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

# OUTCOME BASED EDUCATION
# WITH
# CHOICE BASED CREDIT SYSTEM

## MASTER OF TECHNOLOGY
## AEROSPACE ENGINEERING

## ACADEMIC REGULATIONS, COURSE STRUCTURE AND SYLLABI UNDER AUTONOMOUS STATUS

**M.Tech Regular Two Year Degree Program**
**(for the batches admitted from the academic year 2016 – 17)**

**FAILURE TO READ AND UNDERSTAND THE REGULATIONS IS NOT AN EXCUSE**

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

# PRELIMINARY DEFINITIONS AND NOMENCLATURES

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

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

**Academic Year:** It is the period necessary to complete an actual course of study within a year. It comprises two consecutive semesters i.e., Even and Odd semester.

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

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

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

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

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

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

**Certificate course:** It is a course that makes a student gain hands-on experience and skill required for holistic development in a specific area/field.

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

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

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

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

**Course:** A course is a subject offered by the University for learning in a particular semester.

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

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

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

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

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

**Degree with Specialization:** A student who fulfills all the program requirements of her/his discipline and successfully completes a specified set of professional elective courses in a specialized area is eligible to receive a degree with specialization like Structural Engineering, Embedded Systems, CSE, etc.

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

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

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

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

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

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

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

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

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

**Pre-requisite:** A course, the knowledge of which is required for registration into higher level course.

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

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

**Program:** Means, Master of Technology (M.Tech) degree program / UG degree program: B.Tech.

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

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

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

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

**Regulations:** The regulations, common to all M.Tech programs offered by Institute are designated as "IARE-R16" and are binding on all the stakeholders.

**Semester:** It is a period of study consisting of 15 to 18 weeks of academic work equivalent to normally 90 working days. The odd semester starts usually in July and even semester in December.

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

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

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

**University:** Means the Jawaharlal Nehru Technological University Hyderabad, Hyderabad.

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

**Words 'he', 'him', 'his', occur, they imply 'she', 'her', 'hers' also.**

# FOREWORD

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

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

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

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

**PRINCIPAL**

# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

# ACADEMIC REGULATIONS

**M.Tech. Regular Two Year Degree Program**
**(for the batches admitted from the academic year 2016 - 17)**

For pursuing two year postgraduate Master Degree program of study in Engineering (M.Tech) offered by Institute of Aeronautical Engineering under Autonomous status and herein after referred to as IARE.

## 1.0 CHOICE BASED CREDIT SYSTEM

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

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

Choice Based Credit System (CBCS) is a flexible system of learning and provides choice for students to select from the prescribed elective courses. A course defines learning objectives and learning outcomes and comprises of lectures / tutorials / laboratory work / field work / project work / comprehensive examination / viva / seminars / assignments / presentations / self-study etc. or a combination of some of these.

Under the CBCS, the requirement for awarding a degree is prescribed in terms of number of credits to be completed by the students.

The CBCS permits students to:

1. Choose electives from a wide range of elective courses offered by the departments of the Institute.
2. Undergo additional courses of interest.
3. Adopt an inter-disciplinary approach in learning.
4. Make the best use of expertise of the available faculty.

## 2.0 MEDIUM OF INSTRUCTION

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

## 3.0 ELIGIBILITY FOR ADMISSION

The admissions for category A and B seats shall be as per the guidelines of Telangana State Council for Higher Education (TSCHE) in consonance with government reservation policy.

a) Under Category A: 70% of the seats are filled based on GATE/PGECET ranks.

b) Under Category B: 30% seats are filled on merit basis as per guidelines of TSCHE.

## 4.0 UNIQUE COURSE IDENTIFICATION CODE

Every specialization of the M.Tech programme will be placed in one of the seven groups as listed in the Table 1.

**Table 1: Group of Courses**

| S. No | Specialization | Offering Department | Code |
|---|---|---|---|
| 1 | Structural Engineering | Civil Engineering | ST |
| 2 | Power Electronics and Electrical Drives | Electrical and Electronics Engineering | PE |
| 3 | CAD / CAM | Mechanical Engineering | CC |
| 4 | Embedded Systems | Electronics and Communication Engineering | ES |
| 5 | Computer Science and Engineering | Computer Science and Engineering | CS |
| 6 | Software Engineering | Information Technology | SE |
| 7 | Aerospace Engineering | Aeronautical Engineering | AE |

## 5.0 TYPES OF COURSES

Courses in a programme may be of two kinds: **Core and Elective.**

### 5.1 Core Course:

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

### 5.2 Elective Course:

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

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

An elective may be discipline centric (Professional Elective) focusing on those courses which add generic proficiency to the students or may be chosen from supportive/general discipline called as "Open Elective".

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

## 6.0 SEMESTER STRUCTURE

The institute shall follow semester pattern. An academic year shall consist of a first semester and a second semester and the summer term. Each semester shall be of 23 weeks (Table 2) duration and this period includes time for course work, examination preparation and conduct of examinations. Each main semester shall have a minimum of 90 working days; out of which number of contact days for teaching / practical shall be 75 and 15 days shall be for examination preparation. The duration for each semester shall be a minimum of 17 weeks of instruction. The Academic Calendar is declared at the beginning of the academic year as given in Table 2.

**Table 2: Academic Calendar**

<table>
<tr><td rowspan="6">FIRST SEMESTER<br>(23 weeks)</td><td>I Spell Instruction Period</td><td>9 weeks</td><td rowspan="5">21 weeks</td></tr>
<tr><td>I Mid Examinations</td><td>1 week</td></tr>
<tr><td>II Spell Instruction Period</td><td>8 weeks</td></tr>
<tr><td>II Mid Examinations</td><td>1 week</td></tr>
<tr><td>Preparation and Practical Examinations</td><td>2 weeks</td></tr>
<tr><td colspan="2">Semester End Examinations</td><td>2 weeks</td></tr>
<tr><td colspan="3">Semester Break and Supplementary Exams</td><td>2 weeks</td></tr>
<tr><td rowspan="6">SECOND SEMESTER<br>(23 weeks)</td><td>I Spell Instruction Period</td><td>9 weeks</td><td rowspan="5">21 weeks</td></tr>
<tr><td>I Mid Examinations</td><td>1 week</td></tr>
<tr><td>II Spell Instruction Period</td><td>8 weeks</td></tr>
<tr><td>II Mid Examinations</td><td>1 Week</td></tr>
<tr><td>Preparation & Practical Examinations</td><td>2 weeks</td></tr>
<tr><td colspan="2">Semester End Examinations</td><td>2 weeks</td></tr>
<tr><td colspan="3">Summer Vacation</td><td>4 weeks</td></tr>
<tr><td>THIRD SEMESTER</td><td colspan="2">Project Work Phase - I</td><td>18 weeks</td></tr>
<tr><td>FOURTH SEMESTER</td><td colspan="2">Project Work Phase - II</td><td>18 weeks</td></tr>
</table>

## 7.0 PROGRAM DURATION

A student shall be declared eligible for the award of M.Tech degree, if s/he pursues a course of study and completes it successfully in not less than two academic years and not more than four academic years. A student, who fails to fulfill all the academic requirements for the award of the degree within four academic years from the year of his/her admission, shall forfeit his/her seat in M.Tech course.

a) A student will be eligible for the award of M.Tech degree on securing a minimum of 5.0/10.0 CGPA.

b) In the event of non-completion of project work and/or non-submission of the project report by the end of the fourth semester, the candidate shall re-register by paying the semester fee for the project. In such a case, the candidate will not be permitted to submit the report earlier than three months and not later than six months from the date of registration.

## 8.0 CURRICULUM AND COURSE STRUCTURE

The curriculum shall comprise Core Courses, Elective Courses, Laboratory Course, Comprehensive Examination, Internship and Project Work. The list of elective courses may include subjects from allied disciplines also.

Each Theory and Laboratory course carries credits based on the number of hours/week as follows:

- **Lecture Hours (Theory):** 1 credit per lecture hour per week.
- **Laboratory Hours (Practical):** 1 credit for 2 practical hours, 2 credits for 3 or 4 practical hours per week.
- **Project Work:** 1 credit for 4 hours of project work per week.

### 8.1 Credit distribution for courses offered is shown in Table 3.

**Table 3: Credit distribution**

| S. No | Course | Hours | Credits |
|---|---|---|---|
| 1 | Core Courses | 3 | 3 |
| 2 | Elective Courses | 3 | 3 |
| 3 | MOOC Courses | - | 2 |
| 4 | Laboratory Courses | 3 | 2 |
| 5 | Seminar and Technical Writing | 3 | 2 |
| 6 | Comprehensive Examination | - | 2 |
| 7 | Project Work | 128 | 30 |

### 8.2 Course wise break-up for the total credits:

| | | |
|---|---|---|
| **Total Theory Courses (12)**<br>Core Courses (06) + Professional Electives (04) + Open Electives (02) | 06 @ 3 credits + 06 @ 3 credits | 36 |
| Total Laboratory Courses (03) | 03 @ 2 credits | 06 |
| MOOC Courses (02) | 02 @ 2 credits | 04 |
| Seminar and Technical Writing (01) | 1 @ 2 credits | 02 |
| Comprehensive Examination (01) | 1 @ 2 credits | 02 |
| Project Work | 1 @ 30 credits | 30 |
| **TOTAL CREDITS** | | **80** |

## 9.0 EVALUATION METHODOLOGY

### 9.1 Theory Course:

Each theory course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIE during the semester, marks are awarded by taking average of two sessional examinations.

#### 9.1.1 Semester End Examination (SEE):

The SEE shall be conducted for 70 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE units and each unit carries equal weightage in terms of marks distribution. The question paper pattern shall be as defined below. Two full questions with 'either' 'or' choice will be drawn from each unit. Each question carries 14 marks. There could be a maximum of three sub divisions in a question.

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

| | |
|---|---|
| 50 % | To test the objectiveness of the concept |
| 30 % | To test the analytical skill of the concept |
| 20 % | To test the application skill of the concept |

#### 9.1.2 Continuous Internal Assessment (CIA):

For each theory course the CIA shall be conducted by the faculty/teacher handling the course as given in Table 4. CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Technical Seminar and Term Paper.

**Table 4: Assessment pattern for Theory Courses**

| COMPONENT | THEORY | | TOTAL MARKS |
|---|---|---|---|
| Type of Assessment | CIE Exam (Sessional) | Technical Seminar and Term Paper | |
| Max. CIA | 25 | 5 | 30 |

**Continuous Internal Examination (CIE):**

Two CIE exams shall be conducted at the end of the 9$^{th}$ and 17$^{th}$ week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carrying 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

**Technical Seminar and Term Paper:**

Two seminar presentations are conducted during I year I semester and II semester. For seminar, a student under the supervision of a concerned faculty member, shall identify a topic in each course and prepare the term paper with overview of topic. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

## 9.2 Laboratory Course:

9.2.1 Each lab will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance and 10 marks for the final internal lab assessment. The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being a internal examiner and another is external examiner, both nominated by the Principal from the panel of experts recommended by Chairman, BOS.

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

## 9.3 MOOC Courses:

Meeting with the global requirements, to inculcate the habit of self learning and in compliance with UGC guidelines, MOOC (Massive Open Online Course) courses have been introduced as electives.

9.3.1 The proposed MOOC Courses would be additional choices in all the elective groups subject to the availability during the respective semesters and respective departments will declare the list of the courses at the beginning of the semester. Course content for the selected MOOC Courses shall be drawn from respective MOOCs links or shall be supplied by the department. Course will be mentored by faculty members and Assessment and evaluation of the courses shall be done by the department.

9.3.2 There shall be one Mid Sessional Examination (Quiz exam for 30 marks) after 8 weeks of the commencement of the course and semester end evaluation (Descriptive exam for 70 marks) shall be done along with other regular courses.

9.3.3 Two credits will be awarded upon successful completion of each MOOC Course.

9.3.4 Students interested in doing MOOC Courses shall register the course title at their department office at the start of the semester against the courses that are announced by the department.

## 9.4 Project work

Normally, the project work should be carried out at Host Institute (Institute of Aeronautical Engineering). However, it can also be carried out in any of the recognized Educational Institutions, National Laboratories, Research Institutions, Industrial Organizations, Service Organizations or Government Organizations with the prior permission from the guide and concerned Head of the Department. A student shall submit the outcome of the project work in the form of a dissertation.

9.4.1 The student shall submit the project work synopsis at the end of III semester for Phase-I of project evaluation. The Phase-I of project work shall be evaluated by Project Review Committee (PRC) at the end of the third semester for a maximum of 100 marks. Head of the Department (HOD) shall constitute a PRC comprising of senior faculty of the specialization, Guide and Head of the Department.

9.4.2 The first phase of project work is to be carried out in IV semester for Phase –II of Project work. The student will be allowed to appear for final viva voce examination at the end of IV semester only if s/he has submitted s/he project work in the form of paper for presentation / publication in a conference/journal and produce the proof of acceptance of the paper from the organizers/publishers.

9.4.3 The student shall submit the project work in the form of dissertation at least four weeks ahead of the completion of the program. Head of the Department shall constitute an Internal Evaluation Committee (IEC) comprising of the Chairman BOS (PG), HOD and Guide. As per convenes of all meeting for open pre-submission seminar evaluation of the student. If the open pre-submission seminar by a student is not satisfactory, another seminar shall be scheduled within two weeks.

The evaluation of the project work and the marks allotted are as under:

| S.No | Project Phases | Mode | Evaluation Committee | Marks |
|---|---|---|---|---|
| 1 | Phase - I | Continuous evaluation at the end of III Semester | Guide | 30 |
| 2 | | Evaluation at the end of III Semester | Project Review Committee (PRC) comprising of senior faculty of the specialization, guide and HOD. | 70 |
| **Total(Phase – I)** | | | | **100** |
| 3 | Phase - II | An open pre-submission seminar by the student | The Internal Evaluation Committee (IEC) comprising of the Chairman, BOS (PG), HOD and guide wherein the HOD convenes its meeting. | 30 |
| 4 | | End Semester Examination (An open seminar followed by viva-voce) | The External Evaluation Committee (EEC) comprising of External Examiner, HOD and guide wherein the HOD shall be the chairman of the committee. | 70 |
| **Total(Phase-II)** | | | | **100** |

9.4.4 As soon as a student submits his project work, Principal shall appoint the External Examiner among the panel of examiners recommended by the Chairman, BOS (PG).

9.4.5 The Principal shall schedule the End Semester Examination in project work soon after the completion of the study of program and a student can appear for the same provided s/he has earned successfully all the requisite credits. The student shall produce the dissertation duly certified by the guide and HOD during the Examination.

9.4.6 The project reports of M. Tech students who have not completed their course work successfully will be evaluated in that semester itself and the result sent confidentially to the Controller of Examinations. The results of the project work evaluation will be declared by the Controller of Examinations only after the successful completion of the courses by those students.

### 9.5 Comprehensive Examination

The comprehensive examination is aimed at assessing the student's understanding of various Foundation, Skill and Core courses studied by the end of II semester and is intended to test the student's grasp of the chosen field of study. The comprehensive examination is an online test evaluated for 100 marks.

## 10.0 ATTENDANCE REQUIREMENTS AND DETENTION POLICY

10.1 It is desirable for a candidate to put on 100% attendance in each course. In every course (theory/laboratory), student has to maintain a minimum of 80% attendance including the days of attendance in sports, games, NCC and NSS activities to be eligible for appearing in Semester End Examination of the course.

10.2 For cases of medical issues, deficiency of attendance in each course to the extent of 15% may be condoned by the Institute Academic Committee (CAC) on the recommendation of Head of the Department if his/her attendance is between 80% to 65% in every course, subjected to submission of medical certificate and other needful documents to the concerned department.

10.3 The basis for the calculation of the attendance shall be the period prescribed by the institute by its calendar of events. For late admission, attendance is reckoned from the date of admission to the program.

10.3 However, in case of a student having less than 65% attendance in any course, s/he shall be detained in the course and in no case such process will be relaxed.

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

10.5 A prescribed fee shall be payable towards Condonation of shortage of attendance.

10.6 A candidate shall put in a minimum required attendance at least in three (3) theory courses for getting promoted to next higher class / semester. Otherwise, s/he shall be declared detained and has to repeat semester.

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

## 11.0 CONDUCT OF SEMESTER END EXAMINATIONS AND EVALUATION

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

11.2 Question papers may be moderated for the coverage of syllabus, pattern of questions by Semester End Examination Committee chaired by Head of the Department one day before the commencement of semester end examinations.

11.3 Internal Examiner shall prepare a detailed scheme of valuation.

11.4 The answer papers of semester end examination should be evaluated by the internal examiner immediately after the completion of exam and the award sheet should be submitted to COE in a sealed cover before the same papers are kept for second evaluation by external examiner.

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

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

11.7 Examination Control Committee shall consolidate the marks awarded by internal and external examiners to award grades.

## 12.0 SCHEME FOR THE AWARD OF GRADE

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

i. Not less than 40% marks for each theory course in the semester end examination, and

ii. A minimum of 50% marks for each theory course considering both CIA and SEE

12.2 A student shall be deemed to have satisfied the minimum academic requirements and earn the credits for each Laboratory / Seminar and Technical Writing / Project, if s/he secures

i. Not less than 40% marks for each Laboratory / Seminar and Technical Writing / Project course in the semester end examination,

ii. A minimum of 50% marks for each Laboratory / Seminar and Technical Writing / Project course considering both internal and semester end examination.

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

## 13.0 LETTER GRADES AND GRADE POINTS

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

| Range of Marks | Grade Point | Letter Grade |
|---|---|---|
| 100 - 80 | 10 | S (Superior) |
| 70 – 79 | 9 | A+ (Excellent) |
| 60 – 69 | 8 | A (Very Good) |
| 55 – 59 | 7 | B+ (Good) |
| 50 – 54 | 6 | B (Average) |
| Below 50 | 0 | F (Fail) |
| Absent | 0 | Ab (Absent) |
| Authorized Break of Study | 0 | ABS |

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

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

13.4 "SA" denotes shortage of attendance (as per item 10) and hence prevention from writing Semester End Examination.

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

## 14.0 COMPUTATION OF SGPA AND CGPA

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

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

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

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

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

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

## 15.0 ILLUSTRATION OF COMPUTATION OF SGPA AND CGPA

### 15.1 Illustration for SGPA

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

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

### 15.2 Illustration for CGPA

| Semester 1 | Semester 2 | Semester 3 | Semester 4 |
|---|---|---|---|
| Credit: 20<br>SGPA: 6.9 | Credit: 22<br>SGPA: 7.8 | Credit: 25<br>SGPA: 5.6 | Credit: 26<br>SGPA: 6.0 |

$$Thus,\ CGPA = \frac{20x6.9 + 22x7.8 + 25x5.6 + 26x6.0}{93} = 6.51$$

## 16.0 PHOTOCOPY / REVALUATION

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

## 17.0 GRADUATION REQUIREMENTS

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

17.1 Student shall register and acquire minimum attendance in all courses and secure 80 credits.

17.2 A student who fails to earn 80 credits within four consecutive academic years from the year of his/her admission with a minimum CGPA of 5.0, shall forfeit his/her degree and his/her admission stands cancelled.

## 18.0 AWARD OF DEGREE

Classification of degree will be as follows:

| CGPA ≥ 7.5 | CGPA ≥ 6.5 and < 7.5 | CGPA ≥ 5.5 and < 6.5 | CGPA ≥ 5.0 and < 5.5 | CGPA < 5.0 |
|---|---|---|---|---|
| **First Class with Distinction** | **First Class** | **Second Class** | **Pass Class** | **Fail** |

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

b) All the candidates who register for the semester end examination will be issued of grade sheet by the Institute. Apart from the semester wise grade sheet, the institute will issue the provisional certificate subject to the fulfillment of all the academic requirements.

## 19.0 IMPROVEMENT OF GRADE:

A candidate, after becoming eligible for the award of the degree, may reappear for the final examination in any of the theory courses as and when conducted for the purpose of improving the aggregate and the grade. But this reappearance shall be within a period of two academic years after becoming eligible for the award of the degree.

However, this facility shall not be availed of by a candidate who has taken the Original Degree Certificate. Candidates shall not be permitted to reappear either for CIE in any course or for Semester End Examination (SEE) in laboratory courses (including Project Viva-voce) for the purpose of improvement.

## 20.0 TERMINATION FROM THE PROGRAM

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

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

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

## 21.0 WITH-HOLDING OF RESULTS

If the candidate has not paid any dues to the institute / if any case of indiscipline / malpractice is pending against him/her, the results of the candidate will be withheld. The issue of the degree is liable to be withheld in such cases.

## 22.0 GRADUATION DAY

The institute shall have its own annual Graduation Day for the award of Degrees to students completing the prescribed academic requirements in each case, in consultation with the University and by following the provisions in the Statute.

The institute shall institute prizes and medals to meritorious students annually on Graduation Day. This will greatly encourage the students to strive for excellence in their academic work.

## 23.0 DISCIPLINE

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

## 24.0 GRIEVANCE REDRESSAL COMMITTEE

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

## 25.0 TRANSITORY REGULATIONS

25.1 A student who has been detained in any semester of previous regulations for not satisfying the attendance requirements shall be permitted to join in the corresponding semester of this regulation.

25.2 Semester End Examination in each course under the regulations that precede immediately these regulations shall be conducted three times after the conduct of last regular examination under those regulations. Thereafter, the failed students, if any, shall take examination in the equivalent papers of these regulations as suggested by the Chairman, BOS concerned.

