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 CATALOG AND SYLLABI
MT23

M.Tech Regular Two Year Degree Program
(for the batches admitted from the academic year 2023 - 2024)

These rules and regulations may be altered/changed from time to time by the academic council
FAILURE TO READ AND UNDERSTAND THE RULES IS NOT AN EXCUSE

INSTITUTE VISION | MISSION | QUALITY POLICY

VISION

To bring forth students, professionally competent and socially progressive, capable of working across cultures meeting the global standards ethically.

MISSION

To provide students with an extensive and exceptional education that prepares them to excel in their profession, guided by dynamic intellectual community and be able to face the technically complex world with creative leadership qualities.

Further, be instrumental in emanating new knowledge through innovative research that emboldens entrepreneurship and economic development for the benefit of wide spread community.

QUALITY POLICY

Our policy is to nurture and build diligent and dedicated community of engineers providing a professional and unprejudiced environment, thus justifying the purpose of teaching and satisfying the stake holders.

A team of well qualified and experienced professionals ensure quality education with its practical application in all areas of the Institute.

DEPARTMENT VISION | MISSION

VISION

To build a strong community of dedicated graduates with expertise in the field of aeronautical science and engineering suitable for industrial needs having a sense of responsibility, ethics and ready to participate in aerospace activities of national and global interest.

MISSION

To actively participate in the technological, economic and social development of the nation through academic and professional contributions to aerospace and aviation areas, fostering academic excellence and scholarly learning among students of aeronautical engineering.

M.TECH - PROGRAM OUTCOMES (PO's)

Upon completion of M.Tech Aerospace Engineering, the students will be able to:

PO - 1	:	Independently carry out research /investigation and development work to solve practical problems.
PO - 2	:	Write and present a substantial technical report/document.
PO - 3	:	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO - 4	:	Identify, formulate, analyze and Design complex engineering problems, and design system components or processes by applying appropriate advanced principles of engineering activities and using modern tools.
PO - 5	:	Engage in life-long learning and professional development through self-study and continuing education in understanding the engineering solutions in global and management principles to manage projects in multidisciplinary environments.
PO - 6	:	Function effectively as a member or leader in diverse teams to carry out development work, produce solutions that meet the specified needs with frontier technologies and communicate effectively on complex engineering activities.

CONTENTS

“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.

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 updation 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 course offered by the institute 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 Aerospace Engineering, Computer Science and Engineering, Embedded Systems, Electrical Power Systems, CAD/CAM, Structural Engineering 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

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, course 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 "MT23" 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.

PREFACE

Dear Students,

The focus at IARE is to deliver value-based education with academically well qualified faculty and infrastructure. It is a matter of pride that IARE continues to be the preferred destination for students to pursue an engineering degree.

In the year 2015, IARE was granted academic autonomy status by University Grants Commission, New Delhi under Jawaharlal Nehru Technology University Hyderabad. From then onwards, our prime focus is on developing and delivering a curriculum which caters to the needs of various stakeholders. The curriculum has unique features enabling students to develop critical thinking, solve problems, analyze socially relevant issues, etc. The academic cycle designed on the basis of Outcome Based Education (OBE) strongly emphasizes continuous improvement and this has made our curriculum responsive to current requirements.

The curriculum at IARE has been developed by experts from academia and industry and it has unique features to enhance problem solving skills apart from academic enrichment. The curriculum of M.Tech program has been thoroughly revised as per AICTE / UGC / JNTUH guidelines and have incorporated unique features such as competency training / coding, industry driven elective, internship and many more. The curriculum is designed in a way so as to impart engineering education in a holistic approach towards Excellence.

I hope you will have a fruitful stay at IARE.

Dr. L V Narasimha Prasad
Principal

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

ACADEMIC REGULATIONS

M.Tech. Regular Two Year Degree Program
(for the batches admitted from the academic year 2023 - 24)

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. CHOICE BASED CREDIT SYSTEM

The Indian Higher Education Institutions (HEI's) are changing from the conventional course structure to Choose 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 /mini project work with seminar/ viva / seminars / 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. 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. 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. UNIQUE COURSE IDENTIFICATION CODE

Every specialization of the M.Tech program will be placed in one of the 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	Electrical Power Systems	Electrical and Electronics Engineering	PS
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	Aerospace Engineering	Aeronautical Engineering	AE

5. TYPES OF COURSES

Courses in a program may be of four kinds: **Core, Elective, Open and Mandatory courses.**

5.1 Core Courses:

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

5.2 Elective Courses:

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.

