribution - Social Security schemes.

**PERSONALITY DEVELOPMENT AND LEADERSHIP**

Personality Development: Introduction - Factor influences in personality development. Leadership: Leadership traits and Skills - Indicator of good leader - Honour code concept - Type of leaders - Case studies of effective leader.

**DISASTER MANAGEMENT AND FIRST AID**

Disaster types - Natural and Manmade disasters. Role of NCC cadets in disaster management. Civil defence: Civil defence measures - Civil defence services. First aid: First aid kits and Equipments - First aid for snake bite, Sun stroke and Drowning - Respiration -Types of respiration.

**Total: 20 Hours**

**REFERENCES**

1. Cadet's Hand book Common subject, DG NCC, New Delhi.
2. Cadet's Hand book Special subject, DG NCC, New Delhi.
3. Misra R.C and Sanjaykumar Mishra ―A HAND BOOK OF NCC'' (English), Kanti Prakashan, 2016.

## 18GE0XN DISRUPTIVE INNOVATION BASED START UP ACTIVITIES

**1 0 0 1**

**Course Objectives**

- To make the participants understand as to how to get along with the task disruption led innovations.
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing creativity based disruption strategy

**Course outcomes**

1. Understanding contemporary entrepreneurship as an important careeroption
2. Concept and methodology of creative disruption to viable start-ups
3. Events to occur in the building of a technology based venture for students or working professionals or women with disruptive technology option
4. Overview of Indian trends with reference to disruptive innovation based start-ups

Creativity linked innovation – Differences between Disruptive & incremental Innovations - Historical, theoretical, and practical evolution of disruptive innovation (DI). - Idea generation & communication of creativity leading to DI. Innovation management concepts in DI based entrepreneur generation - How do firms bring in new business models and get new products and services to the market? – Investor preferences in core versus new or disruptive business models - disruptors and the disrupted frameworks for assessing company's capabilities and rethinking product, market and strategy - Right customers for DI: strategy in a world that is changing so rapidly – Application of disruptive theories to complex problems and opportunities.

**Total 15 Hours**

**References**

1. https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1540-5885.2005.00177.x
2. http://www.brinq.com/workshop/archives/2005/01/08/what-is-disruptive-innovation
3. https://hbr.org/2006/12/disruptive-innovation-for-social-change

## 18GE0XO SOCIAL PSYCHLOGY

**1 0 0 1**

**Course Content**

Introduction-Ice breaker, Time Line , Tasks and Challenges of the age( Erik Erikson), Introduction to Reproductive Health, Student Questions Reproductive Organs, Menstruation, Changes during Puberty, Difference between Sex and Gender Introduction to the origins of Patriarchy, Gender Images of Beauty and Body Image, Introduction to Media, Feedback Attraction, Friendship , Differences and Similarities Sexuality Boundaries Relationships, Marriage, Love, Emotional Health Sexual Abuse and Safety Role of Media Abortions, contraception, Wrapping up the Course.

**Total: 15 Hours**

## 18GE0XP FM RADIO BROADCASTING TECHNOLOGY

**1 0 0 1**

**Course Objectives**

• The course focuses on community radio technology and various program productions techniques for FM Radio Broadcasting.

**Course Outcomes (COs)**

1. Understand the hardware required for field recording and setting up a studio and carry out studio and field recording.
2. Examine the available options for telephony interfaces for radio.
3. Demonstrate proper techniques of wiring, fixing of connectors, soldering and use of tools and equipment for studio work.

**UNIT I** **3 Hours**

**INTRODUCTION TO AM/ FM RADIO**

History of Radio-Types of Radio and its Reach- Entertainment Radio- Community Radio- Internet Radio- Satellite Radio. Evolution of Community Radio (CR) in India- principles behind setting up of FM/CR- policy guidelines and their impact on technology and content of a CR station- fundamental principles behind deciding the technology for a CR station.

**UNIT II** **3 Hours**

**STUDIO TECHNOLOGY**

Use of Microphones-Console handling-OB Recordings & Live Shows-Properties and components of sound-difference between analogue and digital audio-hardware required for field recording and setting up a studio-fundamental principles for setting up an audio studio.

**UNIT III** **3 Hours**

**AUDIO PRODUCTION**

Concept of recording and storing audio-hardware related to audio recording-open source software solutions for audio production-telephony interfaces for radio- audio Post Production. Voice Culture Exercise- Radio Production Techniques & Tools.

**UNIT IV** **3 Hours**

**STUDIO OPERATIONS**

Wiring, fixing of connectors, soldering and use of tools and equipment- preventive and corrective maintenance of studio and equipment.

**UNIT V** **3 Hours**

**RADIO TRANSMISSION TECHNOLOGY**

Components of the FM transmission chain- FM transmitter-different types of FM antenna - coaxial cable- propagation and coverage of RF signals-FM transmitter setup- Radio audience - measurements systems.

**Total: 15 Hours**

**Reference(s)**

1. UNESCO (2001). Community Radio Handbook.
2. Vinod Pavarala, Kanchan K Malik, Other Voices: The Struggle for Community Radio in India, SAGE Publications India, 2007.
3. Steve Buckley, Mark Raboy, Toby Mendel, Kreszentia Duer, Monroe E. Price, Sean O Siochru, Broadcasting, Voice, and Accountability: A Public Interest Approach to Policy, Law, and Regulation, University of Michigan Press, 2008.
4. www.floridasound.com
5. www.mediacollege.com
6. www.mediacollege.com