## 26.0 REVISION OF REGULATIONS AND CURRICULUM

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

**FAILURE TO READ AND UNDERSTAND THE REGULATIONS IS NOT AN EXCUSE**

# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

## AEROSPACE ENGINEERING

### COURSE STRUCTURE

### I SEMESTER

| Course Code | Course Name | Subject Area | Category | Periods per week | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | CIA | SEE | Total |
| **THEORY** | | | | | | | | | | |
| BAE001 | Advanced Mathematics in Aerospace Engineering | PC | Core | 3 | - | - | 3 | 30 | 70 | 100 |
| BAE002 | Aerodynamics of Flight Vehicles | PC | Core | 3 | - | - | 3 | 30 | 70 | 100 |
| BAE003 | Flight Vehicle Structures | PC | Core | 3 | - | - | 3 | 30 | 70 | 100 |
| | **Professional Elective - I** | PE | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| | **Professional Elective - II** | PE | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| | **Open Elective – I** | OE | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| BAE301 | MOOC - I (Massive Open Online Course) | PE | Elective | - | - | 3 | 2 | 30 | 70 | 100 |
| **PRACTICAL** | | | | | | | | | | |
| BAE101 | Application of Matlab in Aerospace Engineering Laboratory | PC | Core | - | - | 3 | 2 | 30 | 70 | 100 |
| **TOTAL** | | | | **18** | **00** | **06** | **22** | **240** | **560** | **800** |

### II SEMESTER

| Course Code | Course Name | Subject Area | Category | Periods per week | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | CIA | SEE | Total |
| **THEORY** | | | | | | | | | | |
| BAE004 | Flight Dynamics and Control | PC | Core | 3 | - | - | 3 | 30 | 70 | 100 |
| BAE005 | Aerospace Propulsion | PC | Core | 3 | - | - | 3 | 30 | 70 | 100 |
| BAE006 | Airport Planning and Operation | PC | Core | 3 | - | - | 3 | 30 | 70 | 100 |
| | **Professional Elective -III** | PE | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| | **Professional Elective -IV** | PE | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| | **Open Elective -II** | OE | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| **PRACTICAL** | | | | | | | | | | |
| BAE102 | CFD/CSA Solutions using ANSYS/NASTRAN Laboratory | PC | Core | - | - | 3 | 2 | 30 | 70 | 100 |
| BAE103 | Application Development Mini Project Laboratory | - | Elective | - | - | 3 | 2 | 30 | 70 | 100 |
| **TOTAL** | | | | **18** | **00** | **06** | **22** | **240** | **560** | **800** |

## III SEMESTER

| Course Code | Course Name | Subject Area | Category | Periods per week | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | CIA | SEE | Total |
| **THEORY** | | | | | | | | | | |
| BAE401 | Seminar and Technical Writing | PC | Core | - | - | 3 | 2 | 30 | 70 | 100 |
| BAE302 | MOOC - II (Massive Open Online Course) | PE | Elective | - | - | 3 | 2 | 30 | 70 | 100 |
| **PRACTICAL** | | | | | | | | | | |
| BAE501 | Comprehensive Examination | - | Core | - | - | - | 2 | 30 | 70 | 100 |
| BAE601 | Project Work(Phase -I) | - | Core | - | - | - | 10 | 100 | - | 100 |
| **TOTAL** | | | | **00** | **00** | **06** | **16** | **190** | **210** | **400** |

## IV SEMESTER

| Course Code | Course Name | Subject Area | Category | Periods per week | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | CIA | SEE | Total |
| BAE602 | Project Work(Phase -II) | | Core | - | - | - | 20 | 30 | 70 | 100 |
| **TOTAL** | | | | **00** | **00** | **00** | **20** | **30** | **70** | **100** |

## PROFESSIONAL ELECTIVES

### GROUP – 1: AEROSPACE STRUCTURAL ENGINEERING

| Course Code | Course Name |
|---|---|
| BAE201 | Fatigue and Facture Mechanics |
| BAE202 | Design and analysis of Composite Structures |
| BAE203 | Aeroelasticity |
| BAE204 | Unmanned Air Vehicles |

### GROUP – 2: AERODYNAMICS / FLUID FLOWS

| Course Code | Course Name |
|---|---|
| BAE205 | Ground Vehicle Aerodynamics |
| BAE206 | Wind Engineering |
| BAE207 | Experimental Aerodynamics |
| BAE208 | Missile Aerodynamics |

### GROUP – 3: AEROSPACE PROPULSION SYSTEMS

| Course Code | Course Name |
|---|---|
| BAE209 | Theory of Combustion |
| BAE210 | Turbo machinery and Dynamics |
| BAE211 | Hypersonic And High-Temperature Gas Dynamics |
| BAE212 | Rocket and Missile |

### GROUP – 4: FLIGHT DYNAMICS AND CONTROL

| Course Code | Course Name |
|---|---|
| BAE213 | Missile Guidance And Control |
| BAE214 | Flight Simulation |
| BAE215 | Flight Testing |
| BAE216 | Atmospheric Re-entry Vehicle Mechanics |

## OPEN ELECTIVES-I

| Course Code | Course Title |
|---|---|
| BST701 | Disaster Management |
| BPE701 | Renewable Energy Systems |
| BCC701 | Automotive Design |
| BES001 | Embedded C |
| BCS701 | Advanced JAVA Programming and Web Services |
| BAE701 | Introduction to Aerospace Engineering* |
| Note: * indicates that subject not offered to the students of Aeronautical Engineering Department. | |

## OPEN ELECTIVES-II

| Course Code | Course Title |
|---|---|
| BST702 | Geo Spatial Techniques |
| BPE702 | Solar Photo Voltaic Energy Conversion |
| BCC702 | Computer Graphics |
| BES702 | Microcontrollers for Embedded System Design |
| BCS702 | Linux Programming |
| BCS703 | Research Methodology |
| BAE702 | Industrial Aerodynamics and Wind Energy* |
| Note: * indicates that subject not offered to the students of Aeronautical Engineering Department. | |

# SYLLABI

## ADVANCED MATHEMATICS IN AEROSPACE ENGINEERING

**I Semester: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE001 | Core | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Matrix method more effectively for the solution of both structural mechanics and fluid mechanics problems.
II. Different transform techniques for the solution differential equation.
III. Numerical techniques for the solution of matrix equations.
IV. Numerical technique for the solution of ordinary differential equations and partial differential equations.

| UNIT-I | MATRIX ANALYSIS AND LINEAR ALGEBRA | Classes: 08 |
|---|---|---|

Matrices, vectors addition, scalar multiplication, matrix multiplication; Linear Systems of Equation; Gauss elimination; Linear independence, rank of a matrix, vector space, determinants, Cramer's rule; Inverse of a matrix, Gauss-Jordan elimination; Matrix: Eigen value Problem; Determining Eigen values and Eigen vectors, applications of Eigen value problems, symmetric, skew-symmetric and orthogonal matrices, Eigen bases, diagonalization, quadratic forms.

| UNIT-II | LAPLACE TRANSFORMS | Classes: 10 |
|---|---|---|

Laplace transform, linearity, first shifting theorem, transforms of derivatives and integrals, unit step function, second shifting theorem, short impulse, Dirac's delta function, partial fractions, convolution, integral equations, differentiation and integration of transforms, ordinary differential equations with variable coefficients, systems of ordinary differential equations, general formulas for Laplace transforms.

| UNIT-III | FOURIER SERIES AND FOURIER TRANSFORMS | Classes: 10 |
|---|---|---|

Fourier series, arbitrary period, even and odd functions, half-range expansions, forced oscillations, approximation by trigonometric polynomials.

Fourier integral, Fourier cosine and sine transforms, Fourier transform, discrete and fast Fourier transforms.

| UNIT-IV | NUMERICS IN GENERAL AND NUMERIC LINEAR ALGEBRA | Classes: 09 |
|---|---|---|

Numerics in general-introduction, solution of equations by iteration, interpolation, spline interpolation, numeric integration and differentiation; Numeric linear algebra, linear systems, Gauss elimination, lower upper factorization, matrix inversion, solution by iteration, ill-conditioning, norms; lest squares method,

Matrix Eigen value problems-introduction, inclusion of matrix Eigen values, power method for Eigen values, tridiagonalization and QR factorization.

| UNIT-V | NUMERICS FOR ORDINARY DIFFERENTIAL EQUATIONS AND PARTIAL DIFFERENTIAL EQUATIONS | Classes: 08 |
|---|---|---|

Methods for first order ordinary differential equations, multistep methods, methods for systems and higher order ordinary differential equations, methods for elliptic partial differential equations, Neumann and mixed problems, irregular boundary, methods for parabolic and hyperbolic partial differential equations.

**Text Books :**


1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 10th Edition, 2011.
2. Peter V. O'Neil, "Advanced Engineering Mathematics", Cengage Learning, 7th Edition, 2012.
3. Michael. D. Greenberg, "Advanced Engineering Mathematics", Prentice Hall, 2nd Edition, 1998.


**Reference Books:**


1. Erwin Kreyszig, "Instructor's Manual for Advanced Engineering Mathematics", John Wiley & Sons, 9th Edition, 2006.
2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2014.


**Web References:**

1. http://folk.ntnu.no/magnud/ressurser/kreyszig.pdf
2. https://archive.org/details/SolutionManualOfAdvancedEngineeringMathematicsByErwinKreyszig9thEdition
3. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjizbzBo_fNAhXCMo8KHbuvDpUQFggmMAA&url=http%3A%2F%2Fwww.fkm.utm.my%2F~mazlan%2F%3Fdownload%3DAdMath%2520PO.pdf&usg=AFQjCNGfsmqe2V3SO-lJGK_-PyLcRaRsfg&bvm=bv.127178174,d.c2I

**E-Text Books:**

1. http://www-elec.inaoep.mx/~jmram/Kreyzig-ECS-DIF1.pdf
2. http://www.max.sourmilk.net/Files/Advanced%20Engineering%20Mathematics%20-%20Michael%20D.%20Greenberg,%202nd%20Ed.pdf

# AERODYNAMICS OF FLIGHT VEHICLES

**I Semester: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE002 | Core | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Analyze the vortex flows and flow circulation for different airfoils and finite wings.
II. Understand the basic compressible flow theories for airfoils.
III. Explain the concepts of laminar boundary layer in compressible flows.
IV. Distinguish instabilities in transition flow.
V. Analyze the design parameters for high lift airfoils.

| UNIT-I | AERODYNAMIC CHARACTERISTICS OF AIRFOILS AND FLOW AROUND FINITE WINGS | Classes: 08 |
|---|---|---|

Basic concepts: Circulation, irrotational flow, Stokes theorem, velocity potential, point vortex, vortex filament, Biot-Savart law, bound vortex, Kutta condition; vortex sheet, vortex sheet in thin airfoil theory, planar wing, properties of symmetrical airfoil, properties of cambered airfoil, flapped airfoil; Finite wing**:** Flow fields around finite wings, downwash and induced drag, fundamental equations of finite wing theory, elliptical lift distribution, arbitrary circulation distribution; Twisted wing: Basic and additional lift, approximate calculation of additional lift, winglets.

| UNIT-II | AIRFOILS, WINGS AND WING-BODY COMBINATIONS IN COMPRESSIBLE FLOW | Classes: 10 |
|---|---|---|

Compressible flow field, mach waves, normal shock wave, oblique shock waves, Prandtl-Meyer flow; Linearized compressible flow: Flow equation for small perturbations, steady supersonic flows, pressure coefficient for small perturbations; Airfoils in compressible flows: Boundary conditions, airfoils in subsonic flow: Prandtl-Glauert transformation, critical mach number, airfoils in transonic flow, airfoils in supersonic flow; Wings and bodies in compressible flows: Prandtl-Glauert-Goethert transformation, influence of sweepback, design rules for wing-fuselage combination.

| UNIT-III | LAMINAR BOUNDARY LAYER IN COMPRESSIBLE FLOW | Classes: 10 |
|---|---|---|

Viscous boundary layer, boundary layer equation of motion, conservation of energy in the boundary layer, rotation and entropy gradient in the boundary layer, similarity considerations for compressible boundary layers.

Solution of energy equation for Prandtl number unity, temperature recovery factor, heat transfer versus skin friction, velocity and temperature profiles and skin friction, effects of pressure gradient.

| UNIT-IV | FLOW INSTABILITIES AND TRANSITION FROM LAMINAR TO TURBULENT FLOW, AND TURBULENT FLOWS | Classes: 09 |
|---|---|---|
| Gross effects, Reynolds experiment, Tollmien-Schlichting instability and transition, natural laminar flow and laminar flow control, stability of vortex sheets, stratified flows, transition phenomenon, methods for experimentally detecting transition, flow around spheres and circular cylinders; Turbulent flows: Description of turbulent field, statistical properties, conservation equations, laminar sub layer, fully developed flows in tubes and channels, constant-pressure turbulent boundary layer, turbulent drag reduction, effects of pressure gradient, Stratford criterion for turbulent separation, effects of compressibility on skin friction, Reynolds analogy: Heat transfer and temperature recovery factor, free turbulent shear flows. | | |
| **UNIT-V** | **AIRFOIL DESIGN, MULTIPLE SURFACES, VORTEX LIFT, SECONDARY FLOWS, VISCOUS EFFECTS** | **Classes: 08** |
| Airfoil design for high $C_{lmax}$, multiple lifting surfaces, circulation control, streamwise vorticity, secondary flows; Vortex lift: Strakes, flow about three dimensional bodies, unsteady lift. | | |

**Text Books :**

1. Arnold M. Kuethe, Chuen- Yen Chow, "Foundations of Aerodynamics, Bases of Aerodynamic Design", John Wiley and Sons, Inc, 5th Edition, 1997.

**Reference Books:**

1. J. D. Anderson, "Fundamentals of Aerodynamics", McGraw-Hill, 5th Edition, 2001.
2. J. J. Bertin, R. M Cummings, "Aerodynamics for Engineers", Pearson, 5th Edition, 2009.
3. Argyris G. Panaras, "Aerodynamic Principles of Flight Vehicles", AIAA Inc, 1st Edition, 2012.

**Web References:**

1. https://mitpress.mit.edu/books/flight-vehicle-aerodynamics
2. https://www.edx.org/course/flight-vehicle-aerodynamics-mitx-16-110x-0
3. https://www.mooc-list.com/course/16110x-flight-vehicle-aerodynamics-edx?static=true

**E-Text Books:**

1. http://www.freeengineeringbooks.com/AeroSpace/Aerodynamics-Books.php
2. http://www.booksamillion.com/p/Flight-Vehicle-Aerodynamics/Mark-Drela/Q685536838
3. https://www.overdrive.com/media/1553992/flight-vehicle-aerodynamics

# FLIGHT VEHICLE STRUCTURES

**I Semester: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE003 | Core | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Identify design features of aerospace structures, and calculate load factors and margins of safety;
II. Analyze the behaviour of thin-walled beams subjected to combined loads, including bending, torsion, and shear;
III. Analyze the stability of structural elements and determine critical buckling loads; and
IV. Develop structural finite element models and use them to predict structural deformations and stresses under external loads.

| UNIT-I | STRUCTURAL COMPONENTS AND LOADS OF AIRCRAFT | Classes: 09 |
|---|---|---|

Loads on Structural components, Function of structural components, Fabrication of structural components, Connections; Airworthiness: Factors of Safety- flight envelope, Load factor determination, Airframe loads: Aircraft inertia loads, Symmetric maneuver loads, Normal accelerations associated with various types of maneuvers, Gust loads.

| UNIT-II | SHEAR FLOW AND SHEAR CENTER IN OPEN AND CLOSED THIN WALL SECTIONS | Classes: 09 |
|---|---|---|

Open Sections: Shear center and elastic axis, Concept of shear flow, Beams with one axis of symmetry; Closed Sections: Bradt-Batho formula, Single and multi-cell closed box structures, Semi monocoque and mono cocque structures, Shear flow in single and multi cellmonocoque and semimonocoque box beams subject to torsion.

| UNIT-III | THIN PLATE THEORY AND STRUCTURAL INSTABILITY IN THIN PLATES | Classes: 09 |
|---|---|---|

Bending of thin plates: Pure bending of thin plates, Plates subjected to bending and twisting, Plates subject to distributed transverse load, Combined bending and in-plane loading of a thin rectangular plate, Bending of thin plates having a small initial curvature, Energy method for bending of thin plates.

Buckling of thin plates, Inelastic buckling of plates, Experimental determination of critical loads for a flat plate, Local instability, Instability of stiffened panels, Failure stress in plates and stiffened panels, Tension field beams.

| UNIT-IV | BENDING, SHEAR AND TORSION OF THIN-WALLED BEAMS-I AND II | Classes: 09 |
|---|---|---|

Bending and Open Thin-Walled Beams: Symmetrical bending, Unsymmetrical bending, Deflections due to bending, Calculation of section properties, Applicability of bending theory, Temperature effects, Shear

of Beams: General stress, strain and displacement relationships for open and single cell closed section thin-walled beams, Shear of open and closed section beams; Torsion of Beams: Torsion of closed and open section beams; Combined Open and Closed Section Beams: Bending, Shear, Torsion.

| UNIT-V | STRESS ANALYSIS OF AIRCRAFT COMPONENTS, SMART MATERIALS AND ADAPTIVE STRUCTURES | Classes: 09 |
|---|---|---|

Wing spars, Fuselages, Wings, Fuselage frames and wing ribs, Laminated composite structures, Smart Materials Technologies and Control Applications: Control requirements, Smart Materials-Piezoelectric elements, Electrostrictive elements, Magentostrictive transducers, Electrorheological fluids, Shape memory alloys, Fiber optic sensors, Applications of smart materials, Adaptive Structures: Adaptive aerospace structures-Structural Health Monitoring (SHM), Shape control and active flow, Damping of vibration and noise, Smart skins, Systems.

**Text Books:**


1. T. H. G. Megson, Butterworth-Heinemann, "Aircraft Structures for Engineering Students", Elsevier Ltd, 4th Edition, 2007.


**Reference Books:**


1. C. T. Sun, "Mechanics of Aircraft Structures", John Wiley & Sons, 2nd Edition, 2006.
2. Robert M. Rivello, "Theory and Analysis of Flight Structures", McGraw-Hill, 1969.
3. Earnest E. Sechler, Lois G. Dunn, "Airplane Structural Analysis and Design", Dover Publications, 1963.
4. J. T. Oden and E. A. Ripperger, "Mechanics of Elastic Structures", McGraw-Hill, 1981.
5. H. T. Banks, R. C. Smith, Y. Wang, "Smart Material Structures: Modeling, Estimation and Control", John Wiley & Sons, 1996.
6. David Wagg, Ian Bond, Paul Weaver and Michael Friswell (editors), "Adaptive Structures: Engineering Applications", John Wiley & Sons, 2007.


**Web References:**

1. http://www.aero.iisc.ernet.in/courses/flight-vehicle-structures-30
2. https://www.scribd.com/doc/28727198/Analysis-and-Design-of-Flight-Vehicle-Structures-by-E-F-Bruhn
3. https://www.scribd.com/document/25688785/Bruhn-Analysis-and-Design-of-Flight-Vehicles-Structures

**E-Text Books:**

1. http://www.grancorporation.com/Bruhn_Errata_2nd_Edition_Draft2.
2. http://www.abebooks.com/9780961523404/Analysis-Design-Flight-Vehicle-Structures-0961523409/plp
3. https://www.esdu.com/cgi-bin/ps.pl?sess=unlicensed_1160716085526ycr&t=col&p=col_bruhn

## APPLICATION OF MATLAB IN AEROSPACE ENGINEERING LABORATORY

**I Semester: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE101 | Core | - | - | 3 | 2 | 30 | 70 | 100 |
| Contact Classes: Nil | Tutorials: Nil | Practical Classes: 45 | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Learn basic MATLAB software and use them to solve structural aerodynamic and flight control system problems.
II. Understand the basics of plotting in MATLAB both in two dimensional and three dimensional.
III. Develop codes for solving structural response problems, aerodynamic simulation problems and flight control system analysis and design.

**LIST OF EXPERIMENTS**

| | |
|---|---|
| **Week-1** | **MATLAB/SIMULINK FUNDAMENTALS FOR AEROSPACE APPLICATIONS** |

MATLAB introduction, Plotting and graphics: Plot, log and semi-log plots, polar plots; Subplots, axis, mesh, contour diagrams, flow diagrams, movies, MATLAB tool boxes: continuous transfer functions, root locus, Nichols chart, Nyquist chart, linear quadratic regulator, state space design, digital design, aerospace toolbox; M cells, structures and M-files, MEX files; Standard simulink libraries, simulink aerospace blockset, Building simulink linear models: transfer function modelling in simulink, zero pole model, state-space model; simulink LTI viewer and usage of it, equivalent simulink LTI models, single input single output design tool, building Multi-input, multi output models, building simulink S-functions; State flow introduction: Opening, executing, and saving state flow models, constructing a simple state flow model, using a state flow truth table.

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| **Week-2** | **THIN WALLED BEAMS** |

Software development for thin walled beams using finite element method.

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| **Week-3** | **PLATE BENDING** |

Software development for Plate bending using finite element method.

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| **Week-4** | **BEAMS ANALYSIS** |

Software development for Beams analysis using finite element method.

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| **Week-5** | **TRUSSES ANALYSIS** |

Software development for Trusses analysis using finite element method.

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| **Week-6** | **THIN SHELLS ANALYSIS** |

Software development for Thin shells analysis using finite element method.

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| **Week-7** | **GENERATION OF STRUCTURES AND UNSTRUCTURED** |

Software development for simulation in generation of structures and unstructured grids in two and three dimensions of fluid flows.