There shall be five professional core 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.

5.3 Open Elective Courses:

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

5.4 Mandatory Audit Courses:

The student may opt for audit courses, starting in first semester onwards. Audit courses can help the student to get awareness of different issues which make impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in each semester is provided in curriculum. Student can choose one audit course from the list. Evaluation of audit course will be done at institute level. Method of conduction and method of assessment for audit courses is suggested.

For mandatory non-credit Audit courses, a student have to secure 40 marks out of 100 marks (i.e. 40% of the marks allotted) in the continuous internal evaluation for passing the course/course. These marks should also be uploaded along with the internal marks of other courses.

No marks or letter grades shall be allotted for mandatory non-credit Audit courses. Its result shall be declared with "Satisfactory" or "Not Satisfactory" performance.

6. SEMESTER STRUCTURE

The M.Tech. Programs in institute are of semester pattern, with four semesters consisting of Two academic years. Each academic year having Two Semesters: Odd and Even. Each Semester shall be of 22 weeks of duration (inclusive of Examinations), with a minimum of 90 instructional days per semester.

The two-year M.Tech. program consists of 68 credits and the student has to register for all 68 credits and earn all 68 credits for the award of M.Tech. degree. There is NO exemption of credits in any case.

UGC/AICTE specified definitions/descriptions are adopted appropriately for various terms and abbreviations used in these PG academic regulations, as listed below:

Each Semester shall have 'Continuous Internal Assessment (CIA)' and 'Semester End Examination (SEE)'. Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) are taken as 'references' for the present set of regulations. The terms 'COURSE' and 'COURSE' imply the same meaning here and refer to 'Theory Course', or 'Lab Course', or 'Design/Drawing Course', or 'Mini Project with Seminar', or 'Dissertation', as the case may be.

Before commencement of the class work, all the eligible students are required to register the courses through Samvidha (Student Management Portal) without fail.

7. PROGRAM DURATION

A student shall be declared eligible for the award of M.Tech degree, if he/she 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 6.0/10.0 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. CURRICULUM AND COURSE STRUCTURE

The curriculum shall comprise Professional core courses, Professional elective courses, Audit courses, Open elective courses, Laboratory courses, Mini project with seminar, Phase-I Dissertation and Phase-II Dissertation.

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.
- **Dissertation Work / Project work:** 1 credit for 2 hours of project work per week.

Other student activities like study tour, guest lecture, conference/workshop participations, technical paper presentations and mandatory courses (Non-credit Audit Courses) will not carry any credits.

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	Professional Elective Courses	3	3
3	Audit Courses	2	0
4	Laboratory Courses	4	2
5	Open Elective Courses	3	3
6	Mini Project with Seminar	2	2
7	Phase - I Dissertation	20	10
8	Phase - II Dissertation	32	16

8.2 Course wise break-up for the total credits:

Total Theory Courses (12) Core Courses (04) + Professional Core Electives (05) + Open Electives (01)	04@3credits + 05 @ 3 credits + 01@3 credits	30
Total Laboratory Courses (04)	04@2credits	08
Mini Project with Seminar (01)	1@2credit	02
Research Methodology and IPR	1@2 credit	02
Phase-I Dissertation	1 @10credit	10
Phase-II Dissertation	1 @16credits	16
TOTAL CREDITS		**68**

9. EVALUATION METHODOLOGY

9.1 Theory Course:

Each theory course will be evaluated for a total of 100 marks, out of which 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE).

9.1.1 Semester End Examination (SEE):

The SEE shall be conducted for 60 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE modules and each module 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 12 marks. There could be a maximum of two / 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. CIA is conducted for a total of 40 marks, with 30 marks for Continuous Internal Examination (CIE), 05 marks for Assignment and 05 marks for Alternative Assessment Tool (AAT). **Two CIE Tests are Compulsory** and sum of the two tests, along with the scores obtained in the assignment and AAT shall be considered for computing the final CIA of a student in a given course.