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| **Week-8** | **SOLUTION OF BURGERS EQUATION** |
| Software development for simulation in solution of burgers equation using explicit McCormack method of fluid flows. | |
| **Week-9** | **BLASIUS SOLUTION FOR LAMINAR BOUNDARY LAYER OVER A FLAT PLATE** |
| Software development for simulation in Blasius solution for laminar boundary layer over a flat plate of fluid flows. | |
| **Week-10** | **RIEMANN SOLVER FOR SHOCK TUBE PROBLEM** |
| Software development for simulation in Riemann solver for shock tube problem of fluid flows. | |
| **Week-11** | **SIMULATION OF AIRCRAFT MOTION** |
| Simulation experiment in dynamics and control using MATLAB and simulink to Simulate aircraft motion such as longitudinal dynamics, lateral dynamics. | |
| **Week-12** | **SIMULATION OF AIRCRAFT MOTION WITH ILLUSTRATION OF F-16 MODEL** |
| Six-degrees-of-freedom simulation of aircraft motion with illustration of F-16 model using MATLAB and simulink. | |
| **Week-13** | **SIMULATION OF RE-ENTRY VEHICLE DYNAMICS** |
| Simulation of re-entry vehicle dynamics for ballistic re-entry and maneuvering re-entry. | |
| **Week-14** | **SIMULATION OF NON-LINEAR CONTROL SYSTEM** |
| Simulation of non-linear control system for controlling roll dynamics of a fighter aircraft. | |
| **Week-15** | **SIMULATION OF SATELLITE ATTITUDE DYNAMICS** |
| Simulation of the following relating to satellite attitude dynamics:<br>a. Torque free rotation of axisymmetric and asymmetric spacecraft.<br>b. Attitude maneuvers of spin- stabilized spacecraft. | |

**Reference Books:**


1. Richard Colgren, "Basic MATLAB, Simulink, and State Flow" , AIAA Education Series, 1st Edition, 2007.
2. Steven T. Karris, "Introduction to simulink with engineering application", Orchard Publication, 3rd Edition, 2006.
3. Ashish Tewari, "Atmospheric and space flight dynamics", Birkhauser Publication, 1st Edition, 2007
4. A. Tewari, "Modern control design with MATLAB and simulink", Wiley, 1st Edition, 2002.


**Web References:**

1. http://www.springer.com/us/book/9780817644376
2. https://www.scribd.com/doc/53680598/Modern-Control-Design-With-MATLAB-and-SIMULINK

# FLIGHT DYNAMICS AND CONTROL

**II Semester: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE004 | Core | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | | Total Classes: 45 | | |

**OBJECTIVES:**

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

I. Review basics of stability and control performance of aircraft.
II. Develop governing equation of motions for aircraft.
III. Convert nonlinear equation to a set of linear equation using small perturbation.
IV. Identify different types of instabilities encounter in longitudinal and lateral motion.
V. Evaluate the performance of flight control system for aircraft.

| UNIT-I | INTRODUCTION | Classes: 09 |
|---|---|---|

Basic principles of flight; Flying control surfaces: Elevator, ailerons and rudder; Pilot's controls: The throttle, the control column, modes of flight; Basic principles governing aerodynamic flows: Introduction, continuity principle, Bernoulli's principle, laminar flows and boundary layers, turbulent flows, aerodynamics of airfoils and wings, slender body aerodynamics, wing-body interference, empennage aerodynamics, aerodynamics of complete aircraft, aerodynamic forces and moments.

| UNIT-II | MECHANICS OF EQUILIBRIUM FLIGHT | Classes: 09 |
|---|---|---|

Introduction, speeds of equilibrium flight, basic aircraft performance, conditions for minimum drag, range and endurance estimation, trim, stability of equilibrium flight, longitudinal static stability, maneuverability, lateral stability and stability criteria, experimental determination of aircraft stability margins; Aircraft non-linear dynamics; Equations of motion, introduction, aircraft dynamics, aircraft motion in a two dimensional plane, moments of inertia, Euler's equations and the dynamics of rigid bodies, aircraft equations of motion, motion-induced aerodynamic forces and moments, non-linear dynamics of aircraft motion, trimmed equations of motion.

| UNIT-III | SMALL PERTURBATIONS AND THE LINEARISED, DECOUPLED EQUATIONSOF MOTION | Classes: 09 |
|---|---|---|

Small perturbations and linearization; Linearizing the aerodynamic forces and moments: Stability derivative concept, direct formulation in the stability axis, decoupled equations of motion, decoupled equations of motion in terms of the stability axis aerodynamic derivatives, decoupled equations of motion in terms of the stability axis aerodynamic derivatives.

Non-dimensional longitudinal and lateral dynamics; Simplified state-space equations of longitudinal and lateral dynamics, simplified concise equations of longitudinal and lateral dynamics.

| UNIT-IV | LONGITUDINAL AND LATERAL LINEAR STABILITY AND CONTROL | Classes: 09 |
|---|---|---|
| Dynamic and static stability, modal description of aircraft dynamics and the stability, aircraft lift and drag estimation, estimating the longitudinal aerodynamic derivatives, estimating the lateral aerodynamic derivatives, aircraft dynamic response, numerical simulation and non-linear phenomenon longitudinal and lateral modal equations, methods of computing aircraft dynamic response, system block diagram representation, atmospheric disturbance, deterministic disturbances, principles of random atmospheric disturbance modeling, application to atmospheric turbulence modeling, aircraft non-linear dynamic response phenomenon. | | |
| **UNIT-V** | **AIRCRAFT FLIGHT CONTROL** | **Classes: 09** |
| Automatic flight control systems: An introduction, functions of a flight control system, integrated flight control system, flight control system design. | | |

**Text Books:**

1. Vepa, R., "Flight Dynamics, Simulation and Control: For Rigid and Flexible Aircraft", CRC Press, Taylor and Francis Group, 2015.

**Reference Books:**

1. Wayne Durham, "Aircraft Flight Dynamics and Control"
2. Robert F. Stengel " Flight Dynamics".

**Web References**:

1. http://www.engin.umich.edu/aero/research/areas/controls
2. http://nptel.ac.in/courses/101106043/
3. http://www.princeton.edu/~stengel/MAE331Lectures.html

**E-Text Books**:

1. http://as.wiley.com/WileyCDA/WileyTitle/productCd-1118646819.html
2. http://press.princeton.edu/titles/7909.html
3. http://www.slideshare.net/turnt/aircraft-flight-dynamics-and-control-33771964

# AEROSPACE PROPULSION

**II Semester: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE005 | Core | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | | Total Classes: 45 | | |

**OBJECTIVES:**

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

I. Understand the basic working principles of different types of airbreathing engines.
II. Understand analysis and design principles of IC engines.
III. Analyze and design different components of gas turbine.
IV. Analyze and design different components of solid and liquid propellant rockets.

| UNIT-I | AIR-BREATHING ENGINES | Classes: 09 |
|---|---|---|

Classification, operational envelopes; Description and function of gas generator, turbojet, turbofan, turboprop, turboshaft, ramjet, scramjet, turbojet/ramjet combined cycle engine; Engine thrust, takeoff thrust, installed thrust, thrust equation; Engine performance parameters, specific thrust, specific fuel consumption and specific impulse, thermal efficiency, propulsive efficiency, engine overall efficiency and its impact on aircraft range and endurance; Engine cycle analysis and performance analysis for turbojet, turbojet with afterburner, turbofan engine, turboprop engine.

| UNIT-II | AIRCRAFT ENGINE INLETS, EXHAUST NOZZLES, COMBUSTORS AND AFTERBURNERS | Classes: 09 |
|---|---|---|

Subsonic inlets: Function, design variables, operating conditions, inlet performance, performance parameters; Supersonic inlets: Compression process, types, construction, losses, performance characteristics; Exhaust nozzles: primary nozzle, fan nozzle, converging nozzle, converging-diverging nozzle, variable nozzle, and performance maps, thrust reversers and thrust vectoring, Combustors and Afterburners: Geometries, flame stability, ignition and engine starting, adiabatic flame temperature, pressure losses, performance maps, fuel types and properties.

| UNIT-III | AXIAL FLOW COMPRESSORS AND TURBINES | Classes: 09 |
|---|---|---|

Axial flow Compressors: Geometry, definition of flow angles, stage parameters, cascade aerodynamics, aerodynamic forces on compressor blades, rotor and stator frames of reference, compressor performance maps, velocity polygons or triangles, single stage energy analysis, compressor instability, stall and surge.

Axial Flow Turbines: Geometry, configuration, comparison with axial flow compressors, velocity polygons or triangles, single stage energy analysis, performance maps, thermal limits of blades and vanes, blade cooling, blade and vane materials, blade and vane manufacture.

| UNIT-IV | SOLID-PROPELLANT ROCKET MOTORS | Classes: 09 |
|---|---|---|
| Background description: Classification of rocket propulsion systems; Performance of an ideal rocket, rocket thrust equation, total and specific impulse, effective exhaust velocity, rocket efficiencies, characteristic velocity, thrust coefficient; Description of solid propellant rocket motor, solid propellant grain configurations, homogeneous propellant, heterogeneous or composite propellant, different grain cross sections, propellant burning rate, combustion of solid propellants, physical and chemical processes, ignition process, combustion instability; Hybrid propellant rockets: Hybrid rocket operation and hybrid rocket characteristics. | | |
| **UNIT-V** | **LIQUID PROPELLANT ROCKET ENGINES: PROPELLANT TYPES** | **Classes: 09** |
| Bipropellant, monopropellant, cold gas propellant, cryogenic propellant, storable propellants, gelled propellant; Propellant Storage,different propellant tank arrangements, propellant feed system-pressure feed, turbopump feed; Thrust chambers, injectors, combustion chamber, nozzle, starting and ignition, variable thrust; Combustion of liquid propellants: Combustion process, combustion instability, thrust vector control. | | |

**Text Books:**

1. Ronald D. Flack, "Fundamentals of Jet Propulsion with Applications", Cambridge University Press, Edition, 2011.
2. George P. Sutton, Oscar Biblarz, "Rocket Propulsion Elements", Wiley India Pvt. Ltd, 7$^{th}$Edition, 2010.

**Reference Books:**

1. Jack D. Mattingly, "Elements of Propulsion: Gas Turbines and Rockets", AIAA Education Series, Edition, 2006.
2. Saeed Farokhi, "Aircraft Propulsion", Wiley, 2$^{nd}$Edition, 2014.
3. David R. Greatrix, "Powered Flight: The Engineering of Aerospace Propulsion", Springer, Edition , 2012

**Web References:**

1. http://www.aero.iisc.ernet.in/page/propulsion
2. https://afreserve.com/aerospace-propulsion
3. http://ocw.mit.edu/courses/aeronautics-and-astronautics/16-50-introduction-to-propulsion-systems-spring-2012/Syllabus/

**E-Text Books:**

1. http://as.wiley.com/WileyCDA/WileyTitle/productCd-1118307984.html
2. http://www.freeengineeringbooks.com/AeroSpace/Propulsion-Books.php
3. http://www.springer.com/us/book/9781447124849?token=prtst0416p

# AIRPORT PLANNING AND OPERATION

**II Semester: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE006 | Core | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Understand complexity and functioning of airport operation systems.
II. Understand many operational issues involved in handling passengers, freight and aircraft at airports.

| UNIT- I | THE AIRPORT AS AN OPERATIONAL SYSTEM | Classes: 08 |
|---|---|---|

The airport as a system; National airport systems; The function of the Airport; Centralized and decentralized passenger terminal systems; The complexity of the airport operation; Management and operational structures; Airport influences on aircraft performance characteristics: Aircraft departure performance; Approach and landing performance; Safety considerations; Automatic landing; Operations in inclement weather; Specific implications of the Airbus A380; Operational Readiness: Aerodrome certification; Operating constraints; Operational areas; Airfield INspections; Maintaining readiness.

| UNIT-II | GROUND HANDLING AND BAGGAGE HANDLING | Classes: 10 |
|---|---|---|

Ground handling: Passenger handling; Ramp handling; Aircraft ramp servicing; Ramp layout; Departure control; Division of ground handling responsibilities; Control of ground handling efficiency; Baggage handling: Context, history and trends; Baggage handling processes; Equipment, systems and technologies, process and system design drivers; Organization; Management and performance metrics.

| UNIT-III | PASSENGER TERMINAL AND CARGO OPERATIONS | Classes: 10 |
|---|---|---|

Passenger terminal operations: Functions of the passenger terminal; Terminal functions; Philosophies of terminal management; Direct passenger services; Airline related passenger services; Airline related operational functions; Government requirements; Non-passenger related airport authority functions; processing very important persons; Passenger information systems; Space components and adjacencies.

Aids to circulation; Hubbind considerations; Cargo operations: The cargo market; Expediting the movement; Flow through the terminal; Unit load devices; Handling within the terminal; Cargo apron operation; Facilitation; Examples of modern cargo terminal design and operation; Cargo operations by the integrated carriers.

| UNIT-IV | AIRPORT TECHNICAL SERVICES AND ACCESS | Classes: 09 |
|---|---|---|

Airport technical services: The scope of technical services; Safety management system; Air traffic control; Tele communications; Meteorology; Aeronautical information; Airport access: Access as part of the airport system; access users and modal choice; access interaction with passenger; access modes; In town and other off; airport terminals; Factors affecting access; mode choice.

| UNIT-V | OPERATIONAL ADMINISTRATION AND PERFORMANCE | Classes: 08 |
|---|---|---|

Operational administration and performance: Strategic context; Tactical approach to administration of airport operations; Managing operational performance; Key success factors for high; performance; airport operations control centers: The concept of airport operations; airport operations control system; the airport operations consideration; airport performance monitoring; design and equipment considerations; organizational and human resources considerations; leading AOCCSs; best practices in airport operations.

**Text Books :**

1. Norman J. Ashford, H. P. Martin Stanton, Clifton A. Moore, Pierre Coutu, "Airport Operations", McGraw Hill, 3rd Edition, 2013.
2. R. Horonjeff, F. X. McKelvey, W. J. Sproule, S. B. Young, "Planning and Design of Airports", McGraw Hill, 5th Edition, 2010.

**Reference Books:**

1. A. Kazda, R. E. Caves, "Airport Design and Operation", Elsevier, 2nd Edition, 2007.
2. A. T. Wells, S. B. Young, "Airport Planning and Management", McGraw Hill, 6th Edition, 2011.

**Web References:**

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

**E-Text Books:**

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

## CFD/CSA SIMULATIONS USING ANSYS/NASTRAN LABORATORY

**II Semester: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE102 | Core | - | - | 3 | 2 | 30 | 70 | 100 |
| Contact Classes: Nil | Tutorial Classes: Nil | Practical Classes: 36 | | | Total Classes: 36 | | | |

**OBJECTIVES:**

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

I. Identify the strength of ANSYS and NASTRAN software for the solution of fluid mechanics and structural mechanics problems.
II. Describe steps necessary to solve a particular problem.
III. Solve practical problems.
IV. Interpet the results obtain from ANSYS and NASTRAN software.

### LIST OF EXPERIMENTS

| | |
|---|---|
| **Week-1** | **AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-I** |
| Structural analysis of aircraft wing | |
| **Week-2** | **AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-II** |
| Structural analysis of aircraft wing (composite material) | |
| **Week-3** | **AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-III** |
| Analysis of fuselage | |
| **Week-4** | **AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-IV** |
| Rocket motor case analysis | |
| **Week-5** | **AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-V** |
| Structural and thermal analysis of rocket nozzles | |
| **Week-6** | **AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-VI** |
| Fractural mechanics of crack propagation | |
| **Week-7** | **AEROSPACE STRUCTURAL ANALYSIS USING NASTRA-I** |
| Structural analysis of aircraft wing | |
| **Week-8** | **AEROSPACE STRUCTURAL ANALYSIS USING NASTRA-II** |
| Structural analysis of aircraft wing (composite material) | |

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|---|---|
| **Week-9** | **AEROSPACE STRUCTURAL ANALYSIS USING NASTRA-III** |
| Analysis of fuselage | |
| **Week-10** | **AEROSPACE STRUCTURAL ANALYSIS USING NASTRA-IV** |
| Rocket motor case analysis | |
| **Week-11** | **AEROSPACE STRUCTURAL ANALYSIS USING NASTRA-V** |
| a) Structural and thermal analysis of rocket nozzles<br>b) Fractural mechanics of crack propagation | |
| **Week-12** | **FLOW SIMULATION USING ANSYS/FLUENT** |
| Simulation of flow past airfoils and wings | |

**Reference Books:**


1. Engineering analysis with ANSYS software, Y. Nakasone, S.Yoshimoto, T.A. Stolarski, Elsevier Publication, 2006.
2. MSC Nastran 2014.1 Quick Reference Guide, Jun. 2015.
3. Computational Fluid Mechanics And Heat Transfer, Second Edition, John C.Tannehill, DaleA.Anderson, Richard H.Pletcher, Taylor & Francis Publication, 1997.
4. Computational Fluid Dynamics T.J.Chug, Cambridge University Press, 2002.


**Web References:**

1. http://resource.ansys.com/staticassets/ANSYS/staticassets/resourcelibrary/article/AA-V4-I1-Teaching-Simulation-to-Future-Engineers.pdf
2. http://www.autodesk.in/products/simulation/overview
3. http://www.serc.iisc.in/facilities/ansys-13-0-cfd/

# FATIGUE AND FRACTURE MECHANICS

**Group I: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE201 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Give an understanding of phenomena and theories.
II. Provide an orientation on classical and modern methods and design criteria.
III. Teach basic numerical methods of design.
IV. Serve as an introduction for possible further studies.
V. Give a brief introduction to current research trends in the area.

| UNIT-I | FATIGUE OF STRUCTURES | Classes: 08 |
|---|---|---|

S.N. curves, Endurance limit, 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 | STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR | Classes: 10 |
|---|---|---|

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, other theories.

| UNIT-III | PHYSICAL ASPECTS OF FATIGUE | Classes: 10 |
|---|---|---|

Phase in fatigue life, Crack initiation, Crack growth, Final fracture,.
Dislocations, Fatigue fracture surfaces.

| UNIT-IV | FRACTURE MECHANICS | Classes: 09 |
|---|---|---|

Strength of cracked bodies, potential energy and surface energy, Griffith's theory, Irwin, Orwin extension of Griffith's theory to ductile materials, Stress analysis of cracked bodies, Effect of thickness on fracture toughness, Stress intensity factors for typical geometries.

| UNIT-V | FATIGUE DESIGN AND TESTING | Classes: 08 |
|---|---|---|

Safe life and fail safe design philosophies, Importance of Fracture Mechanics in aerospace structure, Application to composite materials and structures.

**Text Books :**

1. D. Brock, "Elementary Engineering Fracture Mechanics", Noordhoff International Publishing Co., London, 1994.
2. J. F. Knott, "Fundamentals of Fracture Mechanics", Butterworth & Co., (Publishers) Ltd., London, 1983.

**Reference Books:**

1. W. Barrois and L. Ripley, "Fatigue of Aircraft Structures", SPergamon Press, Oxford, 1983.
2. C. G. Sih, "Mechanics of Fracture", Vol.1 Sijthoff and Noordhoff International Publishing Co., Netherland, 1989.
3. S.T. Rolfe and J.M. Barsom , "Fracture and Fatigue Control in Structure" .

**Web References:**

1. http://ocw.mit.edu/courses/materials-science-and-engineering/3-35-fracture-and-fatigue-fall-2003.
2. http://www.eng.ox.ac.uk/solidmech/research/fatigue-fracture-mechanics.
3. http://www.fatiguefracture.com

**E-Text Books:**

1. https://books.google.co.in/books/about/Fatigue_and_Fracture.html?id=rE5K9zBrprAC&redir_esc=y
2. http://www.springer.com/us/book/9789024725809
3. https://www.scribd.com/doc/111356174/D-Broek-Elementary-Engineering-Fracture-MechanicsV

## DESIGN ANALYSIS OF COMPOSITE STRUCTURES

**Group I: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE202 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Develop advance research and development projects on composite materials and its fabrication.
II. Classify the composite materials based on matrix and fibres.
III. Understand the methods for analysis the composite materials

| UNIT-I | PROPERTIES OF CONSTITUENT MATERIALS & COMPOSITE LAMINATES | Classes: 09 |
|---|---|---|

Introduction to laminated composite plates- mechanical properties of constituent materials such as matrices and filaments of different types. Netting analysis of composite materials, determination of properties of laminates with fibers and matrices.

| UNIT-II | ELASTIC PROPERTIES | Classes: 09 |
|---|---|---|

Stress-strain relations of isotropic, orthotropic and anisotropic materials, transformation of material properties for arbitrary orientation of fibers.

| UNIT-III | METHODS OF ANALYSIS- I & METHODS OF ANALYSIS- II | Classes: 09 |
|---|---|---|

Mechanics of materials approach to determine Young's modulus, shear modulus and Poisson's ratio. Brief mention of elasticity approach and macro mechanics of laminates.

Anisotropic elasticity, stress –strain relations in material coordinates - Transformation of geometric axes, strength concepts, biaxial strength theories, maximum stress and maximum strain.

| UNIT-IV | ANALYSIS OF LAMINATED BEAMS AND PLATES | Classes: 09 |
|---|---|---|

Classical plate theory, Classical lamination theory – Special cases of single layer, symmetric, antisymmetric & unsymmetric composites with cross ply, angle ply layup. Deflection analysis of laminated plates, Analysis of laminated beams and plates.

| UNIT-V | SHEAR DEFORMATION ANALYSIS & BUCKLING ANALYSIS | Classes: 09 |
|---|---|---|

Shear deformation theories for composite laminated beams, plates- first, second and third order theories. nth order theory.
Buckling analysis of laminated composite plates with different orientation of fibers, Tsai-wu criteria and Tsai – Hill Criteria

**Text Books:**

1. Agarwal.B.D, Broutman.L.J, "Analysis and Performance of Fibre Composites", John Wiley and sons, New York, 1980.
2. Lubin.G, Von. Nostrand, "Advanced Plastics and Fibre Glass", Reinhold Co. Newyork,1989.

**Reference Books:**

1. Gupta.L, Advanced Composite Materials, Himalayan Books, NewDelhi, 1998.
2. Jones.R.M, Mechanics of Composite Materials, McGraw Hill Kogakusha ltd. Tokyo.
3. Reddy. J.N, Mechanics of Composite Materials,

**Web References:**

1. http://onlinelibrary.wiley.com/book.
2. https://www.asme.org/products/courses/design-analysis-fabrication-composite-structures.
3. http://as.wiley.com/WileyCDA/WileyTitle/productCd-1118401603.html

**E-Text Books:**

1. https://www.bookshout.com/ebooks/design-and-analysis-of-composite-structures
2. https://www.overdrive.com/media/1303069/design-and-analysis-of-composite-structures
3. http://www.lehmanns.de/technik/25035754-9781119957065-design-and-analysis-of-composite-structures

# AEROELASTICITY

**Group I: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE203 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | | Total Classes: 45 | | |

**OBJECTIVES:**

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

I. Outline importance of aeroelasticity in flight vehicle design and classify static and dynamic aeroelastic problems.
II. Describe structural dynamic and steady and unsteady aerodynamics aspects of airframe and its components and their role in aeroelasticity.
III. Construct theoretical basis for the solution of static aeroelastic problems an estimate loads and other critical speeds.
IV. Construct theoretical basis for the solution of flutter problems and estimate of flutter speeds.

| UNIT-I | AEROELASTIC PHENOMENA | Classes: 08 |
|---|---|---|

Stability versus response problems; The aeroelastic triangle of forces; Aeroelasticity in Aircraft Design; Prevention of aero elastic instabilities. Influence and stiffness coefficients. Coupled oscillations.

| UNIT-II | DIVERGENCE OF A LIFTING SURFACE | Classes: 10 |
|---|---|---|

Simple two dimensional idealizations; Strip theory, Integral equation of the second kindExact solutions for simple rectangular wings, 'Semirigid' assumption and approximate solutions; Generalised coordinates, successive approximations, numerical approximations using matrix equations.

| UNIT-III | STEADY STATE AEROLASTIC PROBLEMS | Classes: 08 |
|---|---|---|

Loss and reversal of aileron control, critical aileron reversal speed, aileron efficiency, semi rigid theory and successive approximations, lift distribution, rigid and elastic wings.

Tail efficiency, effect of elastic deformation on static longitudinal stability.

| UNIT-IV | FLUTTER PHENOMENON | Classes: 10 |
|---|---|---|

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

| UNIT-V | EXAMPLES OF AEROELASTIC PROBLEMS | Classes: 09 |
|---|---|---|
| Galloping of transmission lines and Flow induced vibrations of transmission lines, tall slender structures and suspension bridges. | | |

**Text Books:**

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

**Reference Books:**

1. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, "Aeroelasticity", 2nd Edition Addison Wesley Publishing Co., Inc., 1996.
2. R.H. Scanlan and R. Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.
3. R. D. Blevins, "Flow Induced Vibrations", Krieger Pub Co., 2001

**Web References:**

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

**E-Text Books:**

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

## UNMANNED AIR VEHICLES

**Group I: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE204 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES :**

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

I. Acquire the knowledge of various disciplines contributing to the design, development and deployment of UAVs.
II. Explain the design of UAV systems and their configuration.
III. Develop and deploy the UAV systems.

| UNIT-I | INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS | Classes: 10 |
|---|---|---|

Applications of UAS, categories of UAV systems, roles of unmanned aircraft, composition of UAV system.

| UNIT-II | DESIGN OF UAV SYSTEMS-I | Classes: 08 |
|---|---|---|

Introduction to design and selection of the systems-conceptual phase, preliminary design, detailed design; Aerodynamics and airframe configurations-Lift-induced Drag, Parasitic Drag, Rotary-wing Aerodynamics, Response to Air Turbulence, Airframe Configurations; Medium-range, Tactical Aircraft, Characteristics of Aircraft Types-Long-endurance, Long-range Role Aircraft, Medium-range, Tactical Aircraft, Close-range/Battlefield Aircraft, MUAV Types, MAV and NAV Types, UCAV, Novel Hybrid Aircraft Configurations, Aspects of Airframe Design: Scale Effects, Packaging Density, Aerodynamics, Structures and Mechanisms, Selection of power- plants, Modular Construction, Ancillary Equipment, Design for Stealth: Acoustic Signature, Visual Signature, Thermal Signature, Radio/Radar Signature, Payload Types: Non-dispensable and dispensable payloads.

| UNIT-III | DESIGN OF UAV SYSTEMS-II | Classes: 09 |
|---|---|---|

Communications-Communication Media, Radio Communication, Mid-air Collision (MAC) Avoidance, Communications Data Rate and Bandwidth Usage, Antenna Type; Control and Stability: HTOL Aircraft, Convertible Rotor Aircraft, Payload Control, Sensors, Autonomy; Navigation: NAVSTAR Global Positioning System (GPS), TACAN, LORAN C, Inertial Navigation, Radio Tracking, Way-point Navigation; Launch and Recovery.

Design for Reliability: Determination of the Required Level of Reliability, Achieving Reliability, Reliability Data Presentation, Multiplexed Systems, Reliability by Design, Design for Ease of Maintenance; Design for Manufacture and Development

| UNIT-IV | THE DEVELOPMENT OF UAV SYSTEMS: | Classes: 10 |
|---|---|---|
| System Development and Certification-System Development, Certification, Establishing Reliability; System Ground Testing: UAV Component Testing, UAV Sub- assembly and Sub-system Testing, Testing Complete UAV, Control Station Testing , Catapult Launch System Tests, Documentation; System In-flight Testing: Test Sites, Preparation for In-flight Testing, In- flight Testing, System Certification. | | |
| **UNIT-V** | **DEPLOYMENT AND FUTURE OF UAV SYSTEMS:** | **Classes: 08** |
| Operational trials and full certification; UAV System Deployment- Network-centric Operations (NCO), Teaming with Manned and Other Unmanned System; Naval, arm and air force roles, civilian, paramilitary and commercial roles | | |

**Text Books:**

1. Reg Austin, Wiley, "Unmanned Aircraft Systems , UAVS Design and Deployment" , 2nd Edition, 2010.

**Reference Books:**

1. Richard K. Barnhart, Stephen B. Hottman, Douglas M. Marshall, Eric Shappee, (eds.), "Introduction to Unmanned Aircraft Systems" , CRC Press, 2012.
2. Valavanis, Kimon P., Vachtsevanos, George J. "Handbook of Unmanned Aerial Vehicles" AIAA series, 3rd Edition, 2004.

**Web References:**

1. http://www.tndte.com
2. http://www.scribd.com
3. http://www.sbtebihar.gov.in
4. http://www.ritchennai.org

**E-Text Books:**

1. Corrosion.ksc.nasa.gov/electrochem_cells.htm
2. http://www.science.uwaterloo.ca/~cchieh/cact/applychem/watertreatment.html
3. http://www.acs.org/content/acs/en/careers/college-to-career/areas-of-chemistry/polymer-chemistry.html

# GROUND VEHICLE AERODYNAMICS

**Group II: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE205 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Understand the basics of vehicle aerodynamics
II. Invent methods for the reduction of drag and fuel consumption
III. Evaluate methods for the improvement of operational characteristics such as stability, safety, handling characteristics.
IV. Identify the improvement of comfort characteristics such as noise generation, mud deposition.

| UNIT-I | OVERVIEW AND INTRODUCTION | Classes: 08 |
|---|---|---|

Historical developments and trends, fundamentals of fluid mechanics, flow phenomenon related to vehicles, external and internal flow problem, resistance to vehicle motion, Mechanics of air flow around a vehicle, pressure distribution, Aerodynamic forces, Vehicle drag and types, side and lift forces, cars as a bluff body, flow field around car, performance potential of vehicle aerodynamics.

| UNIT-II | AERODYNAMIC DRAG AND SHAPE OPTMIZATION OF CARS | Classes: 10 |
|---|---|---|

Cars as a bluff body, flow field around a car, analysis of aerodynamic drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles; Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back, dust flow patterns at the rear. Effect of rear configuration, effect of fasteners.

| UNIT-III | VEHICLE HANDLING AND STABILITY | Classes: 10 |
|---|---|---|

Origin, characteristics and effects of forces and moments on a vehicle, lateral stability problems, vehicle dynamics under side winds-dirt accumulation on the vehicle, wind noise.

Mechanisms and generation design features, measurement and techniques.

| UNIT-IV | RACE CAR AERODYNAMICS | Classes: 09 |
|---|---|---|

Basic vehicle body concepts, aerodynamics of the complete vehicle, flow over wheels, sliding seal and skirts, under body channels, simple add ons: spoilers, strakes and wickers, internal flow, Race car wings, most current examples in detail- design, aerodynamic behaviour and flow field.

| UNIT-V | MEASUREMENT AND TEST TECHNIQUES | Classes: 08 |
|---|---|---|

Wind tunnel, scope, fundamental techniques, simulation limitations, prototype tests, wind tunnel types and testing methods; Test techniques- scope, measuring equipment and transducers, road testing methods.

**Text Books :**


1. Wolf Heinrich Hucho, "Aerodynamics of Road vehicles", SAE International, 1998.
2. A. Pope, "Wind Tunnel Testing" John Wiley & sons, New York, 2nd Edition, 1974.


**Reference Books:**


1. Mark Drela, "Flight Vehicle Aerodynamics", MIT Press, 1st Edition, 2014.
2. Joseph Katz, "Race Car Aerodynamics Designing for Speed", Bentley Publishers, 1995.


**Web References:**

1. http://www.yanfabu.com/resources/edituploa d/files/2013112216461820.pdf
2. http://www.ara.bme.hu/oktatas/letolt/Vehicleaerodyn/Vehicleaerodyn.pdf
3. http://kth.diva-portal.org/smash/get/diva2:461388/FULLTEXT01.pdf

**E-Text Books:**

1. http://store.elsevier.com/Aerodynamics-of-Road-Vehicles/isbn-9781483102078/
2. http://samples.sainsburysebooks.co.uk/9781483102078_sample_760841.pdf
3. http://www.sciencedirect.com/science/book/9780750612678
4. http://www.abebooks.com/Low-Speed-Wind-Tunnel-Testing-2nd-edition/9297496646/bd

# WIND ENGINEERING

**Group II: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE206 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Stimulate research efforts in wind engineering to build a knowledge base for wind hazard mitigation.
II. Prioritize leading-edge research in wind engineering.
III. Develop and execute plans for learning from future windstorms and hurricanes by gathering post-disaster data and analyzing and disseminating information.

| UNIT-I | ATMOSPHERIC WINDS & ATMOSPHERIC BOUNDARY LAYER | Classes: 08 |
|---|---|---|

Causes of wind- thermal drive, Coriolis effect, pressure gradient effect; Geotrophic winds; Land and sea breeze, mountain winds, thermals, cause of turbulence at ground level; Atmospheric boundary layer, velocity profile laws- effect of terrain on atmospheric boundary layer; Wind tunnels: Basic features and components; Wind tunnel models: Role of non-dimensional groups; Creation of atmospheric boundary layer type flow in a wind tunnel.

| UNIT-II | WIND ENERGY- I & WIND ENERGY- II | Classes: 10 |
|---|---|---|

Ship propulsion- sails- lift and drag translators- modern yachts; Horizontal and vertical axis wind turbines- history, classification; Power coefficient, torque coefficient- elementary actuator disc theory- Betz coefficient; Working principle and power coefficients of conventional horizontal axis wind turbines, avonious vertical axis wind turbines, Darrieus vertical axis wind turbines; Introduction to blade element theory.

| UNIT-III | VEHICLE AERODYNAMICS & BUILDING AERODYNAMICS | Classes: 10 |
|---|---|---|

Power requirements and drag coefficients of automobiles- causes of vortex formation and drag- effects of cut back angle- racing cars, commercial transport vehicles- buses, trucks, driver cabin and trailer combinations;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; Interference effect of building.

| UNIT-IV | FLOW INDUCED VIBRATIONS | Classes: 09 |
|---|---|---|

Effects of Reynolds number on wake formation of bluff shapes; Vortex induced vibrations, galloping of transmission lines and stall flutter.

| UNIT-V | DESIGN OF CHIMNEY | Classes: 08 |
|---|---|---|
| Height of chimney for various gas effluents, Effective height of chimney, flume rise, Different types of flume rise for various climatic conditions. | | |

**Text Books :**

1. R. D. Blevins, "Flow Induced Vibrations", Van Nostard, 1990.
2. N. G. Calvert, "Wind Power Principles", Charles Griffin & Co., London, 1979.

**Reference Books:**

1. R. S. Scorer, "Environmental Aerodynamics", Ellis Harwood Ltd, England, 1978.
2. M. Sovran, "Aerodynamics Drag Mechanisms of Bluff Bodies and Road Vehicles", Plenum Press, 1978.
3. P. Sachs, "Wind Forces in Engineering", Pergamon Press, 1988.

**Web References:**

1. https://www.scribd.com/doc/42602999/Flow-Induced-Vibration-by-Robert-D-Blevins-2nd-Ed
2. https://books.google.co.in/books?isbn=1846284937
3. https://books.google.co.in/books?isbn=047059365

**E-Text Books:**

1. https://books.google.co.in/books?id=355RAAAAMAAJ&source=gbs_navlinks_s&redir_esc=y
2. http://www.abebooks.co.uk/book-search/title/windpower-principles-their-application-on-the-small-scale/author/calvert-n-g/
3. https://books.google.co.in/books?isbn=0080559131

# EXPERIMENTAL AERODYAMICS

**Group II: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE207 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | | Practical Classes: Nil | | | Total Classes: 45 | | |

**OBJECTIVES:**

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

I. Identify different components of wind tunnel and their function.
II. Estimate pressure distribution on airfoil, sphere, cylinder other aerodynamic surfaces and bluff body.
III. Perform experiment to measure forces on a model force balance.
IV. Perform experiment to determine boundary layer.
V. Determine flow visualization techniques.

| UNIT-I | AERODYNAMIC EXPERIMENTS- HISTORY, MODEL TESTNG AND WIND TUNNELS- TYPES, APPLICATION | Classes: 08 |
|---|---|---|

Forms of aerodynamic experiments: observation, measurement, objectives, history, means; Model testing- wind tunnel, principles, scaling laws, scale parameters, significance; Wind tunnels, low speed types, description; High speed tunnels, transonic, supersonic, hypersonic, shock tubes, special tunnels, low turbulence, high Re, environmental, automobile, function, distinctive features, application; Major wind tunnel facilities- description, details.

| UNIT-II | LOW SPEED WIND TUNNELS- CONSTRUCTION, COMPONENTS, PERFORMANCE & WIND TUNNEL CORRECTIONS | Classes: 10 |
|---|---|---|

Low speed wind tunnel, principal components, working section, diffuser, corners, turning vanes, fan, straighteners, honeycombs, screens, contraction cone, fan, motor- function, description, design requirements, constraints, construction, performance- loss coefficients; Wind tunnel performance, flow quality, power losses; Wind tunnel corrections; Sources of inaccuracies, buoyancy, solid blockage, wake blockage, streamline curvature- causes, estimation, and correction; Total correction on airspeed, dynamic pressure, zero lift drag.

| UNIT-III | LOAD MEASUREMENTS- WIND TUNNEL BALANCES AND FLOW MEASUREMENTS- INSTRUMENTATION | Classes: 10 |
|---|---|---|

Load measurements, wind tunnel balances, types, description, application; Steady and unsteady pressure measurements and various types of pressure probes and transducers, errors in pressure measurements.

Measurement of temperature using thermocouples, resistance thermometers, temperature sensitive paints and liquid crystals; Measurement of airspeed, flow direction, boundary layer profile using Pitot static tubes, 5 hole probes, total head rake- function, working principle, types, details of design and construction, use.

| UNIT-IV | FLOW VISUALISATION TECHNIQUES | Classes: 09 |
|---|---|---|
| Flow visualisation, need, types, tufts, china clay, oil film, smoke, working principle, description, setting up, operation, observation, recording, interpretation of imagery, relative merits, applications; High speed flows, optical methods, shadow graphy, Schleiren, interferometry. | | |
| **UNIT-V** | **MEASUREMENT OF VELOCITY- HOTWIRE ANEMOMETRY, LASER DOPPLER ANEMOMETRY, PARTICLE IMAGE VELOCIMETRY- OVERVIEW** | **Classes: 08** |
| Hot wire anemometry, laser Doppler anemometry, particle image velocimetry, working principles, description of equipment, experimental setup, settings, calibration, measurement, data processing , applications. | | |

**Text Books :**

1. Low Speed Wind Tunnel Testing, Barlow, J.B., Rae, W.H., Pope, A., Wiley 1999.
2. High Speed Wind Tunnel Testing, Pope, A. and Goin, K.L., Wiley, 1965.
3. Yang, W.J., Handbook of Flow Visualization, 2nd edition, Taylor and Francis, 2001.

**Reference Books:**

1. Bradshaw, P., Experimental Fluid Mechanics, Pergamon Press, 1970.
2. Goldstein, R.J., (Ed.) Fluid Mechanics Measurements, Taylor Francis, Washington 1996. 84.
3. Tropea, C., Yarin, A. L., Foss, J. F., Handbook of Experimental Fluid Mechanics, Springer, 2007.

**Web References:**

1. www.mace.manchester.ac.uk/our-research/research-themes/.../aerodynamics/
2. ocw.metu.edu.tr/pluginfile.php/1876/mod_resource/.../0/.../AE547_1_Outline1.pdf
3. https://www.coursehero.com/file/13548586/AE547-1-Outline1pdf/

**E-Text Books:**

1. https://books.google.co.in/books?isbn=0471694029
2. https://books.google.co.in/books?id=VxchAAAAMAAJ
3. http://as.wiley.com/WileyCDA/WileyTitle/productCd-0471557749.html
4. http://www.gbv.de/dms/ilmenau/toc/318379147.PDF

# MISSILE AERODYNAMICS

**Group II: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE208 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Explain the aerodynamic characteristics in missile.
II. Discuss the lateral and directional stability, control and maneuvering flight.
III. Understand the aerodynamic loads in missile.

| | | |
|---|---|---|
| **UNIT-I** | **INTRODUCTION** | **Classes: 08** |

Theory of bodies of revolution; Lift and moment of slender bodies of revolution; Planar W-B interference; Classes of missiles, types of design and control; Wing, canard, tail, tailless control; Dorsal, jet control, monowing, triform, and cruciform.

| | | |
|---|---|---|
| **UNIT-II** | **AERODYNAMIC CHARACTERISTICS OF AIRFRAME COMPONENTS & MISSILE PERFORMANCE** | **Classes: 10** |

Forebody: Conical, Ogival, hemi-spherical, etc.; Midsection: Boat-tail; Characteristics of bodies of revolution; Aerodynamics of airfoil, aspect-ratio, wing plan form; Aerodynamic control: Wing, canard and tail; Missile performance: Introduction; Drag: Friction, pressure, interference, induced and boat tail drag; Boost glide trajectory: graphical and iterative method; Long range cruise trajectory; Maximum speed, rate of climb, time to climb, stall speed, maximum range; Long range ballistic trajectory: powered and unpowered flight and design consideration.

| | | |
|---|---|---|
| **UNIT-III** | **LONGITUDINAL STABILITY AND CONTROL, MANEUVERING FLIGHT** | **Classes: 10** |

Introduction, two-degree of freedom analysis, complete missile aerodynamics: static stability margin, load factor capability for forward control and rear control.

Flat turn: Cruciform, triform, pull-ups; Relation between maneuverability and load factor; Stability margin.

| | | |
|---|---|---|
| **UNIT-IV** | **DIRECTIONAL & LATERAL STABILITY AND CONTROL** | **Classes: 09** |

Introduction; Cruciform configuration: wing, body and tail contribution; Directional control; Introduction to lateral stability and control; Induced roll: Cruciform, lateral control cruciform, special design consideration, damping in roll, induced roll, mono wing, lateral control, mono wing.

| | | |
|---|---|---|
| **UNIT-V** | **AIR LOADS: DESIGN CRITERIA** | **Classes: 08** |

Forward control; Rear control; Component air loads: Body, aerodynamic surfaces; Component load distribution: Body and lifting surfaces; Aerodynamic hinge moments and aerodynamic heating.

**Text Books :**

1. S. S. Chin, “Missile Configuration Design”, McGraw Hill, 196.
2. Jack N. Neilson, “Missile Aerodynamics”, McGraw Hill, 1960.

**Reference Books:**

3. M. J. Hemsch, J. N. Nielsen, “Tactical Missile Aerodynamics”, AIAA, 2006.
4. J. H. Blacklock, “Automatic Control of Aircraft and Missiles”, John Wiley & Sons, 2nd Edition, 1991.