The CIE Tests/Assignment /AAT shall be conducted by the course faculty with due approval from the HOD. Advance notification for the conduction of Assignment/AAT is mandatory and the responsibility lies with the concerned course faculty.

Table 4: Outline of the Continuous Internal Assessments (CIA – 1 and CIA – 2) and SEE

Activities	CIA - 1	CIA - 2	SEE	Total Marks
Continuous Internal Examination (CIE)	10 marks	10 marks		20 marks
Assignment / Quiz	05 marks	05 marks		10 marks
Alternative Assessment Tool (AAT)	05 marks	05 marks		10 marks
Semester End Examination (SEE)			60 marks	60 marks
Total	--	--	100 marks	

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered. The valuation and verification of answer scripts of CIE exams shall be completed within a week after the conduct of the Examination.

Assignment:

To improve the writing skills in the course an assignment will be evaluated for 05 marks. Assignment has to submit either at the end of the CIE1 or CIE2 for the questions provided by each course coordinator in that semester. Assignments to be handed in as loose paper collection stapled together at the top left corner. The assignment should be presented as a professional report. It must consist of a cover sheet, content page, and should have an introduction, a body, a conclusion or recommendation, and a reference page.

Quiz: It is online proctor based online examination conducted either at the end of the CIE1 or CIE2.

The choice of conduction of Assignment / Quiz in CIE1 or CIE2 is purely choice of course handling faculty.

Alternative Assessment Tool (AAT):

In order to encourage innovative methods while delivering a course, the faculty members are encouraged to use the Alternative Assessment Tool (AAT). This AAT enables faculty to design own assessment patterns during the CIA. The AAT enhances the autonomy (freedom and flexibility) of individual faculty and enables them to create innovative pedagogical practices. If properly applied, the AAT converts the classroom into an effective learning center. **The AAT may include, Course related term paper, Technical seminar, Term paper, Case Study, Paper presentations conducted by reputed organizations relevant to the course etc.**

The choice of selection of AAT is based on course handling faculty.

Note:

First mid-term examination shall be conducted on 50% of the syllabus, and the second mid-term examination shall be conducted on the remaining 50% of the syllabus.

The semester end examinations (SEE), for theory courses, will be conducted for 60 marks consisting of five questions (numbered from 1 to 5) carrying 12 marks each. Each of these questions is from each module and may contain sub-questions, for each question there will be an "either" "or" choice, which means, there will be two questions from each module, student should answer either of the two questions.

The duration of Semester End Examination is 3 hours.

9.2 Laboratory Course: For practical courses there shall be a Continuous Internal Assessment (CIA) during the semester for 40 marks and 60 marks for semester end examination. Out of the 40 marks for internal evaluation:

1. A write-up on day-to-day experiment in the laboratory (in terms of Preparation / Performance in the laboratory / Calculations and graphs / Results and error analysis / Viva-voce) which shall be evaluated for **10 marks**.
2. Viva-voce (or) tutorial (or) case study (or) application (or) poster presentation of the course concerned – **10 marks.**
3. Internal practical examination conducted by the laboratory teacher concerned shall be evaluated for **10 marks.**
4. The remaining 10 marks are for Laboratory Project, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.
5. The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the cluster / other colleges which will be decided by the Principal. The Semester End Examination held for 3 hours and total 60 marks are divided and allocated asshown below:

    1. 10 marks for write-up
    2. 15 for experiment/program
    3. 15 for evaluation of results
    4. 10 marks for presentation on another experiment/program in the same laboratory course
    5. 10 marks for viva-voce on concerned laboratory course

9.3 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.

Registration of Dissertation Work: A candidate is permitted to register for the Dissertation Work after satisfying the attendance requirement in all the courses, both theory and laboratory. After satisfying the attendance requirement candidate must present in Dissertation Work Review - I, in consultation with his Supervisor, the title, objective and plan of action of his/her Dissertation work to the Project Review Committee (PRC) for approval within four weeks from the commencement of III semester. Only after obtaining the approval of the PRC can the student initiate the Dissertation work.