**Web References:**

1. http://techdigest.jhuapl.edu/views/pdfs/V04_N3_1983/V4_N3_1983_Cronvich.pdf
2. http://www.dtic.mil/dtic/tr/fulltext/u2/a217480.pdf
3. http://ntrs.nasa.gov/archive/nasa/casi; ntrs.nasa.gov/19880020389; pdf

**E-Text Books:**

1. http://www.abebooks.com/Missile-Configuration-Design-CHIN-S-S/9847235911/bd
2. https://aerocastle.files.wordpress.com/2012/04/missile_configuration_desig.pdf
3. http://www.worldcat.org/title/missile-configuration-design/oclc/602683910
4. https://www.waterstonesmarketplace.com/Missile-aerodynamics-Jack-Norman-Nielsen/book/4396415

# THEORY OF COMBUSTION

**Group III: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE209 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Understand the concepts in combustion theory.
II. Familiarize in the area of combustion in various engines.
III. Calculate the combustion efficiency.
IV. Determine the supersonic combustion.

| | | |
|---|---|---|
| **UNIT-I** | **BASICS OF COMBUSTION THEORY** | **Classes: 08** |

Combustion stochiometry and thermo chemical calculation, chemical kinetics and equilibrium, transport phenomena, theory of viscosity, conductivity and diffusivity.

| | | |
|---|---|---|
| **UNIT-II** | **PRE-MIXED FLAMES** | **Classes: 10** |

Description of premixed flames, burning velocity and parametric dependences, experimental methods of measuring burning velocity, simple one-dimensional thermal theory of flame, concepts of minimum ignition energy, quenching distance, stability limits and flame stabilization; Turbulent premixed flame.

| | | |
|---|---|---|
| **UNIT-III** | **DIFFUSION FLAME** | **Classes: 10** |

Jet flame physical description, theoretical analysis-Burke-Schumann's analysis, mechanism of soot formation, difference between premixed and diffusion flames, liquid fuel combustion, difference between premixed and diffusion flames.

Liquid fuel combustion, difference between premixed and diffusion flames, liquid fuel combustion-conservation equations, calculation of mass burning rate, droplet burning time, droplet combustion in convective environment.

| | | |
|---|---|---|
| **UNIT-IV** | **COMBUSTION IN RECIPROCATING AND GAS- TURBINE ENGINES** | **Classes: 09** |

Description of the combustion process in piston engines, Combustion efficiency and factors affecting it, Rankine-Hugoniot curves, deflagration and detonation in reciprocating engines and preventive methods; Description of different types of combustion chambers in gas-turbine engines, primary requirements of the combustor, flow structure, recirculation and flame stabilization in main combustion chamber, afterburners.

| | | |
|---|---|---|
| **UNIT-V** | **COMBUSTION IN ROCKET ENGINES AND EMISSION** | **Classes: 08** |

Types of rockets based on combustion, solid fuel combustion, combustion of carbon particle, simplified analysis, boundary layer combustion, combustion of carbon sphere with co burning gas phase; Chemical emission from combustion and its effects, exhaust gas analysis, emission control methods.

**Text Books :**

1. Stephen R Turns, "An Introduction to combustion Concepts and Application", TMH Publication, 3rd Edition, 2011.
2. Fawzy El-Mahallawy, Saad El-Din Habik,Elsevier "Fundamentals and Technology of combustion", 1st Edition, 2002.
3. D. P. Mishra, "Fundamentals of combustion", PHI Publication, 1st Edition, 2007.

**Reference Books:**

1. Charles E. Baukal, "Heat Transfer in Industrial Combustion" CRC Press, 1st Edition, 2000.
2. G. Singer, "Combustion, Fossil Power Systems" Ed Publications, 4th Edition, 1966.
3. S. P. Sharma, Chandra Mohan "Fuels and Combustion", Tata McGraw Hill Publishing Co., New Delhi, 1st Edition, 1987.
4. M. L. Mathur, R. P. Sharma, "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers and Distributors, New Delhi, 1988.

**Web References:**

1. http://www.personal.utulsa.edu/~kenneth-weston/chapter3.pdf
2. http://www.em-ea.org/guide%20books/book-2/2.1%20fuels%20and%20combustion.pdf

**E-Text Books:**

1. https://books.google.co.in/books?id=cVJkP4oEjZsC&printsec=frontcover&dq=Fuels+and+Combustion+latest+edition&hl=en&sa=X&ved=0ahUKEwjK2tWHzPfNAhVMto8KHRiMCBAQ6AEIHTAA#v=onepage&q=Fuels%20and%20Combustion%20latest%20edition&f=false
2. http://poisson.me.dal.ca/site2/courses/mech4840/04_Fuels%20&%20Combustion%20calculation09.pdf

## TURBOMACHINERY AND DYNAMICS

**Group III: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE210 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | | Practical Classes: Nil | | | Total Classes: 45 | | |

**OBJECTIVES:**

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

I. Understand the energy transfer in turbo machines.
II. Analyze the steam, water turbines.
III. Explain rotary fans, blowers and compressors.
IV. Infer Power Transmitting turbo machines.

| UNIT-I | ENERGY TRANSFER IN TURBO MACHINES | Classes: 08 |
|---|---|---|

Application of first and second laws of thermodynamics to turbo machines, moment of momentum equation and Euler turbine equation, principles of impulse and reaction machines, degree of reaction, energy equation for relative velocities, one dimensional analysis only.

| UNIT-II | STEAM TURBINES | Classes: 10 |
|---|---|---|

Impulse staging, velocity and pressure compounding, utilization factor, analysis for optimum U.F curtis stage, and rateau stage, include qualitative analysis, effect of blade and nozzle losses on vane efficiency, stage efficiency and analysis for optimum efficiency, mass flow and blade height; Reactions staging: Parson's stages, degree of reaction, nozzle efficiency, velocity coefficient, stator efficiency, carry over efficiency, stage efficiency, vane efficiency, conditions for optimum efficiency, speed ratio, axial thrust, reheat factor in turbines, problem of radial equilibrium, free and forced vortex types of flow, flow with constant reaction, governing and performance characteristics of steam turbines.

| UNIT-III | WATER TURBINES | Classes: 10 |
|---|---|---|

Classification, Pelton, Francis and Kaplan turbines, vector diagrams and work-done, draft tubes, governing of water turbines; Centrifugal pumps: classification, advantage over reciprocating type, definition of mano-metric head, gross head, static head, vector diagram and work done.

Performance and characteristics: Application of dimensional analysis and similarity to water turbines and centrifugal pumps, unit and specific quantities, selection of machines, hydraulic, volumetric, mechanical and overall efficiencies, Main and operating characteristics of the machines, cavitations.

| UNIT-IV | ROTARY FANS, BLOWERS AND COMPRESSORS | Classes: 09 |
|---|---|---|

Classification based on pressure rise, centrifugal and axial flow machines; Centrifugal Blowers Vane shape, velocity triangle, degree of reactions, slip coefficient, size and speed of machine, vane shape and stresses, efficiency, characteristics, fan laws and characteristics; Centrifugal Compressor – Vector diagrams, work done, temp and pressure ratio, slip factor, work input factor, pressure coefficient, Dimensions of inlet eye, impeller and diffuser; Axial flow compressors; Vector diagrams, work done factor, temp and pressure ratio, degree of reaction, dimensional analysis, characteristics, surging, polytrophic and isentropic efficiencies.

| UNIT-V | POWER TRANSMITTING TURBO MACHINES | Classes: 08 |
|---|---|---|
| Application and general theory, their torque ratio, speed ratio, slip and efficiency, velocity diagrams, fluid coupling and Torque converter, characteristics, positive displacement machines and turbo machines, their distinction; Positive displacement pumps with fixed and variable diplacements, hydrostatic systems hydraulic intensifier, accumulator, press and crane. | | |
| **Text Books :** | | |
| 1. Yahya S.H., Turbines, "Compressor and Fans", TMH, 2nd Edition, 2008.<br>2. Venkanna B. K., "Fundamentals of Turbomachines", PHI Learning Private Limited, 5th Edition, 2005. | | |
| **Reference Books:** | | |
| 1. Kadambi V Manohar Prasad; "An introduction to EC Turbomachinery" Vol.III, WileyEastern, 1st Edition, 1999. | | |
| **Web References:** | | |
| 1. http://www.slideshare.net/asifzhcet/fluid-mechanics-and-hydraulic-machines-dr-r-k-bansal<br>2. http://as.wiley.com/WileyCDA/WileyTitle/productCd-0470124229.html | | |
| **E-Text Books:** | | |
| 1. http://files.asme.org/Divisions/FED/16300.pdf<br>2. ftp://210.212.172.242/Digital_Library/Mechanical/TURBOMACHINES/Principles%20of%20Turbomachinery.pdf | | |

## HYPERSONIC AND HIGH-TEMPERATURE GAS DYNAMICS

**Group III: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE211 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Provide a fundamental description of hypersonic flow phenomena, including aerodynamic heating and non-equilibrium real-gas effects.
II. Explain the fundamental features of hypersonic flows, and how these differ from other flows.
III. Infer the importance and influence of non-equilibrium real-gas effects in high temperature flows.
IV. Illustrate the physical mechanisms causing aerodynamic heating of high speed vehicles.
V. Explain the design influence of hypersonic vehicles.

| UNIT-I | OVERVIEW AND INTRODUCTION | Classes: 08 |
|---|---|---|

Hypersonic flight: Some historical firsts; Hypersonic flow: why is it important, what is it; Fundamental sources of aerodynamic force and aerodynamic heating; Hypersonic flight paths: velocity-altitude map; Hypersonic shock and expansion-wave relations: hypersonic shock and expansion-wave relations, hypersonic shock relations in terms of the hypersonic similarity parameter, hypersonic expansion-wave relations.

| UNIT-II | SURFACE INCLINATION METHODS AND THEORIES | Classes: 10 |
|---|---|---|

Local surface inclination methods: Newtonian flow, modified Newtonian law, centrifugal force corrections to Newtonian theory, tangent-wedge tangent-cone methods, shock-expansion method; Hypersonic inviscid flowfields: Approximate methods: Governing equations, mach-number independence, hypersonic small-disturbance equations, hypersonic similarity; Hypersonic small-disturbance theory: Some results, hypersonic equivalence principle and blast-wave theory, thin shock-layer theory; Hypersonic inviscid flowfields: Exact methods: method of characteristics, time-marching finite difference method, correlations for hypersonic shock-wave shapes, shock–shock interactions, space-marching finite difference method.

| UNIT-III | VISCOUS FLOW AND HYPERSONIC VISCOUS INTERACTIONS | Classes: 10 |
|---|---|---|

Viscous flow: Basic aspects boundary layer results and aerodynamic heating: Governing equations for viscous flow: Navier–stokes equations, boundary-layer equations for hypersonic flow, hypersonic boundary-layer theory, non-similar hypersonic boundary layers, hypersonic transition, hypersonic turbulent boundary layer, reference temperature method.

Hypersonic viscous interactions: Strong and weak viscous interactions, role of x in hypersonic viscous interaction, hypersonic shock-wave/boundary-layer interactions, computational-fluid-dynamic solutions of hypersonic viscous flows, viscous shock-layer technique, Parabolized Navier–stokes solutions, full navier–stokes solutions.

| UNIT-IV | HIGH-TEMPERATURE GAS DYNAMICS | Classes: 09 |
|---|---|---|
| Importance of high-temperature flows, nature of high-temperature flows; Chemical effects in air: The velocity-altitude map; Elements of kinetic theory: Perfect-gas equation of state, collision frequency and mean free path, velocity and speed distribution functions, definition of transport phenomena, transport coefficients, mechanism of diffusion, energy transport by thermal conduction and diffusion, transport properties for high-temperature air. | | |
| **UNIT-V** | **INVISCID HIGH-TEMPERATURE EQUILIBRIUM FLOWS AND NONEQUILIBRIUM FLOWS** | **Classes: 08** |
| Governing equations for inviscid high-temperature equilibrium flow, equilibrium normal and oblique shock-wave flows, equilibrium quasi-one-dimensional nozzle flows, frozen and equilibrium flows, equilibrium and frozen specific heats, equilibrium speed of sound, equilibrium conical flow, equilibrium blunt-body flows, governing equations for inviscid, non-equilibrium flows, non-equilibrium normal and oblique shock-wave flows, non-equilibrium quasi-one-dimensional nozzle flows, non-equilibrium blunt-body flows, binary scaling, non-equilibrium flow over other shapes: non-equilibrium method of characteristics. | | |

**Text Books :**

1. John D. Amderson, "Hypersonic and High Temperature Gas Dynamics", McGraw Hill, 2nd Edition, 1989.
2. John J. Berlin, "Hypersonic Aerodynamics" AIAA Education series, 1st Edition, 1994.

**Reference Books:**

1. W. D. Hayes, Ronalds F. Probstein, "Hypersonic Flow Theory" Academic Press, 1st Edition, 1959.
2. H. W. Liepman, A. Roshko, "Elements of Gas Dynamics" John Wiley and Sons Inc., 4th Edition, 2002.

**Web References:**

1. http://www.southampton.ac.uk/engineering/undergraduate/modules/sesa6074_hypersonic_and_high_temperature_gas_dynamics.page#aims_and_objectives

**E-Text Books:**

1. https://www.scribd.com/doc/248036966/Anderson-Hypersonic-and-High-Temperature-Gas-Dynamics

# ROCKETS AND MISSILES

**Group III: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE212 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | | Total Classes: 45 | | |

**OBJECTIVES:**

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

I. Understand the basics of rocket and missiles, their constructions and functions.
II. Understand the combustion and propulsion systems in rockets.
III. Analyze the various aerodynamic forces and moments.
IV. Select suitable materials for the rockets and missiles.

| UNIT-I | ROCKET SYSTEMS | Classes: 08 |
|---|---|---|

Ignition system in rockets, types of igniters, igniter design considerations; Design consideration of liquid rocket combustion chamber, injector propellant feed lines, valves, propellant tanks and their outlets; Pressurized and turbine feed systems; Propellant slosh and propellant hammer; Elimination of geysering effect in missiles; Combustion system of solid rockets.

| UNIT-II | AERODYNAMICS OF ROCKET AND MISSILES | Classes: 10 |
|---|---|---|

Airframe components of rockets and missiles; Forces acting on a missile while passing through atmosphere; Classification of missiles; Method 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 | ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD | Classes: 10 |
|---|---|---|

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 | STAGING AND CONTROL OF ROCKET AND MISSILES | Classes: 09 |
|---|---|---|

Rocket vector control, methods, thrust termination; Secondary injection thrust vector control system; Multistaging of rockets; Vehicle optimization; Stage separation dynamics; Separation techniques.

| UNIT-V | MATERIALS FOR ROCKET AND MISSILES | Classes: 08 |
|---|---|---|

Selection of materials; Special requirements of materials to perform under adverse conditions.

**Text Books :**

1. G. P. Sutton, O. Biblarz, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 8th Edition, 2010.
2. M. J. L. Turner, "Rocket and Spacecraft propulsion", Praxis publishing, 2nd Edition, 2006.
3. M. Mathur, R. P. Sharma, "Gas Turbines and Jet and Rocket Propulsion", Standard Publishers, New Delhi, 4th Edition, 2005.
4. P.G. Hill, C. R. Peterson, "Mechanics & Thermodynamics of Propulsion" Addison Wesley Longman Inc, 3rd Edition, 1999.

**Reference Books:**

1. J.W. Cornelisse H.F.R. Schoyer & K.F. Wakker "Rocket Propulsion and Space Dynamics" , pitman publications, London, 1st Edition, 1979.
2. E. R. Parket, "Materials for Missiles and Spacecraft", McGraw Hill Book Co., 2nd Edition, 1982.
3. Gordon C. Oates "Aerothermodynamics of Gas Turbine Rocket Propulsion" American Institute of Aeronautics and Astronautics, Inc. 3rd Edition, 1997.

**Web References:**

1. http://as.wiley.com/WileyCDA/WileyTitle/productCd-0470080248.html
2. https://archive.org/details/RocketPropulsionAndSpaceflightDynamics
3. http://rapidshare.com/files/163497637/The_Jet_Engine.rar
4. http://www.personal.utulsa.edu/~kenneth-weston/chapter5.pdf

**E-Text Books:**

1. http://www.ewp.rpi.edu/hartford/~ernesto/S2013/EP/MaterialsforStudents/Lee/Sutton-Biblarz-Rocket_Propulsion_Elements.pdf
2. https://archive.org/details/RocketPropulsionAndSpaceflightDynamics
3. http://www.pyrobin.com/files/rocket%20and%20spacecraft%20propulsion%203540221905_1.pdf

# MISSILE GUIDANCE AND CONTROL

**Group IV: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE213 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Understand the advanced concepts of missile guidance and control.
II. Exposure on missile systems, missile airframes, autopilots, guidance laws.
III. Deploy these skills effectively in the understanding of missile guidance and control.

| UNIT-I | MISSILE SYSTEMS INTRODUCTION | Classes: 08 |
|---|---|---|

History of guided missile for defence applications, classification of missiles, the generalized missile equations of motion coordinate Systems, Lagrange's equations for rotating coordinate systems rigid-body equations of motion missile system elements, missile ground systems.

| UNIT-II | MISSILE AIRFRAMES, AUTOPILOTS AND CONTROL | Classes: 10 |
|---|---|---|

Missile aerodynamics: Force equations, moment equations, phases of missile flight; Missile control configurations; Missile mathematical model; Autopilots: Definitions, types of autopilots, example applications, open-loop autopilots; Inertial instruments and feedback; Autopilot response, stability and agility- pitch autopilot design, pitch-yaw-roll autopilot design.

| UNIT-III | MISSILE GUIDANCE LAWS | Classes: 10 |
|---|---|---|

Tactical guidance intercept techniques, derivation of the fundamental guidance equations, explicit, proportional navigation, augmented proportional navigation, beam riding, bank to turn missile guidance.

Three-dimensional proportional navigation, comparison of guidance system performance, application of optimal control of linear feedback systems.

| UNIT-IV | STRATEGIC MISSILES | Classes: 09 |
|---|---|---|

Introduction, the two-body problem, Lambert's theorem, first order motion of a ballistic missile , correlated velocity and velocity-to-be-gained concepts, derivation of the force equation for ballistic missiles, atmospheric re-entry, ballistic missile intercept, missile tracking equations of motion, introduction to cruise missiles , the terrain contour matching concept.

| UNIT-V | WEAPON DELIVERY SYSTEMS | Classes: 08 |
|---|---|---|

Weapon delivery requirements, factors influencing weapon delivery accuracy, unguided weapons, the bombing problem, guided weapons, integrated flight control in weapon delivery, missile launch envelope and mathematical considerations pertaining to the accuracy of weapon delivery computations.

**Text Books :**

1. G.M. Siouris, "Missile Guidance and control systems", Springer, 2003.
2. J. H. Blakelock, Automatic Control of Aircraft and Missiles, 2nd Edition, John Wiley & Sons, 1990.
3. Eugene L. Fleeman, Tactical Missile Design, First Edition, AIAA Education series, 2001.

**Reference Books:**

1. P. Garnell, "Guided Weapon Control Systems", , Pergamon Press, 2nd Edition 1980.
2. Joseph Ben Asher, Isaac Yaesh "Advances in Missile Guidance Theory" AIAA Education series, 1998
3. Paul Zarchan, "Tactical and Strategic Missile Guidance" AIAA Education series,2007

**Web References:**

1. http://www.sciencedirect.com/science/article/pii/S1000936108600217https://www.academia.edu/8521925/Atmospheric_re-entry_vehicle_mechanics
2. http://link.springer.com/article/10.1007/s11633-010-0563-z
3. http://as.wiley.com/WileyCDA/WileyTitle/productCd-0471506516.html

**E-Text Books:**

1. http://read.pudn.com/downloads165/doc/project/753314/Missile%20Guidance%20and%20Control%20Systems.pdf
2. http://rahauav.com/Library/Stability-Control/Aircraft%20&%20Missile%20BLAKELOCK.pdf
3. https://info.aiaa.org/Regions/SE/CF/Meeting%20Minutes/AIAA%20Distinguished%20Lecture-Missile%20Design%20and%20System%20Engineering-24%20Slides.pdf

# FLIGHT SIMULATION

**Group IV: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE214 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Illustrate the history of flight simulation.
II. Understand the principle of modeling and simulation of flight control systems.
III. Describe the dynamics of aircraft and model validation.

| UNIT-I | INTRODUCTION | Classes: 08 |
|---|---|---|

Historical Perspective, the first 40 years of flight 1905–1945,analogue computing, 1945–1965, digital computing 1965–1985, the microelectronics revolution, 1985 present, the case for simulation, safety, financial benefits, training transfer, engineering flight simulation, the changing role of simulation, the organization of a flight simulator, equations of motion, aerodynamic model, engine model, data acquisition, gear model, weather model, visual system, sound system, motion system, control loading, instrument displays, navigation systems, maintenance, the concept of real-time simulation, pilot cues, visual cueing, motion cueing, training versus simulation, examples of simulation, commercial flight training, military flight training, Ab initio flight training, land vehicle simulators, engineering flight simulators aptitude testing, computer-based training, maintenance training.

| UNIT-II | PRINCIPLES OF MODELLING | Classes: 10 |
|---|---|---|

Modelling concepts, Newtonian mechanics, axes systems, differential equations, numerical integration, approximation methods, first order methods, higher order methods, real-time computing, data acquisition, data transmission, data acquisition, flight data, interpolation, distributed systems, a real-time protocol, problems in modelling,

| UNIT-III | AIRCRAFT DYNAMICS | Classes: 10 |
|---|---|---|

Principles of flight modelling, the atmosphere, forces, aerodynamic lift, aerodynamic side force, aerodynamic drag, propulsive forces, gravitational force, moments, static stability, aerodynamic moments, aerodynamic derivatives, axes systems, the body frame, stability axes, wind axes, inertial axes, transformation between axes.