9.3.1 The student shall submit the project work synopsis at the end of III semester for Phase-I of project evaluation. The Phase-I Dissertation 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, Supervisor / Guide and Head of the Department.

9.3.2 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.

9.3.3 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 Supervisor/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	Supervisor / Guide	40
2		Evaluation at the end of III Semester	Project Review Committee (PRC) comprising of senior faculty of the specialization, Supervisor / Guide and HOD.	60
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 Supervisor / Guide wherein the HOD convenes its meeting.	40
4		End Semester Examination (An open seminar followed by viva- voce)	The External Evaluation Committee (EEC) comprising of External Examiner, HOD and Supervisor / Guide wherein the HOD shall be the chairman of the committee.	60
Total (Phase-II)				**100**

9.3.4 As soon as a student submits project work, Principal shall appoint the external examiner among the panel of examiners recommended by the Chairman, BOS (PG).

9.3.5 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.

9.3.6 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.

10. ATTENDANCE REQUIREMENTS AND DETENTION POLICY

The programs are offered based on a unit system with each course being considered a unit. Attendance is calculated separately for each course.

10.1 Attendance in all classes (Lectures/Laboratories) is compulsory. The minimum required attendance in each theory course (***also mandatory Audit Courses***) including the attendance of mid-term

examination / Laboratory etc. is 75%. Two periods of attendance for each theory course shall be considered, if the student appears for the mid-term examination of that course. A student shall not be permitted to appear for the Semester End Examinations (SEE), if s/he attendance is less than 75%.

10.2 **A** student's Seminar report and presentation on Mini Project shall be eligible for evaluation, only if he ensures a minimum of 75% of his attendance in seminar presentation classes on Mini Project during that semester.

10.3 **Condoning of shortage of attendance** (between 65% and 75%) up to a maximum of 10% (considering the days of attendance in sports, games, NCC, NSS activities and medical grounds) in each course (Theory /Laboratory / Mini Project with Seminar) of a semester shall be granted by the institute academic committee on genuine reasons.

10.4 A prescribed fee per course shall be payable for condoning shortage of attendance.

10.5 Shortage of Attendance below 65% in any course shall in **no case be condoned.**

10.6 A Student, whose shortage of attendance is not condoned in any course(s) (Theory/Lab/Mini Project with Seminar) in any semester, is considered as 'Detained in that course(s), and is not eligible to write Semester End Examination(s) of such course(s), (in case of Mini Project with Seminar, s/he Mini Project with Seminar Report or Presentation are not eligible for evaluation) in that Semester; and s/he has to seek re-registration for those course(s) in subsequent semesters, and attend the same as and when offered.

10.7 A student fulfills the attendance requirement in the present semester, shall not be eligible for readmission into the same class.

10.8 **a)** A student shall put in a minimum required attendance in at least **three theory courses (excluding *mandatory (non-credit audit)* course)** in first semester for promotion to second semester.

b) A student shall put in a minimum required attendance in at least **three theory courses (excluding *mandatory (non-credit audit)* course)** in second semester for promotion to third semester.

11. 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 COE shall invite 3-9 external examiners to evaluate all the semester end examinations answer scripts on a prescribed date(s).

11.3 Laboratory examinations are conducted by involving external examiners.

11.4 Examinations control office headed by COE shall consolidate the marks awarded by internal and external examiners and award grades.

12. 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 (16 out of 40 marks) for each theory course in the CIA.

ii. Not less than 40% marks (24 out of 60 marks) for each theory course in the SEE.

iii. A minimum of 50% marks (50 out of 100 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 / Mini project with Seminar / Dissertation Project, if s/he secures.

i. Not less than 40% marks (16 out of 40 marks) in the CIA.
ii. Not less than 40% marks (24 out of 60 marks) in the SEE.
iii. A minimum of 50% marks (50 out of 100 marks) considering both CIA and SEE.

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:

% of Marks Secured in a Course (Class Intervals)	Letter Grade (UGC Guidelines)	Grade Points
90% and above (≥ 90%, ≤ 100%)	O (Outstanding)	10
Below 90% but not less than 80% (≥ 80%, <90%)	A+ (Excellent)	9
Below 80% but not less than 70% (≥ 70%, <80%)	A (Very Good)	8
Below 70% but not less than 60% (≥ 60%, <70%)	B+ (Good)	7
Below 60% but not less than 50% (≥ 50%, <60%)	B (above Average)	6
Below 50% (<50%)	F (Fail)	0
Absent	AB (Absent)	0

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: “O”, “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 student's 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 of calculation of SGPA

Course	Credits	Letter Grade	Grade Points	Credit Points (Credit x Grade)
Course 1	4	A	8	4 x 8 = 32
Course 2	4	O	10	4 x 10 = 40
Course 3	4	B	6	4 x 6 = 24
Course 4	3	B	6	3 x 6 = 18
Course 5	3	A+	9	3 x 9 = 27
Course 6	3	B	6	3 x 6 = 18
	21			**159**

Thus, SGPA = 159 / 21 = 7.57

15.2 Illustration of calculation of CGPA

Semester	Credits	SGPA	Credits * SGPA
Semester I	24	7	24 * 7 = 168
Semester II	24	6	24 * 6 = 144
Semester III	24	6.5	24 * 6.5 = 156
Semester IV	24	6	24 * 6 = 144
	96		**612**

Thus, *CGPA = 612* / 96 = 6.37

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 68 credits.

17.2 A student who fails to earn 68 credits within four consecutive academic years from the year of his/her admission (with CGPA ≥ 6.0), shall forfeit his/her degree and his/her admission stands cancelled.

18.0 AWARD OF DEGREE

After a student has earned the requirements prescribed for the completion of the program and is eligible for the award of M.Tech degree, he shall be placed in one of the following three classes based on the CGPA:

Classification of degree will be as follows:

Class Awarded	CGPA
First Class with Distinction	≥ 7.75
First Class	6.75≤ CGPA < 7.75
Second Class	6.00≤ CGPA < 6.75

Note: A student with final CGPA (at the end of the M.Tech Program) < 6.00 shall not be eligible for the Award of Degree.

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

19. 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.

20. WITH-HOLDING OF RESULTS

If the candidate has not paid any dues to the college / 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.

21. 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.

22. 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.

23. TRANSITORY REGULATIONS

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.

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.

24. 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

FREQUENTLY ASKED QUESTIONS AND ANSWERS ABOUT AUTONOMY

1. Who grants Autonomy? UGC, Govt., AICTE or University

In case of Colleges affiliated to a university and where statutes for grant of autonomy are ready, it is the respective University that finally grants autonomy but only after concurrence from the respective state Government as well as UGC. The State Government has its own powers to grant autonomy directly to Govt. and Govt. aided Colleges.

2. Shall IARE award its own Degrees?

No. Degree will be awarded by Jawaharlal Nehru Technological University, Hyderabad with a mention of the name IARE on the Degree Certificate.

3. What is the difference between a Deemed University and an Autonomy College?

A Deemed University is fully autonomous to the extent of awarding its own Degree. A Deemed University is usually a Non-Affiliating version of a University and has similar responsibilities like any University. An Autonomous College enjoys Academic Autonomy alone. The University to which an autonomous college is affiliated will have checks on the performance of the autonomous college.

4. How will the Foreign Universities or other stake – holders know that we are an Autonomous College?

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

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

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

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

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

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

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

8. Can IARE have its own Convocation?

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

9. Can IARE give a provisional degree certificate?

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

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

11. What is the proportion of Internal and External Assessment as an Autonomous College?
Presently, it is 70 % external and 30% internal. As the autonomy matures the internal assessment component shall be increased at the cost of external assessment.

12. Is it possible to have complete Internal Assessment for Theory or Practicals?
Yes indeed. We define our own system. We have the freedom to keep the proportion of external and internal assessment component to choose.

13. Why Credit based Grade System?
The credit based grade system is an accepted standard of academic performance the world over in all Universities. The acceptability of our graduates in the world market shall improve.