Earth-centred earth-fixed frame, latitude and longitude, quaternions, equations of motion; Propulsion, piston engines, jet engines, the landing gear, the equations collected; The equations revisited: Long range navigation, coriolis acceleration.

| UNIT-IV | SIMULATION OF FLIGHT CONTROL SYSTEMS | Classes: 09 |
|---|---|---|

The Laplace transform, simulation of transfer functions; Proportional–integral–derivative control systems, trimming, aircraft flight control systems, the turn coordinator and the yaw damper, the auto-throttle, vertical speed management, altitude hold, heading hold, localizer tracking, auto-land systems, flight management systems.

| UNIT-V | MODEL VALIDATION AND VISUAL SYSTEMS | Classes: 08 |
|---|---|---|

Simulator qualification and approval, model validation methods, cockpit geometry, open-loop tests, closed-loop tests, latency, performance analysis, longitudinal dynamics, lateral dynamics, model validation in perspective; Visual systems: Background, the visual system pipeline, graphics operations, real-time image generation, a rudimentary real time wire frame image generation system, an open GL real-time image generation system, an open GL real-time textured image generation system, an open scene graph image generation system, visual database management, projection systems, problems in visual systems .

**Text Books :**


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


**Reference Books:**


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


**Web References:**

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

**E-Text Books:**

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

# FLIGHT TESTING

**Group IV: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE215 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Understand the basic methods for flight testing.
II. Evaluating measurement of different quantities.
III. Explain the flight performance in different approaches.
IV. Determining the static and dynamic stability.

| | | |
|---|---|---|
| **UNIT-I** | **INTRODUCTION** | **Classes: 08** |

Introduction: Methods for reducing data uncertainty in flight test data; Air speed systems theory and calibration; stall speed measurement; Determination of engine power in flight.

| | | |
|---|---|---|
| **UNIT-II** | **MEASUREMENT OF DIFFERENT QUANTITIES** | **Classes: 10** |

Jet Thrust measurement in flight, level flight performance theory, level flight performance flight test and data; Reduction methods for propeller; Driven aircraft; Level flight performance jet aircraft; Range and endurance climb performance theory; climb performance methods, Data reduction.

| | | |
|---|---|---|
| **UNIT-III** | **PERFORMANCE** | **Classes: 10** |

Energy approach to performance flight; Turning performance; Methods for drag determination in flight.

Airspeed vs. Flight path angle performance method for powered-lift Aircraft; Take-off and landing theory and methods.

| | | |
|---|---|---|
| **UNIT-IV** | **STATIC STABILITY** | **Classes: 09** |

Introduction to static stability and control flight, static longitudinal stability theory, static longitudinal stability flight test methods.

| | | |
|---|---|---|
| **UNIT-V** | **DYNAMIC STABILITY** | **Classes: 08** |

Dynamic longitudinal stability theory; Dynamic longitudinal stability flight test methods and data reduction; Longitudinal maneuvering stability theory, maneuvering stability methods and data, longitudinal control and trim theory and flight test methods, methods for improving longitudinal stability, lateral directional stability theory and flight, dynamic lateral-directional stability theory and flight test methods, lateral control power, directional control, flying qualities.

**Text Books :**

1. Ralph D. Kimberlin, "Flight Testing of Fixed Wing Aircraft", AIAA, 1st Edition, 2003.
2. Mikhail Grigor′evich Kotik, "Flight testing of aircraft", National Aeronautics and Space Administration, 1st Edition, 1967.

**Reference Books:**

1. Hubert C. Smith, "Understanding Performance Flight Testing: Kitplanes and Production Aircraft", McGraw Hill, 2nd Edition, 2002.
2. Ward Donald T , Strganac Thomas W, Niewohhner Rob, " Introduction to flight test engineering", Vol-I, Kendall Hunt Publishing; 3rd Edition, 2006.

**Web References:**

1. http://www.velocityaircraft.com/manuals/16_GGG.pdf
2. http://doi.contentdirections.com/mr/mgh.jsp?doi=10.1036/0071376798

**E-Text Books:**

1. http://www.faa.gov/documentlibrary/media/advisory_circular/ac_90-89b.pdf
2. http://cecs.wright.edu/balloon/images/a/ab/Introduction_to_Flight_Test_Engineering.pdf

## ATMOSPHERIC REENTRY VEHICLE MECHANISM

**Group IV: AE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE216 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Understand the basic mechanism of reentry vehicle.
II. Define aerodynamic principles and flight dynamics.
III. Solve the equations of motion for reentry vehicles.

| UNIT-I | OVERVIEW AND INTRODUCTION | Classes: 08 |
|---|---|---|

Classical point mass mechanics, mechanics of rigid bodies, topography and gravitation, the geodetic frame of reference, the terrestrial field of gravitation, models of atmosphere, main parameters and hypotheses, the isothermal exponential model, standard models of earth's atmosphere, martian models.

| UNIT-II | AERODYNAMICS | Classes: 10 |
|---|---|---|

Aerodynamic coefficients, modes of flow, continuous mode, rare field mode, qualities of flight, characteristics of a family of sphere cones, planetary entry capsule.

| UNIT-III | SPECIAL TREATMENT FOR REENTRY VEHICLE | Classes: 10 |
|---|---|---|

Inertial Models: Moments of inertia, cg offset and principal axis misalignment; Changing of Reference Frame: Direction cosine matrices, Euler angles, representations with four parameters;

Exoatmospheric phase: Movement of the center of mass , movement around mass center.

| UNIT-IV | EQUATIONS OF MOTION | Classes: 09 |
|---|---|---|

Six degree-of-freedom reentry: General equations of motion, solutions of general equations, zero angle of attack reentry; Allen's reentry results, influence of ballistic coefficient and flight path angle, influence of range; Decay of initial incidence: Zero spin rate, nonzero spin.

| UNIT-V | FLIGHT DYNAMICS OF REENTRY VEHICLE | Classes: 08 |
|---|---|---|

End of the convergence of the incidence: Linear equations, instantaneous angular movement, real angular motion; Roll-lock-in Phenomenon: Association of aerodynamic asymmetry and cg offset, isolated center of gravity, isolated principal axis misalignment, combined cg offset and principal axis misalignment, instabilities: static instabilities, dynamic instabilities; Reentry errors: Zero angle-of-attack dispersions, nonzero angle of attack.

**Text Books :**

1. Patrick Gallais, "Atmospheric Re-Entry Vehicle Mechanics", Springer, 1st Edition, 2007.
2. W. Hankey, "Re-Entry Aerodynamics", AIAA Education series, 1st Edition, 1988.
3. Frank J. Regan "Dynamics of Atmospheric Re-Entry" American institute of astronautics and aeronautics publications, 1st Edition, 1993.

**Reference Books:**

1. Peter Fortes cue , "spacecraft systems engineering" Wiley, 4th Edition, 1992.
2. Vladimir A. Chobotov," Orbital Mechanics" AIAA Education series, 3rd edition 2002.

**Web References:**

1. http://spacecraft.ssl.umd.edu/academics/791S04/791S04.040302.text.pdf

**E-Text Books:**

1. http://download.e-bookshelf.de/download/0000/0122/72/L-G-0000012272-0002345666.pdf
2. http://www.spaceatdia.org/uploads/mariano/ss1/Spacecraft%20Systems%20Engineering.pdf

# DISASTER MANAGEMENT

**Open Elective I : AE / (CAD/CAM) / CSE / ES / SE /PEED**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BST701 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Exposure to disasters, their significance and types.
II. Understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
III. Explore on Disaster Risk Reduction (DRR) approaches.
IV. Enhance awareness of institutional processes in the country.
V. Develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live,with due sensitivity.

| UNIT-I | INTRODUCTION TO NATURAL AND MANMADE DISASTERS | Classes: 09 |
|---|---|---|

Concepts and definitions of Disaster, Hazard, Vulnerability, Resilience, Risks. Impact of drought, review of past disasters and drought in India, its classification and characteristics. Classification of drought, causes, Impacts (including social, economic. political, environmental, health, psychosocial, etc.).

| UNIT-II | DISASTER, DIFFERENTIAL IMPACTS, CYCLONES AND FLOODS | Classes: 09 |
|---|---|---|

Classifications, Causes, Impacts including social, economic, political, environmental, health, psychosocial etc. Differential Impacts in terms of caste, class, gender, age, location, disability Global trends in disasters, urban disasters, pandemics, complex emergencies, climate change.

Tropical cyclones & Local storms, Destruction by tropical cyclones and local storms, Cumulative atmospheric hazards/ disasters, Cold waves, Heat waves, Causes of floods, Rood hazards in India.

| UNIT-III | APPROACHES TO DISASTER RISK REDUCTION | Classes: 09 |
|---|---|---|

Disaster cycle, its analysis, phases, culture of safety, prevention, mitigation and preparedness community based Disaster risk reduction.

Structural, nonstructural sources, roles and responsibilities of community, Panchayati raj Institutions, Urban local bodies, states, centre and other stake holders.

| UNIT-IV | INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT | Classes: 09 |
|---|---|---|

Factors affecting vulnerabilities, differential impacts, impact of development projects such as darns, embankments, changes in Land-use etc. Climate Change Adaptation, Relevance of indigenous knowledge, appropriate technology and local resources.

| UNIT-V | DISASTER RISK MANAGEMENT IN INDIA | Classes: 09 |
|---|---|---|

Hazard and Vulnerability profile of India Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, OM Act and Policy, other related policies, plans, programmes and legislation).
Field work and case Studies to understand vulnerabilities and to work on reducing disaster risks and to build a culture of safety. Projects must be conceived creatively based on the geographic location and hazard profile of the region where the institute is located.

**Text Books:**


1. Nick, "Disaster Management: A Disaster Manager's Handbook", Asian Development Bank, Manila Philippines, 1991.
2. Kapur, et al., "Disasters in India: Studies of Grim Reality", Rawat Publishers, Jaipur, 2005.
3. Pelling Mark, "The Vulnerability of Cities: Natural Disaster and Social Resilience", Earthscan Publishers, London, 2003.


**Reference Books:**


1. Sharma, V. K. (1999), "Disaster Management", National Centre for Disaster Management, IIPE, Delhi, 1999.
2. Anil, K. Gupta and Sreeja, S. Nair (2011), "Environmental Knowledge for Disaster Risk Management", NIDM, New Delhi, 2011.


**Web References:**

1. http://humanityroad.org/
2. http://www.wcpt.org/disaster-management/what-is-disaster-management
3. http://www.ndmindia.nic.in/
4. http://nidm.gov.in/default.asp
5. http://www.unisdr.org/2005/mdgs-drr/national-reports/India-report.pdf

**Web References:**

1. http://www.ekalavvya.com/disaster-management-in-india-volume-i-free-ebook/
2. http://cbse.nic.in/natural%20hazards%20&%20disaster%20management.pdf
3. http://www.undp.org/content/dam/india/docs/disaster_management_in_india.pdf
4. http://www.digitalbookindex.org/_search/search010emergencydisastera.asp

# RENEWABLE ENERGY SYSTEMS

**Open Elective I : AE / (CAD / CAM) / CSE / ES / SE / ST**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BPE701 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | | Practical Classes: Nil | | | Total Classes: 45 | | |

**OBJECTIVES:**

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

I. Illustrate the concept of photo voltaic power generation.
II. Discuss the Magneto hydrodynamic (MHD) and wind energy power conversion systems.
III. Explain tidal and wave energy.
IV. Design energy conversion systems with low impact on environment.
V. Understand the technology of fuel cells.

| UNIT-I | PHOTOVOLTAIC POWER GENERATION SYSTEMS | Classes: 09 |
|---|---|---|

Photo voltaic power generation: spectral distribution of energy in solar radiation, solar cell configurations, voltage developed by solar cell, photo current and load current, practical solar cell performance, commercial photo voltaic systems, test specifications for PV systems, applications of super conducting materials in electrical equipment systems.

| UNIT-II | MHD WIND ENERGY CONVERSION AND WIND POWER GENERATION | Classes:10 |
|---|---|---|

Principles of MHD power generation, ideal MHD generator performance, practical MHD generator, MHD technology; Wind Energy conversion: Power from wind, properties of air and wind, types of wind turbines, operating characteristics.

| UNIT-III | TIDAL AND WAVE ENERGY CONVERSION | Classes:08 |
|---|---|---|

Tides and tidal power stations, modes of operation, tidal project examples, turbines and generators for tidal power generation.

Wave energy conversion: Properties of waves, power content, vertex motion of waves, device applications, types of ocean thermal energy conversion systems application of OTEC systems examples.

| UNIT-IV | ENERGY CONVERSION SYSTEMS AND ENVIRONMENTAL EFFECTS | Classes:09 |
|---|---|---|

Miscellaneous energy conversion systems: coal gasification and liquefaction, biomass conversion, geothermal energy, thermo electric energy conversion, principles of EMF generation, co generation and energy storage, combined cycle co generation, energy storage; Global energy position and environmental effects: energy units, global energy position.

| UNIT-V | FUEL CELLS | Classes:09 |
|---|---|---|

Fuel cells: Types of fuel cells, $H_2O_2$ Fuel cells, application of fuel cells, batteries, description of batteries, battery application for large power, environmental effects of energy conversion systems.

**Text Books:**

1. Ashok Desai V, Non-Conventional Energy, Wiley Eastern Ltd, 1990.
2. Rakosh das Begamudre, "Energy conversion systems", New age International publishers, New Delhi - 2000.
3. Freris L.L. Prentice Hall1, "Wind energy Conversion Systems", 1990.
4. Spera D.A., "Wind Turbine Technology: Fundamental concepts of wind turbine technology", ASME Press, NY, 1994.

**Reference Books:**

1. Mittal K.M, Non-Conventional Energy Systems, Wheeler Publishing Co. Ltd, 1997.
2. Ramesh R, Kurnar K.U, Renewable Energy Technologies, Narosa Publishing House, New Delhi, 1997.
3. John Twidell, Tony Weir "Renewable Energy Resources", 2nd edition.
4. Kreith, Kreider, "Solar Energy Handbook", McGrawHill

**Web References:**

1. http://www.nrel.gov/docs/fy13osti/54909.pdf
2. http://www.gisday.com/resources/ebooks/renewable-energy.pdf
3. http://www.geni.org/globalenergy/library/energytrends/currentusage/renewable/Renewable-Energy-Potential-for-India.pdf
4. http://www.cerien.upc.edu/jornades/jiie2005/ponencies/power%20converters%20and%20control%20of%20renewable%20energy%20systems%20paper.pdf
5. https://www.irena.org/DocumentDownloads/Publications/RE_Technologies_Cost_Analysis-SOLAR_PV.pdf

**E-Text Books:**

1. http://maxwell.sze.hu/~marcsa/MegujuloEnergiaforrasok/Books/renewable%20energy%20resources.pdf
2. http://lab.fs.uni-lj.si/kes/erasmus/Renewable%20Energy%20Conversion,%20Transmission,%20and%20Storage.pdf
3. http://www.landartgenerator.org/LAGI-FieldGuideRenewableEnergy-ed1.pdf

# AUTOMOTIVE DESIGN

**Open Elective I : AE / CSE / ES / SE / ST / PEED**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BCC701 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Understand and Specify automotive styling and design principles of automotive exteriors.
II. Analyze automotive exterior design trends.
III. Design automotive exteriors using manual and digital renderings.
IV. Create clay models of automotive exterior design.

| UNIT-I | AUTOMOTIVE DESIGN TERMINOLOGY , CLASSIFICATION OF CARS BASED ON BODY STYLE | Classes: 09 |
|---|---|---|

Overview, Automotive design terminology, automotive design process and factors influencing automotive design, development and history behind different body styles, micro cars, hatchback and it sub types, sedan and its sub-types, coupe and its variants, convertible and its variants, station wagon, sports utility vehicles, multi utility vehicles.

| UNIT-II | PLATFORM TECHNOLOGY, TYPES OF CHASSIS, AND AUTOMOTIVE PACKAGING | Classes: 09 |
|---|---|---|

Platform technology, types of chassis, and automotive packaging: Definition, motivation, versions of platform, benefits of platform sharing and downside of platform technology; History of automotive chassis, composite construction, unibody construction, tubular space frame, glass-fibre monocoque chassis, aluminium monocoque construction, carbon fibre monocoque construction, ULSAB type, definition and different layout sectors in packaging, Interior dimensions, exterior dimensions, front end (engine compartment), rear end (luggage space), under-body, major factors influencing automotive packaging, regulatory requirements.

| UNIT-III | AUTOMOTIVE FRONT- REAR END DESIGN | Classes: 09 |
|---|---|---|

Factors affecting the front end design, front end design for better air cooling, latest design trends, bumper design theme, regulation for bumper design.

Evolution of grille design, grille design as a new brand image, hood design and new trends in exterior design, tail lamp, spoiler, bumper design, overall rear design for aerodynamics.

| UNIT-IV | AUTOMOTIVE LIGHTING SYSTEM , AUTOMOTIVE GLASSES | Classes: 09 |
|---|---|---|

History and development in automotive lighting, different types of optical system, light sources used in lighting, headlamp design and styling, advanced lighting technology, pedestrian friendly lights, signal lamps, latest trends in automotive lighting, different types of automotive glasses, recent development in automotive glass design, importance of glass in car design, role of glazing for car safety, developments in automotive glass design.

| UNIT-V | AUTOMOTIVE EXTERIOR DESIGN, PAINTING , SURFACE PROTECTION | Classes: 09 |
|---|---|---|

Design methodology, image boards: lifestyle board, mood board, theme board, design trends, design movements, application of design principles, product aesthetics, different types of corrosion on automotive bodies, corrosion protection methods, automotive body painting procedure, paint components and latest trends in automotive body colors.

**Text Books:**

1. J.Fenton, "Handbook of Automotive Body and System Design", Professional Engineering Publishing, 1st Edition, 2000.
2. Erik Eckermann, "World History of the Automobile", SAE International, 1st Edition, 2002.

**Reference Books:**

1. Stephen Newbury, "Car Design Year Book 1 to 5", Marrell, 1st Edition, London, 2007.
2. Tony Lewin, "How to Design Car Like A Pro", Motorbooks International, 1st Edition, 2003.

**Web References:**

1. www.carbodydesign.com
2. www.style4cars.com
3. www.cardesignnews.com

**E-Text Books:**

1. http://www.sciencedirect.com/science/book/9780750656924
2. http://books.sae.org/r-312/

# EMBEDDED C

**Open Elective I: AE / (CAD / CAM) / CSE / SE / ST /PEED | I Semester: ES**

| Course code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BES001 | Core/Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Understand embedded C and use it for programming embedded system.
II. Apply techniques for data transfer between I/O ports and memory.
III. Apply object oriented programming for designing embedded system.
IV. Use timers to generate time delays.

| UNIT-I | PROGRAMMING EMBEDDED SYSTEMS IN C | Classes: 09 |
|---|---|---|

Introduction, what is an embedded system, which processor should you use, which programming language should you use, which operating system should you use, how do you develop embedded software, conclusions; Introduction, what's in a name, the external interface of the standard 8051, reset requirements, clock frequency and performance, memory issues, I/O pins, timers, interrupts, serial interface, power consumption, conclusions.

| UNIT-II | SWITCHES | Classes: 09 |
|---|---|---|

Introduction, basic techniques for reading from port pins; Example: Reading and writing bytes, example: Reading and writing bits (simple version), Example: Reading and writing bits (generic version), The need for pull-up resistors, Dealing with switch bounce, Example: Reading switch inputs (basic code), example: counting goats, conclusions.

| UNIT-III | ADDING STRUCTURE TO THE CODE | Classes: 09 |
|---|---|---|

Introduction, object oriented programming with C, the project header (MAIN.H), the port header (PORT.H).
Example: Restructuring the 'Hello Embedded World' example, Example: Restructuring the goat-counting example, further examples and conclusions.

| UNIT-IV | MEETING REAL-TIME CONSTRAINTS | Classes: 09 |
|---|---|---|

Introduction, creating hardware delays using Timer 0 and Timer 1, example: Generating a precise 50 ms delay, example: Creating a portable hardware delay, Why not use Timer 2? The need for timeout mechanisms, creating loop timeouts and example: Testing loop timeouts, example: A more reliable switch interface, Creating hardware timeouts, example: Testing a hardware timeout, conclusions.

| UNIT-V | CASE STUDY: INTRUDER ALARM SYSTEM | Classes: 09 |
|---|---|---|

Introduction, The software architecture, key software components used in this example, running the program, the software, conclusions.

**Text Books:**

1. Michael J. Pont, "Embedded C", Pearson Education, 2nd Edition, 2008.

**Reference Books:**

1. Nigel Gardner, "The Microchip PIC in CCS C", Ccs Inc, 2nd Revision Edition, 2002.

**Web References:**

1. http://www.keil.com/forum/5973/
2. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Embedded%20systems /New_index1.html
3. http://nptel.iitg.ernet.in/courses/Elec_Engg/IIT%20Delhi/Embedded%20Systems%20(Video).htm
4. http://freevideolectures.com/Course/2999/Embedded-Systems-I/5

**E-Text Books:**

1. http://teachers.teicm.gr/kalomiros/Mtptx/e-books/eBook%20-%20PIC%20Programming%20with%20C.pdf
2. http://www.ecpe.nu.ac.th/ponpisut/22323006-Embedded-c-Tutorial-8051.pdf
3. http://dsp-book.narod.ru/CPES.pdf
4. http://staff.ustc.edu.cn/~shizhu/WinCE/winCE6%20Fundamentals.pdf
5. http://read.pudn.com/downloads167/ebook/769402/Wrox.Professional.Microsoft.Windows.Embedd
6. ed.CE.6.0.Nov.2008.eBook-DDU.pdf
7. https://syhpullpdf.files.wordpress.com/2015/05/embedded-systems-textbook-pdf.pdf

## ADVANCED JAVA PROGRAMMING AND WEB SERVICES

**Open Elective I: AE / (CAD/CAM) / ES / ST / PEED**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BCS701 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Understand OOPS Concepts Describe client side technologies.
II. Implement database connections.
III. Develop the skills to design user interfaces for web Applications.

| UNIT-I | INTRODUCTION TO OOPs | Classes: 09 |
|---|---|---|

Basic concepts of OOPs: Java History, Java Features, Comparison in Java and C++, Java Virtual Machine, Java Environment, Program, Data types, operators, Control Structure, Classes and Objects, Constructors, Interfaces, Exception Handling.

| UNIT-II | APPLETS AND SWINGS | Classes: 09 |
|---|---|---|

Applets: Introduction to applet, applet vs application, applet class, advantages of applet, applet lifecycle, applet tag, passing parameters to applet, types of applets, examples; swing: introduction to JFC, swing, Swing, Features, JComponent, JApplet, JFrame, JPannel, JButtons, Jcheckboxes and JRadiobuttons, JTextField, JMenu, JMenuBar

| UNIT-III | HTML AND XML | Classes: 09 |
|---|---|---|

HTML common tags: list, tables, images, forms, frames; cascading style sheets; introduction to java scripts, objects in java script, dynamic HTML with java script.