14. What exactly is a Credit based Grade System?
The credit based grade system defines a much better statistical way of judging the academic performance. One Lecture Hour per week of Teaching Learning process is assigned One Credit. One hour of laboratory work is assigned half credit. Letter Grades like A, B, C, D, etc. are assigned for a Range of Marks. (e.g. 91% and above is A+, 80 to 90 % could be A etc.) in Absolute Grading System while grades are awarded by statistical analysis in relative grading system. We thus dispense with sharp numerical boundaries. Secondly, the grades are associated with defined Grade Points in the scale of 1 to 10. Weighted Average of Grade Points is also defined Grade Points are weighted by Credits and averaged over total credits in a Semester. This process is repeated for all Semesters and a CGPA defines the Final Academic Performance

15. What are the norms for the number of Credits per Semester and total number of Credits for UG/PG program?
These norms are usually defined by UGC or AICTE. Usually around 25 Credits per semester is the accepted norm.

16. What is a Semester Grade Point Average (SGPA)?
The performance of a student in a semester is indicated by a number called SGPA. The SGPA is the weighted average of the grade points obtained in all the courses registered by the student during the semester.

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

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

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

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

$$CGPA = \sum_{j=1}^{n} (C_i S_i) / \sum_{j=1}^{n} C_i$$

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 of Academics of the Autonomous College to keep and preserve all the records.

30. What is our relationship with the JNT University?
We remain an affiliated college of the JNT University. The University has the right to nominate its members on the academic bodies of the college.

31. Shall we require University approval if we want to start any New Courses?
Yes, It is expected that approvals or such other matters from an autonomous college will receive priority.

32. Shall we get autonomy for PG and Doctoral Programs also?
Yes, presently our PG programs also enjoying autonomous status.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

S. No	Nature of Malpractices/Improper conduct	Punishment
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, cell phones, pager, palm computers or any other form of material concerned with or related to the course 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 course of the examination)	Expulsion from the examination hall and cancellation of the performance in that course 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 course 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 course of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the courses of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the Controller of Examinations.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate, who has been impersonated, shall be cancelled in all the courses of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining courses 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 course 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 course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses 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 course 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 course.
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 course and all other courses the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the courses 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 course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses 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 course to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses 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 course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses 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 course and all other courses 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

COURSE CATALOGUE

REGULATIONS: MT-23

AEROSPACE ENGINEERING

I SEMESTER

Course Code	Course Name	Course Area	Category	Periods Per Week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
BAED01	Advanced Vehicle Aerodynamics	PCC	Core	3	0	0	3	40	60	100
BAED02	Jet and Rocket Propulsion	PCC	Core	3	0	0	3	40	60	100
	Professional Core Elective - I	PCE	Elective	3	0	0	3	40	60	100
	Professional Core Elective - II	PCE	Elective	3	0	0	3	40	60	100
BHSD01	Research Methodology & IPR	--	--	2	0	0	2	40	60	100
	Audit Course - I	Audit - I	Audit	2	0	0	0	--	--	--
PRACTICAL										
BAED11	Advanced Aerodynamics Laboratory	PCC	Core	0	0	4	2	40	60	100
BAED12	Computational Aerospace Engineering Laboratory	PCC	Core	0	0	4	2	40	60	100
TOTAL				**16**	**00**	**8**	**18**	**280**	**420**	**700**

***Professional Elective- I and Professional Elective- I Lab must be of same course.**

II SEMESTER

Course Code	Course Name	Course Area	Category	Periods Per Week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
BAED13	Flight Dynamics and Control	PCC	Core	3	0	0	3	40	60	100
BAED14	Aircraft Structural Mechanics	PCC	Core	3	0	0	3	40	60	100
	Professional Core Elective – III	PCE	Elective	3	0	0	3	40	60	100
	Professional Core Elective - IV	PCE	Elective	3	0	0	3	40	60	100
	Audit Course - II	Audit - II	Audit	2	0	0	0	--	--	--
PRACTICAL										
BAED23	Flight Simulation and Controls Laboratory	PCC	Core	0	0	4	2	40	60	100
BAED24	Advanced Structural Analysis Laboratory	PCC	Core	0	0	4	2	40	60	100
BAED25	Mini Project with Seminar	PCC	Core	0	0	4	2	40	60	100
TOTAL				**14**	**00**	**12**	**18**	**280**	**420**	**700**