XML: document type definition, XML schemas, document object model, presenting XML, using XML processors: DOM and SAX.

| UNIT-IV | WEB SERVERS,SERVLETS AND JSP | Classes: 09 |
|---|---|---|

Web servers: Tomcat server installation and testing, introduction to servelets: lifecycle of a servelet, JSDK, servelet API, javax. servelet package, reading servelet parameters, reading initialization parameters; servlets: javax, servelet HTTP package, handling http request and responses, using cookies session tracking, security issues, JSP: problem with servelet, anatomy of a JSP Page, JSP processing, JSP application design with MVC architecture, AJAX.

| UNIT-V | JDBC AND ODBC | Classes: 09 |
|---|---|---|

JDBC & ODBC :Java and JDBC , JDBC vs ODBC, JDBC driver model, JDBC driver types, two-tier architecture for data access ,three-tier architecture for data access , types of driver managers, connecting to an ODBC data source, JDBC programs

**Text Books:**

1. Dreamtech Chris Bates, "Web Programming, building internet applications", WILEY, 2nd Edition.
2. Patrick Naughton and Herbert Schildt, "The complete Reference Java 2" , TMH, 5th Edition.
3. Hans Bergsten , "Java Server Pages", SPD O"Reilly.

**Reference Books:**

1. Sebesta, "Programming world wide web", Pearson Core,8th Edition 2008.
2. Marty Hall, Larry Brown, "Servlets and Javaserver Pages", Volume 1: Core Technologies, Pearson 2nd Edition 1998.

**Web References:**

1. http://engineeringppt.blogspot.in/2010/01/advance-java-web-technology.html
2. http://www.scoopworld.in/2015/02/ajwt-ppt-lab-materials-cse.html
3. http://jntuh.ac.in/new/bulletin_board/WEB_TECHNOLOGIES.pdf

**E-Text Books:**

1. http://www.freetechbooks.com/advanced-programming-for-the-java-2-platform-t36.html
2. https://www.mkyong.com/featured/top-5-free-java-ebooks/
3. http://www.e-booksdirectory.com/listing.php?category=226

# INTRODUCTION TO AEROSPACE ENGINEERING

**Open Elective I: (CAD/CAM) / CSE / ES / SE / ST / PEED**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE701 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Outline different aspects of flight vehicles and their operational environment.
II. Description of flow behavior of one-dimensional incompressible and compressible flow, two-dimensional flow and finite wing.
III. Apprise about boundary layer effects, aerodynamic forces on airfoils, wings and high-lift systems.
IV. Analyze airplane performance, stability and control.

| UNIT-I | INTRODUCTION TO AERONAUTICS AND ASTRONAUTICS | Classes: 08 |
|---|---|---|

Historical perspective of aeronautics and astronautics, anatomy of the airplane, anatomy of a space vehicle, aerodynamic forces; Parameters affecting aerodynamic forces: Dimensional analysis; Theory and experiment, wind tunnels; Atmosphere: Properties of U.S. standard atmosphere, definitions of altitude.

| UNIT-II | ONE DIMENSIONAL FLOW IN INCOMPRESSIBLE AND COMPRESSIBLE FLUIDS, TWO DIMENSIONAL FLOW AND FINITE WING | Classes: 10 |
|---|---|---|

Continuity equation, Bernoulli's equation; Application of Bernoulli's equation: Airspeed indicators and wind tunnels, one dimensional compressible flow concepts, speed of sound, compressible flow equations in a variable-area stream tube, application to airspeed measurement, applications to channels and wind tunnels; Two dimensional flow and finite wing: Limitations of one dimensional flow equations; Theory of lift: circulation, Airfoil pressure distribution, Helmholtz vortex theorems, Simulating the wing with a vortex Line, downwash, elliptic lift distribution; Lift and drag: Momentum and energy, Slope of finite wing lift curve, verification of Prandtl wing theory, additional effects of wing vortices, search for reduced induced drag.

| UNIT-III | VISCOUS EFFECTS, DRAG DETERMINATION, AIRFOILS, WINGS AND HIGH-LIFT SYSTEMS | Classes: 10 |
|---|---|---|

Boundary layer, boundary layer on bluff bodies, creation of circulation, laminar and turbulent boundary layers: skin friction, nature of Reynolds number, effect of turbulent boundary layer on separation; Total Incompressible drag: Parasite drag, drag due to lift, importance of aspect ratio; Compressibility drag: Prediction of drag divergence Mach number, sweptback wings, total drag.

Supersonic flow: Shock waves and Mach waves, supersonic wing lift and drag, area rule, supersonic aircraft, airfoils; Wings: early airfoil development, modern airfoils, supersonic airfoils, airfoil pitching moments, effects of sweepback on lift, airfoil characteristics, airfoil selection and wing design; High-lift Devices: Airfoil maximum lift coefficient, leading and trailing edge devices, effect of sweepback, deep stall, effect of Reynolds number, propulsive lift.

| UNIT-IV | AIRPLANE PERFORMANCE, STABILITY AND CONTROL, AEROSPACE PROPULSION | Classes: 09 |
|---|---|---|
| Level flight performance, climb performance, range, endurance, energy-state approach to airplane performance, takeoff performance, landing performance; Static longitudinal stability; Dynamic longitudinal stability; Dynamic lateral stability; Control and maneuverability: Turning performance, control systems, active controls; Aerospace propulsion: Piston engines, gas turbines; Speed limitations of gas turbines: Ramjets, propellers, overall propulsion efficiency, rocket engines, rocket motor performance, propulsion-airframe integration. | | |
| **UNIT-V** | **AIRCRAFT STRUCTURES, HYPERSONIC FLOWS, ROCKET TRAJECTORIES AND ORBITS** | **Classes: 08** |
| Aircraft structures: Importance of structural weight and integrity, development of aircraft structures, importance of fatigue, materials, loads, weight estimation; Hypersonic flows: temperature effects, Newtonian theory; rocket trajectories, multistage rockets, escape velocity, circular orbital or satellite velocity, elliptical orbits, orbital maneuvers. | | |

**Text Books :**

1. Richard S. Shevell, Fundamentals of Flight, Pearson Education Publication, 2nd Edition, 1988.
2. Anderson J. D, "Introduction to Flight", McGraw-Hill, 5th Edition, 1989.
3. Newman D, "Interactive Aerospace Engineering and Design", McGraw-Hill, 1st Edition, 2002.
4. Barnard R.H and Philpot. D.R, "Aircraft Flight", Pearson, 3rd Edition, 2004.

**Reference Books:**

1. Introduction to Flight, John D. Anderson, Jr., Tata McGraw-Hill Publishing Company, Fifth Edition, Fifth Edition, 2007.
2. Kermode, A. C, "Flight without Formulae", McGraw Hill, 4th Edition, 1997.
3. Swatton P. J, "Flight Planning", Blackwell Publisher, 6th Edition, 2002.

**Web References:**

1. https://fas.org/irp/doddir/army/fm3-04-203.pdf
2. http://www.aerospaceengineering.es/book/
3. http://www.ne.nasa.gov/education/
4. http://nptel.ac.in

**E-Text Books:**

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

# GEOSPATIAL TECHNIQUES

**Open Elective-II: AE / (CAD/CAM) / CSE / ES / SE /PEED**

| Course Code | Category | Periods / Week | | | Credit | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BST702 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | | Total Classes: 45 | | |

**OBJECTIVES:**

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

I. Provide technical skills to use geo-referenced data for the purpose of economic, educational, and social development.
II. Learn the art of image interpretation and mapping.
III. Learn the applications of geospatial technologies.

| UNIT-I | INTRODUCTION TO GEOSPATIAL DATA | Classes: 09 |
|---|---|---|

Geospatial data, why to study geospatial data, importance of geospatial technology, spatial data infrastructure, three important geospatial technologies, spatial elements., coordinates and coordinate systems, basic electromagnetic radiation.

| UNIT-II | PHOTOGRAMMETRY AND REMOTE SENSING | Classes: 10 |
|---|---|---|

Definition and scope, history of photogrammetry and remote sensing, principle, remote sensing data acquisition, Remote sensing data analysis methods, advantages and limitations, hardware and software required. Map Vs mosaic, ground control points. Energy interactions with atmosphere and earth surface features.

| UNIT-III | MAPPING AND CARTOGRAPHY | Classes: 10 |
|---|---|---|

What is map and its importance, map scale and types, elements of map and Indexing, map coordinate systems, visual interpretation of satellite images, and interpretation of terrain evaluation.

Introduction to digital data analysis, cartographic symbolization, classification of symbols, colours in cartography, scale and purpose of a map, cartographic design, thematic cartography, digital cartography.

| UNIT-IV | GEOGRAPHIC INFORMATION SYSTEM | Classes:10 |
|---|---|---|

Introduction to GIS, definition and terminology, GIS categories, components of GIS, fundamental operations of GIS, theoretical framework for GIS, GIS data structures, data collection and input overview, processing of spatial data, data Input or output, vector data model, raster data model, geometric representation of spatial feature and data structure. Spatial data and modeling, TIN, DTM, overlay, spatial measurement etc.,

| UNIT-V | GEOSPATIAL TECHNOLOGIES APPLICATIONS | Classes:09 |
|---|---|---|

Visual image analysis for land use / land cover mapping, land use and land cover in water resources, surface water mapping and Inventory, geological and soil mapping, agriculture applications for forestry applications, water resources applications, urban and regional planning, environmental assessment, principles of land form identification and evaluation: sedimentary, igneous and metamorphic rock terrain.

**Text Books :**

1. John D. Bossler, "Manual of Geospatial Science and Technology" Taylor & Francis.
2. M. Anji Reddy, "Textbook of Remote Sensing and Geographical Information Systems", BS Publications.

**Reference Books:**

1. C. P. Lo Albert, K.W. Yonng, "Concepts and Techniques of GIS", Prentice Hall (India) Publications.
2. Peter A Burragh and Rachael A. Mc Donnell, "Principles of Geo- Physical Information Systems", Oxford Publishers, 2004.
3. M. Anji Reddy, "Geo-informatics for Environmental Management" BS Publications.

**Web References:**

1. https://www.aaas.org/content/what-are-geospatial-technologies
2. http://www.istl.org/10-spring/internet2.htmls

**E-Text Books:**

1. http://www.springer.com/us/book/9781441900494
2. https://www.amazon.com/Introduction-Geospatial-Technologies-Bradley-Shellito/dp/146413345X
3. http://www.springer.com/us/book/9784431555186
4. http://gep.frec.vt.edu/VCCS/materials/2011/Day1/Handouts/1.2-Ch.1_GIS_Intro.pdf
5. http://www.slideshare.net/CuteGirl11/introduction-to-geospatial-technologies-pdf

# SOLAR PHOTOVOLTAIC ENERGY CONVERSION

**Open Elective II : AE / (CAD / CAM) / CSE / ES / SE / ST**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BPE702 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Illustrate the operation of Photo voltaic power generation.
II. Analyze the characteristics of solar photovoltaic power generation.
III. Design energy conversion systems with low impact on environment.
IV. Understand the technology of fuel cells.

| UNIT-I | INTRODUCTION | Classes: 09 |
|---|---|---|

Introduction: Highlights, an atomic description of silicon, the effect of light on silicon the potential barrier, the function of the barrier, the potential barrier in action the electric current.

| UNIT-II | PHYSICAL ASPECTS OF SOLAR CELL EFFICIENCY | Classes: 09 |
|---|---|---|

Physical aspects of solar cell efficiency: Reflection light with too little or too much energy, recombination of electron hole pairs, direct recombination indirect recombination, resistance, self shading, performance degradation at non optimal temperatures, high temperature losses, low temperature losses.

| UNIT-III | SINGLE CRYSTAL SILICON SOLAR CELLS AND ARRAYS | Classes: 09 |
|---|---|---|

Single Crystal Silicon Solar cells: New fabrication edge, defined film fed growth (dendritic web growth, Ribbon to ribbon (rtr) growth innovative cell designs back surface fields (BSF) and other minority carrier mirrors (MCM). Schottky barrier cells, inversion layer cells, cells for concentrated sun light advances in component technology highlights, PV building blocks, boosting voltage and amperage design requirements for connecting components, the physical connection. placing the cells;

Arrays: Array support, module covers, module cooling, hybrid designs, Brayton cycle, electricity production, the rmo electric generators, intercepting sunlight, arrays with relectors, arrays that follow the sun, controlling intensity, imaging optics, mirrors,
lenses tracking devices, steering mechanisms, tracking device controls, optimizing the use of the spectrum, splitting the spectrum, converting the spectrum to a single color.

| UNIT-IV | SOLAR ARRAY CONSTRUCTIONS | Classes: 09 |
|---|---|---|

Solar array constructions: Intercepting sunlight, arrays with relectors, arrays that follow the sun, controlling intensity, imaging optics, mirrors, lenses; Tracking devices: steering mechanisms, tracking device controls, optimizing the use of the spectrum, splitting the spectrum, converting the spectrum to a single color.

| UNIT-V | PV SUPPORT EQUIPMENT | Classes: 09 |
|---|---|---|

PV support equipment: PV vs conventional electricity, storing PV's electricity, batteries, fuel cells, power conditioning equipment the inverter regulators other devices; system analysis, design procedure, design constraints, other considerations.

**Text Books:**

1. CS Solanki, "Solar photovoltaic's fundamentals, Technologies and Applications", PHI Learning Pvt. Ltd., 2011.
2. Rai. G.D, "Solar energy utilization", Khanna publishes, 1993.
3. Rai,G.D., "Non- conventional resources of energy", Khanna publishers, Fourth edition, 2010.

**Reference Books:**

1. Rai. G.D, "Solar energy utilization", Khanna publishes, 1993.
2. Pai, B. R. and Ram Prasad, "Power Generation through Renewable Sources of Energy", Tata McGraw Hill, New Delhi, 1991.
3. Bansal, Kleeman and Meliss, "Renewable Energy Sources and Conversion Techniques", Tata Mc Graw Hill, 1990.
4. Godfrey Boyl, "Renewable Energy: Power sustainable future", Oxford University Press, Third edition, 2012.
5. B.H.Khan, "Non-Conventional Energy Resources", The McGraw Hills, Second edition, 2009.
6. John W Twidell and Anthony D Weir, "Renewable Energy Resources", Taylor and Francis, 2006.

**Web References:**

1. http://www.tue.nl/fileadmin/content/faculteiten/tn/PMP/White_papers/Delft2012_-_ALD4PV.pdf
2. http:// www.en.wikipedia.org/wiki/Photovoltaics
3. http://www.desware.net/Sample-Chapters/D06/D10-014.pdf
4. http://www.southampton.ac.uk/~solar/files/Strasbourg.pdf
5. http:// www.science.nasa.gov/science-news/science-at-nasa/2002/solarcells/

**E-Text Books:**

1. http://www.nrel.gov/docs/legosti/old/1448.pdf
2. http://www.irena.org/DocumentDownloads/Publications/IRENAETSAP%20Tech%20Brief%20E11%20Solar%20PV.pd
3. http://www.opalrt.com/sites/default/files/technical_papers/SOLAR%20PHOTOVOLTAIC%20ENERGY%20GENERATION%20AND%20CONVERSION.pdf

# COMPUTER GRAPHICS

**Open Elective II: AE / CSE / ES / SE / ST / PEED**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BCC702 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Understand the basics of Computer Graphics needed for CAD/ CAM applications.
II. Apply the geometrical modeling for computer graphics.
III. Apply data structures in computer graphics.

| UNIT-I | INTRODUCTION TO COMPUTER GRAPHICS | Classes: 09 |
|---|---|---|

Introduction: Role of computer graphics in CAD/CAM, configuration of graphic workstations, menu design and graphical user interfaces, customization and parametric programming.

| UNIT-II | GEOMETRIC TRANSFORMATIONS, PROJECTIONS AND FUNDAMENTALS OF 2D AND 3D TRANSFORMATIONS | Classes: 09 |
|---|---|---|

Geometric transformations and projections: Vector representation of geometric entities, homogeneous coordinate systems; Fundamentals of 2D and 3D transformations: reflection, translation, rotation, scaling, and shearing, various types of projections.

| UNIT-III | DEVELOPMENT OF GEOMENTRICAL MODELLING | Classes: 09 |
|---|---|---|

Curves: Modeling planar and space curves, analytical and synthetic approaches, non-parametric and parametric equations.

Surfaces: Modeling of bi-parametric freedom surfaces, Coons, Bezier, B-spline, and NURBS surfaces, surface manipulation techniques.

| UNIT-IV | GEOMENTRICAL MODELING | Classes: 09 |
|---|---|---|

Geometric Modeling: Geometric modeling techniques, wireframe modeling, solid modeling: B Rep CSG, hybrid modelers, feature based, parametric and variation modeling.

| UNIT-V | DATA STRUCTURES IN COMPUTER GRAPHICS | Classes: 09 |
|---|---|---|

Data Structure in Computer Graphics: Introduction to product data standards and data structures, data-base integration for CIM.

**Text Books:**


1. D. F. Rogers, J. A. Adams, “Mathematical Elements for Computer Graphics”, Tata McGraw Hill. 1989.
2. I. D. Faux, M. J. Pratt, “Computational Geometry for Design and Manufacture”, Ellis Horwood, 1979.
3. Mortenson, M. E., “Geometric Modeling”, 3rd Ed., Industrial Press. 2006
4. Ibrahim Zeid, “CAD/CAM: Theory and Practice”, Tata McGraw Hill, 1998.
5. B. K. Choi, B. K., “Surface Modeling for CAD/CAM", John Wiley & Sons 1991

| **Reference Books:** |
| --- |
| 1.C. Pozrikidis, “Introduction to Theoretical and Computational Fluid Dynamics”, Oxford University Press, 2nd Edition, 2013.<br>2.V. Patankar, Hema shava Suhas , “ Numerical heat transfer and fluid flow”, Tata McGraw Hill |
| **Web References:** |
| 1. http://nptel.ac.in/courses/106106090/<br>2. http://nptel.ac.in/courses/112102101/ |
| **E-Text Books:** |
| 1. http://www.freebookcentre.net/CompuScience/Free-Computer-Graphics-Books-Download.html<br>2.https://docs.google.com/file/d/0B_YZ665nBRhlYmNiOTU5ZDItMmU2OC00YTVmLThiNmMtMjg<br>3 Y2E3ZTgwZDYw/edit?hl=en_US&pref=2&pli=1 |

# MICROCONTROLLERS FOR EMBEDDED SYSTEM DESIGN

**Open Elective II: AE / (CAD / CAM) / CSE / SE / ST /PEED**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BES702 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Understand hardware units and devices for design of embedded systems.
II. Use architectures of embedded RISC processors and system on chip processor design of embedded systems.
III. Analyze interrupt latency, context switching time, for development of device drives for timing devices.

| UNIT-I | INTRODUCTION TO EMBEDDED SYSTEMS | Classes: 09 |
|---|---|---|

Overview of embedded systems, processor embedded into a system, embedded hardware units and devices in system, embedded software, complex system design, design process in embedded system, formalization of system design, classification of embedded systems.

| UNIT-II | MICROCONTROLLERS | Classes: 09 |
|---|---|---|

8051 architecture, input/output ports and circuits, external memory, counters and timers, PIC controllers; Interfacing processor 8051, PIC, memory interfacing, I/O devices, memory controller and memory arbitration schemes.

| UNIT-III | EMBEDDED RISC PROCESSORS | Classes: 09 |
|---|---|---|

Programmable system on chip architectures, continuous timer blocks, switched capacitor blocks, I/O blocks, digital blocks, programming of PSOC.

Embedded RISC processor architecture, ARM processor architecture, registers set, modes of operation and overview of Instructions.

| UNIT-IV | INTERRUPTS AND DEVICE DRIVERS | Classes: 09 |
|---|---|---|

Exceptions and Interrupt handling Schemes, Context and periods for context switching, deadline and interrupt latency; Device driver using interrupt service routine, serial port device driver and device drivers for internal programmable timing devices.

| UNIT-V | NETWORK PROTOCOLS | Classes: 09 |
|---|---|---|

Serial communication protocols, Ethernet protocol, SDMA, Channel and IDMA, external bus interface.

**Text Books:**


1. Raj Kamal, "Embedded Systems, Architecture Programming and Design", Tata Mc Graw Hill, 2nd Edition, 2008.
2. Muhammad Ali Mazidi, Rolin D. Mckinaly, Danny Causy, "PIC Microcontroller and Embedded Systems", Pearson Education, 1st Edition, 2008.