*** Professional Elective- III and Professional Elective- III Lab must be of same course.**

III SEMESTER

Course Code	Course Name	Course Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
	Professional Core Elective – V	PCE	Elective	3	0	0	3	40	60	100
	Open Elective	OE	Elective	3	0	0	3	40	60	100
PRACTICA										
BAED34	Dissertation Work Review - II	Major Project	Core	0	0	12	6	40	60	100
TOTAL				**06**	**00**	**12**	**12**	**120**	**180**	**300**

IV SEMESTER

Course Code	Course Name	Course Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
BAED35	Dissertation Work Review - III	Major Project	Core	0	0	12	6	40	60	100
BAED36	Dissertation Viva-Voce	--	Core	0	0	28	14	40	60	100
TOTAL				**00**	**00**	**32**	**20**	**80**	**120**	**200**

ELECTIVE COURSES

PROGRAM CORE ELECTIVES (PCE)

S.No	Course code	Name of the Course	Professional Electives
1	BAED03	Fracture Mechanics and Failure Analysis	**I**
2	BAED04	Vibration and Aeroelasticity	**I**
3	BAED05	CFD For Aerospace Applications	**I**
4	BAED06	Autonomous Flight Control System	**I**
5	BAED07	Unmanned Aerial Vehicles	**II**
6	BAED08	Structural Analysis of Composite Structures	**II**
7	BAED09	Instrumentation and Experiments in Fluids	**II**
8	BAED10	Continuum Mechanics	**II**
9	BAED15	Guidance and Controls	**III**
10	BAED16	Rockets and Missiles	**III**
11	BAED17	Ground Vehicle Aerodynamics	**III**
12	BAED18	Experimental Methods of Stress Analysis	**III**
13	BAED19	Computational Heat Transfer	**IV**
14	BAED20	High Enthalpy Gas Dynamics	**IV**
15	BAED21	Aerodynamics of Turbomachinery	**IV**
16	BAED22	Advanced Finite Element Methods	**IV**
17	BAED26	Missile Aerodynamics	**V**
18	BAED27	Flight Simulation	**V**
19	BAED28	Compressible Jet Flows	**V**
20	BAED29	Aerospace Optimization Techniques	**V**

OPEN ELECTIVE COURSES FOR OTHER DEPARTMENTS

S No	Course Code	Course Name
1	BAED30	Elements of Aerospace Engineering
2	BAED31	Fundamentals of Aerospace Propulsion
3	BAED32	Composite materials for Aerospace Structure
4	BAED33	Low Speed Aerodynamics

AUDIT COURSES – I AND II

S.No	Course Code	Course Title
1	BHSD02	English for Research Paper Writing
2	BHSD03	Disaster Management
3	BHSD04	Sanskrit for Technical Knowledge
4	BHSD05	Value Education
5	BHSD06	Constitution of India
6	BHSD07	Pedagogy Studies
7	BHSD08	Stress Management by Yoga
8	BHSD09	Personality Development through Life Enlightenment Skills

SYLLABUS
(I – III SEMESTERS)

ADVANCED VEHICLE AERODYNAMICS

I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED01	Core	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

This course is intended to provide advance concepts to aerodynamics of the flight vehicle and research topics. This covers the incompressible and compressible flows along with different computational methods related to panel method used for industrial purposes.

II. COURSE OBJECTIVES:

The students will try to learn:

1. The physics behind the aerodynamic flows used for flight vehicles.
2. The viscous effects in the aircrafts and related systems.
3. The different computational modeling techniques used for simulation systems.
4. The different wind tunnel experimentation techniques to measure the flow pattern of the model

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	Relate the physics of the aerodynamic flow for predicting aerodynamics characteristics.
CO 2	Demonstrate viscous effects of the aerodynamic flows by using Lifting Line theory, Lifting Surface theory.
CO 3	Illustrate the boundary layer theory by using governing equations for getting drag of the system.
CO 4	Analyze the relations between choices made early in the turbo machinery design process and the final components and operability.
CO 5	Apply the Euler's equations for turbo machinery to analyze energy transfer in turbo machines
CO 6	Analyze the aerodynamic performance of air vehicle by using the wind tunnel techniques.