3. Robert Ashpy, “Designers Guide to the Cypress PSOC”, Elsevier, 1st Edition, 2005.

**Reference Books:**

1. Jonathan W. Valvano – Brookes / Cole, “Embedded Microcomputer Systems, Real Time Interfacing”, Thomas Learning, 1st Edition, 1998.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, “ARM Systems Developers Guides, Design & Optimizing System Software”, Elsevier, 1st Edition, 2004.
3. John B. Peatman, “Designing with PIC Microcontrollers”, PH Inc, 1st Edition, 1998.

**Web References:**

1. http://nptel.ac.in/syllabus/108102045/
2. http://nptel.ac.in/courses/Webcourse-contents/IIT,KANPUR/microcontrollers/micro/ui/Course_home1_1.Htm

**E-Text Books:**

1. http://microcontrollershop.com/default.php?cPath=239
2. http://www.sciencedirect.com/science/book/9780750667555
3. https://books.google.co.in/books/about/Embedded_Systems_Design_with_8051_Microc.html?id=YiTa,HChn0UC&redir_esc=y
4. https://books.google.co.in/books/about/Microcontroller_And_Embedded_Systems.html?id=4GrXJeC6HFkC

## LINUX PROGRAMMING

**Open Elective II: AE / (CAD/CAM) / ES / ST / PEED**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BCS702 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Total Tutorials: Nil | Total Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Understand basic Linux utilities and Shell scripting language (bash) to solve Problems.
II. Explore on implementation of Linux utilities using system calls.
III. Develop the skills necessary for systems programming
IV. Illustrate the basic skills required to write inter process communication programs.

| UNIT-I | LINUX UTILITIES | Classes: 09 |
|---|---|---|

File handling utilities, Security by file permissions, Process utilities, Disk utilities, Networking commands, Filters, Text processing utilities and Backup utilities; Sed-Scripts, Operation, Addresses, Commands, awk-Execution, Fields and Records, Scripts, Operation, Patterns, Actions, Associative Arrays, String and Mathematical functions, System commands in awk, Applications.

| UNIT-II | SHELL PROGRAMMING | Classes: 09 |
|---|---|---|

Introduction, shell responsibilities, pipes and Redirection, here documents, running a shell script, the shell as a programming language, shell meta characters, file name substitution, shell variables, command substitution, shell commands, the environment, quoting, test command, control structures, arithmetic in shell, shell script examples, interrupt processing, debugging shell scripts.

| UNIT-III | FILES AND DIRECTORIES | Classes: 09 |
|---|---|---|

Files: File types, File System Structure, file metadata: Inodes, kernel support for files, system calls for file I/O operations: open, create, read, write, close, lseek, dup2, file status information: stat family, file and record locking: fcntl function.

File permissions - chmod, fchmod, file ownership, links: soft and hard links: symlink, link, unlink. Directories: Creating, removing and changing Directories, obtaining current working directory: getcwd, Directory contents, Scanning Directories: opendir, readdir, closedir, rewinddir functions.

| UNIT-IV | INTERPROCESS COMMUNICATION AND MESSAGE QUEUES | Classes: 09 |
|---|---|---|

Introduction to IPC, IPC between processes on a single computer system, IPC between processes on different systems, pies-creation, IPC between related processes using unnamed pipes, FIFOs: creation, IPC between unrelated processes using FIFOs(Named pipes), differences between unnamed and named pipes, popen and pclose library functions, Message Queues: Kernel support for messages, APIs for message queues, client/server example. Semaphores-Kernel support for semaphores, APIs for semaphores, file locking with semaphores.

| UNIT-V | SHARED MEMORY AND SOCKETS | Classes: 09 |
|---|---|---|

Shared Memory: Kernel support for shared memory, APIs for shared memory, shared memory example, Sockets: Introduction to Berkeley Sockets, IPC over a network, Client-Server model, Socket address structures (unix domain and Internet domain), Socket system calls for connection oriented protocol and connectionless protocol.

**Text Books:**


1. T. Chan , "Unix System Programming using C++", PHI, 2nd Edition,2005.
2. Sumitabha Das, "Unix Concepts and Applications", 4th Edition, TMH, 2011.
3. W. R. Stevens , "Unix Network Programming", PHI, 2nd Edition ,1999.


**Reference Books:**


1. Mathew, R. Stones, Wrox, "Beginning Linux Programming", Wiley India Edition,4th Edition,2008.
2. Graham Glass, King Ables, "Unix for programmers and users", 3rd Edition,Pearson, 2006.
3. Hoover, "SystemProgramming with C and Unix", Pearson, 2nd Edition ,2009.
4. K. A. Robbins, "Unix System Programming, Communication, Concurrency and Threads", Pearson Education, 6th Edition, 2007.


**Web References:**

1. http://www.fuky.org/abicko/beginning-linux-programming.pdf
2. https://www.pdc.kth.se/about/links/linux-programming-for-beginners
3. http://www.tutorialspoint.com/unix/unix_tutorial.pdf
4. http://www.rpi.edu/dept/arc/training/shell/slides.pdf

**E-Text Books:**

1. http://onlinevideolecture.com/ebooks/?subject=Linux
2. http://www.onlineprogrammingbooks.com/linux-succinctly/
3. http://ebook-dl.com/item/beginning_linux_programming_4th_edition_neil_matthew_richard_stones/

# RESEARCH METHODOLOGY

**Open Elective II: AE / (CAD / CAM) / CSE / ES / SE / ST / PEED**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BCS703 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | | Total Classes: 45 | | |

**OBJECTIVES:**

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

I. Identify an appropriate research problem in their interesting domain.
II. Organize and conduct research project.
III. Prepare a research project thesis report.
IV. Understand the law of patent and copyrights.
V. Adequate knowledge on process for filing Patent.

| | | |
|---|---|---|
| **UNIT-I** | **INTRODUCTION** | **Classes: 09** |

Definition, types of research, research approaches, research process, validity and reliability in research, features of good design, types of research design, and basic principles of experimental design.

| | | |
|---|---|---|
| **UNIT-II** | **MEASUREMENT AND SCALING TECHNIQUES** | **Classes: 09** |

Errors in measurement, tests of sound measurement, scaling and scale construction techniques, forecasting techniques, time series analysis, interpolation and extrapolation.

| | | |
|---|---|---|
| **UNIT-III** | **METHODS OF DATA COLLECTION** | **Classes: 09** |

Primary data, questionnaire and interviews, collection of secondary data, cases and schedules.

Professional attitude and goals, concept of excellence, ethics in science and engineering, some famous frauds in science, case studies.

| | | |
|---|---|---|
| **UNIT-IV** | **INTERPRETATION OF DATA AND REPORT WRITING** | **Classes: 09** |

Layout of a research paper, techniques of interpretation, making scientific presentation at conferences and popular lectures to semi technical audience, participating in public debates on scientific issues.

| | | |
|---|---|---|
| **UNIT-V** | **INTRODUCTION TO INTELLECTUAL PROPERTY** | **Classes: 09** |

Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights; Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law; Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer.

**Text Books:**

1. C. R. Kothari, "Research Methodology: Methods and Techniques", New Age International Publishers, 2nd Edition, 2004.

2. P. Gupta, “Statistical Methods”, Sultan Chand and Sons, New Delhi, 1st Edition, 2005.
3. Richard W. Stim, “Intellectual Property: Patents, Trademarks, and Copyrights”, Cengage learning, 2nd Edition, 2001.

**Reference Books:**

1. P. Narayana Reddy, G. V. R. K. Acharyulu, “Research Methodology and Statistical Tools”, Excel Books, New Delhi, 1st Edition, 2008.
2. Prabuddha Ganguli, “Intellectual Property Right, Unleashing the Knowledge Economy”, Tata Mc Graw Hill Publishing Company Ltd, 1st Edition, 2001.

**Web References:**

1. http://nptel.ac.in/courses/109103024/40
2. http://study.com/academy/topic/introduction-to-research-methods.html
3. https://www.vutube.edu.pk/vu-lectures/viewcategory/240/research-methods-sta630

**E-Text Books:**

1. http://www.metastudio.org/Science%20and%20Ethics/file/readDoc/535a76367d9d331598f49e2d/34_Hb_on_IPR.pdf
2. http://www.bits-pilani.ac.in/uploads/Patent_ManualOct_25th_07.pdf
3. http://euacademic.org/BookUpload/9.pdf

# INDUSTRIAL AERODYNAMICS AND WIND ENERGY

**Open Elective II : (CAD/CAM) / CSE / ES / SE / ST / PEED**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| BAE702 | Elective | 3 | - | - | 3 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: Nil | Practical Classes: Nil | | | Total Classes: 45 | | | |

**OBJECTIVES:**

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

I. Understand the atmospheric boundary layer and conditions.
II. Describe the wind energy and its application in turbines.
III. Familiarize with non-aeronautical uses of aerodynamics such as road vehicle, building aerodynamics and problems of flow induced vibrations.

| UNIT-I | ATMOSPHERIC WINDS AND ATMOSPHERIC BOUNDARY LAYER | Classes: 08 |
|---|---|---|

Causes of wind thermal drive, Coriolis effect, pressure gradient effect, Geotropic winds; Land and sea breeze, mountain winds, thermals, cause of turbulence at ground level; Atmospheric boundary layer, velocity profile laws, effects of terrain on atmospheric boundary Layer; Wind tunnels basic features and components; Wind tunnel models, role of non-dimensional groups; Creation of atmospheric boundary layer type flow in a wind tunnel.

| UNIT-II | WIND ENERGY | Classes: 10 |
|---|---|---|

Ship propulsion, sails, lift and drag translators, modern yachts; Horizontal and vertical axis wind turbines: History, first example of automatic feedback control for yaw in $16^{th}$ century English windmills, classification. Horizontal axis wind turbine: Elementary actuator disc theory, Betz coefficient; Definition of power coefficient and torque coefficient for all wind turbines; Working principle, power coefficients, tip speed ratio explanation, by introductory blade element theory, conventional horizontal axis wind turbine, savonious vertical axis wind turbine, Darries vertical axis wind turbine, merits and demerits of horizontal axis wind turbines and vertical axis wind turbines.

| UNIT-III | VEHICLE AERODYNAMICS | Classes: 10 |
|---|---|---|

Relative importance of rolling resistance and aerodynamics resistance, power requirements and drag coefficients of automobiles, notch front and notch rear wind screens versus streamlined shape, causes of vortex formation and drag, attached transverse vortex , trailing vortex, trailing vortex drag, effect of floor height on lift, effects of cut bank angle; Rear end taper.

Side panels and bottom, effects of chamfering of edges and cambering of roof and side panels; Racing cars: Traction and steering strip and use of aerofoils, high cornering seed; Commercial transport vehicles: Drag reduction on buses and tucks, driver cabin and trailer combinations.

| UNIT-IV | BUILDING AERODYNAMICS | Classes: 09 |
|---|---|---|

Use of light weight components in modern buildings, pressure distribution on low-rise buildings, wind forces on buildings-aerodynamics of flat plate and circular cylinder , critical Reynold's no, sub -, super- & ultra critical Reynold's No. Role of wind tunnel requirements in determining shape factors (Drag coefficients) of building/structure shapes such as circular cylinder (chimneys & towers), rectangle, I-shape, L-shape, H-shape etc. vortex shedding & transverse oscillating loads. Slenderness ratio & correction factor. Special problems of tall buildings, interference effect of building.

| UNIT-V | FLOW INDUCED VIBATIONS | Classes: 08 |
|---|---|---|

Classification: Vortex induced vibration and flow induced instability such as galloping and stall flutter; Effects of Reynolds number on wake formation of bluff shapes; Vortex induced vibration: Experimental determination of strouhal numbers for different shapes such as circular cylinder, square, rectangle, L-shape ect, universal strouhal number, unsteady Bernoulli equation, concept of added mass, resonance; Fluid-structure interaction: Effect of transverse cylinder motion on flow and wake, lock-in vortex shedding near resonant frequency, experimental evidence of cylindrical motion influencing flow and thereby reducing strength of shed vortices; Methods of suppression of vortex induced vibration; Galloping & Stall flutter: Motion of one degree-of-freedom, quasi steady flow assumption, aerodynamic damping; Galloping: Force in the direction of plunging (transverse motion ) and positive force coefficient, critical speed, galloping of transmission wire with winter ice, stall flutter of airfoils.

**Text Books :**


1. Siraj Ahmed, "Wind Energy theory and practice", PHI learning Pvt Ltd., 3rd Edition, 2015.
2. R. D. Blevins, "Flow Induced Vibrations", Van Nostard, 2nd Edition, 1990.
3. P. Sachs, "Wind Forces in Engineering", Pergamon press, 2nd Edition, 1988.
4. N. G. Calvert, "Wind Power Principles", Charles Griffin & co. London, 1st Edition, 1979.


**Reference Books:**


1. R. S. Scorer, "Environmental Aerodynamics", Ellis Harword Ltd, England, 1st Edition, 1978.
2. M. Sorvan, "Aerodynamics Drag Mechanisms of Bluff Bodies and Road vehicles", plenum press, 2nd Edition, 1978.


**Web References:**

1. http://www.mech.canterbury.ac.nz/research/fluid%20mechanics.shtml
2. http://www.journals.elsevier.com/journal-of-wind-engineering-and-industrial-aerodynamics

**E-Text Books:**

1. http://www.sciencedirect.com/science/journal/01676105
2. https://www.scribd.com/doc/42602999/Flow-Induced-Vibration-by-Robert-D-Blevins-2nd-Ed
3. http://store.elsevier.com/Wind-Forces-in-Engineering/Peter-Sachs/isbn-9781483148359/

## VISION AND MISSION OF THE INSTITUTE

### VISION

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

### MISSION

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

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

## M.TECH - PROGRAM OUTCOMES (PO's)

**PO-1:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems (**Engineering Knowledge**).

**PO-2:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences **(Problem Analysis).**

**PO-3:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations **(Design/Development of Solutions).**

**PO-4:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions **(Conduct Investigations of Complex Problems).**

**PO-5:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations **(Modern Tool Usage).**

**PO-6:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice **(The Engineer and Society).**

**PO-7:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development **(Environment and Sustainability).**

**PO-8:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice **(Ethics).**

**PO-9:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings **(Individual and Team Work).**

**PO-10:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions **(Communication).**

**PO-11:** Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO-12:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change **(Life-long learning).**

# OBJECTIVES OF THE DEPARTMENT

## DEPARTMENT OF AERONAUTICAL ENGINEERING

### Program Educational Objectives (PEO's)

The current Aeronautical Engineering program educational objectives were developed as part of the program's ongoing efforts to maintain through innovation in undergraduate program that meets the needs of our constituents. The current educational objectives of the Aeronautical Engineering program are:

**PEO – I:** To prepare and provide student with an academic environment for students to excel in postgraduate programs or to succeed in industry / technical profession and the life-long learning needed for a successful professional career in Aeronautical Engineering and related fields (Preparation & Learning Environment).

**PEO – II:** To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve engineering problems and also to pursue higher studies (Core Competence).

**PEO – III:** To train students with good scientific and engineering breadth so as to comprehend, analyze, design, and create novel products and solutions for the real life problems (Breadth).

**PEO – IV:** To inculcate in students professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate engineering issues to broader social context (Professionalism).

### PROGRAM SPECIFIC OUTCOMES (PSO's)

**PSO – I:** **Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products

**PSO – II:** **Problem solving skills:** Imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles

**PSO – III:** **Practical implementation and testing skills:** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies

**PSO – IV:** **Successful career and entrepreneurship:** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats.

## FREQUENTLY ASKED QUESTIONS AND ANSWERS ABOUT AUTONOMY

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

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

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

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

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

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

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

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

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

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

11. **What is the proportion of Internal and External Assessment as an Autonomous College?**
    Presently, it is 70 % external and 30% internal. As the autonomy matures the internal assessment component shall be increased at the cost of external assessment.

12. **Is it possible to have complete Internal Assessment for Theory or Practicals?**
    Yes indeed. We define our own system. We have the freedom to keep the proportion of external and internal assessment component to choose.

13. **Why Credit based Grade System?**
    The credit based grade system is an accepted standard of academic performance the world over in all Universities. The acceptability of our graduates in the world market shall improve.

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

15. **What are the norms for the number of Credits per Semester and total number of Credits for UG/PG programme?**
    These norms are usually defined by UGC or AICTE. Usually around 25 Credits per semester is the accepted norm.

16. **What is a Semester Grade Point Average (SGPA)?**
    The performance of a student in a semester is indicated by a number called SGPA. The SGPA is the weighted average of the grade points obtained in all the courses registered by the student during the semester.

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

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

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

$$CGPA = \sum_{j=1}^{n} (C_i S_i) / \sum_{j=1}^{n} C_i$$

Where, $S_i$ is the SGPA of the $i^{th}$ semester and $C_i$ is the total number of credits in that semester and $j$ represent the number of courses in which a student's is registered upto the semester. CGPA is rounded to two decimal places.

18. **Is there any Software available for calculating Grade point averages and converting the same into Grades?**
Yes, The institute has its own MIS software for calculation of SGPA, CGPA, etc.

19. **Will the teacher be required to do the job of calculating SGPAs etc. and convert the same into Grades?**
No. The teacher has to give marks obtained out of whatever maximum marks as it is. Rest is all done by the computer.

20. **Will there be any Revaluation or Re-Examination System?**
No. There will double valuation of answer scripts. There will be a make up Examination after a reasonable preparation time after the End Semester Examination for specific cases mentioned in the Rules and Regulations. In addition to this, there shall be a 'summer term' (compressed term) followed by the End Semester Exam, to save the precious time of students.

21. **How fast Syllabi can be and should be changed?**
Autonomy allows us the freedom to change the syllabi as often as we need.

22. **Will the Degree be awarded on the basis of only final year performance?**
No. The CGPA will reflect the average performance of all the semester taken together.

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

24. **Who takes Decisions on Academic matters?**
The Governing Body of institute is the top academic body and is responsible for all the academic decisions. Many decisions are also taken at the lower level like Boards of Studies. Decisions taken at the Board of Studies level are to be ratified at the Academic Council and Governing Body.

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

26. **Is there any mechanism for Grievance Redressal?**
The institute has grievance redressal committee, headed by Dean - Student affairs and Dean - IQAC.

27. **How many attempts are permitted for obtaining a Degree?**
All such matters are defined in Rules & Regulation

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

29. **Who will keep the Student Academic Records, University or IARE?**
It is the responsibility of the Dean, Academics of the Autonomous College to keep and preserve all the records.

30. **What is our relationship with the JNT University?**
We remain an affiliated college of the JNT University. The University has the right to nominate its members on the academic bodies of the college.

31. **Shall we require University approval if we want to start any New Courses?**
Yes, It is expected that approvals or such other matters from an autonomous college will receive priority.

32. **Shall we get autonomy for PG and Doctoral Programmes also?**
Yes, presently our PG programs also enjoying autonomous status.

# MALPRACTICES RULES

## DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

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

| | | |
|---|---|---|
| 4. | Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination. | Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all semester end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. |
| 5. | Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks. | Cancellation of the performance in that subject. |
| 6. | Refuses to obey the orders of the Controller of Examinations /Additional Controller of Examinations/any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the COE or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the COE or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the Institute premises or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination. | In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them. |
| 7. | Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall. | Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all semester end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. |
| 8. | Possess any lethal weapon or firearm in the | Expulsion from the examination hall and |

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

# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

Dundigal, Hyderabad - 500 043

## UNDERTAKING BY STUDENT / PARENT

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

I, Mr./Ms. ---------- joining I Semester for the academic year 2016-2017 in Institute of Aeronautical Engineering, Hyderabad, do hereby undertake and abide by the following terms, and I will bring the ACKNOWLEDGEMENT duly signed by me and my parent and submit it to the Dean, Academic.

1. I will attend all the classes as per the timetable from the starting day of the semester specified in the institute Academic Calendar. In case, I do not turn up even after two weeks of starting of classes, I shall be ineligible to continue for the current academic year.
2. I will be regular and punctual to all the classes (theory/practical/drawing) and secure attendance of not less than 80% in every course as stipulated by Institute. I am fully aware that an attendance of less than 70% in more than three courses will make me lose one year.
3. I will compulsorily follow the dress code prescribed by the college.
4. I will conduct myself in a highly disciplined and decent manner both inside the classroom and on campus, failing which suitable action may be taken against me as per the rules and regulations of the institute.
5. I will concentrate on my studies without wasting time in the Campus/Hostel/Residence and attend all the tests to secure more than the minimum prescribed Class/Sessional Marks in each course. I will submit the assignments given in time to improve my performance.
6. I will not use Mobile Phone in the institute premises and also, I will not involve in any form of ragging inside or outside the campus. I am fully aware that using mobile phone to the institute premises is not permissible and involving in Ragging is an offence and punishable as per JNTUH/UGC rules and the law.
7. I declare that I shall not indulge in ragging, eve-teasing, smoking, consuming alcohol drug abuse or any other anti-social activity in the college premises, hostel, on educational tours, industrial visits or elsewhere.
8. I will pay tuition fees, examination fees and any other dues within the stipulated time as required by the Institution / authorities, failing which I will not be permitted to attend the classes.
9. I will not cause or involve in any sort of violence or disturbance both within and outside the college campus.
10. If I absent myself continuously for 3 days, my parents will have to meet the HOD concerned/ Principal.
11. I hereby acknowledge that I have received a copy of IARE - R16 Academic Rules and Regulations, Syllabus copy and hence, I shall abide by all the rules specified in it.

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### ACKNOWLEDGEMENT

I have carefully gone through the terms of the undertaking mentioned above and I understand that following these are for my/his/her own benefit and improvement. I also understand that if I/he/she fail to comply with these terms, shall be liable for suitable action as per Institute/JNTUH/AICTE/UGC rules and the law. I undertake that I/he/she will strictly follow the above terms.

**Signature of Student with Date**

**Signature of Parent with Date**
**Name & Address with Phone Number**