IV. COURSE CONTENT:

MODULE-I: PHYSICS OF AERODYNAMIC FLOW AND FLOW MODELING (10)

Physics of Aerodynamic flows: Atmospheric properties, conservation laws, conservation equations, units and parameters, adiabatic flows, Isentropic flows. Low speed and Incompressible flows, Vorticity transport and irrationality.

Flow Field Modeling: Aerodynamic modeling, Vorticity and Source Lumping, 3D Vortex Sheet Strength Divergence Constraints, Equivalence of Vortex and Doublets Sheets. Velocity Potential Integrals, Flow Field Modeling with Source and Vortex Sheets, 2D Far Field Approximation. 3D Far Fields, Approximation.

MODULE-II: VISCOUS EFFECT IN AERODYNAMIC FLOW (10)

Inviscid Flow Model, Displacement Effect, Improved Inviscid Flow Model, Viscous De cambering Stall Mechanism, and Consideration in Flow Model Selection. Lifting Line theory, Lifting Surface theory, Vortex lattice Method

MODULE-III: BOUNDARY LAYER ANALYSIS (10)
Boundary layer flow features, Defect Integrals and thickness, Boundary layer Governing equations, Boundary layer response to pressure and shear gradient, Integral boundary layer relations, Self-Similar boundary layers, Axisymmetric boundary layers, 3D boundary layers, 2D Boundary layer solution methods, Integral boundary layer solution, Coupling of potential flow and boundary layers, profile drag prediction, Transition and types.

MODULE-IV: UNSTEAY & COMPRESSIBLE AERODYNAMIC FLOWS (10)
Unsteady Potential flows, Governing equations for Unsteady Potential Flows, Potential Jump, Unsteady Panel Method, Unsteady 2D Airfoil Effects of compressibility, Compressible flow Quantities, Shock wave and Wave drag, Compressible Potential Flows, Small distance Compressible Flows, Prandtle-Glauert Analysis, Subsonic Compresible Far -Fields, Small Disturbance Supersonic Flows, Transonic Flows,

MODULE-V: FLOW FIELD AND FORCE MEASUREMENTS (08)
Wind Tunnel Methods, Direct Force Measurements, Wind Tunnel Corrections, 2D Tunnel Drag Measurements.

V. TEXT BOOKS:

1. Mark D rela., "Flight Vehicle Aerodynamics", MIT Press, Cambridge, Massachusetts London, England.
2. Anderson J D, "Modern Compressible Fluid Flow", Mc-Graw Hill, 2nd edition, 1990.

VI. REFERENCE BOOKS:

1. Rathakrishnan E, "Gas Dynamics", Prentice-Hall India, 2004.
2. Anderson J D, "Fundamentals of Aerodynamics", Tata Mc-Graw Hill, 5th edition, 2010

VII. ELECTRONICS RESOURCES:

1. http://rcdata.ir/wpcontent/uploads/2016/10/Mark_Drela_Flight_Vehicle_AerodynamicsBookZZ.org_.pdf
2. www.wind.civil.aau.dk/lecture/8sem_CFD/Lecture1/Lecture1.pdf.
3. personalpages.manchester.ac.uk/staff/david.d.apsley/lectures/comphydr/timedep.pdf

VIII. MATERIALS ONLINE

1. Course template
2. Assignments
3. Tutorial question bank
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations

COURSE CONTENT

JET AND ROCKET PROPULSION								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED02	Core	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerospace propulsion								

I. COURSE OVERVIEW:

An aerospace propulsion system is a device that generates forces to push the aerospace vehicles forward. This course discusses about the various Aerospace propulsive devices in micro level, it includes an overview of different types of propulsive system present in aircrafts and rockets such as turbojet, turboprop, turbofan, IC engine, solid propellant, hybrid propellant and liquid propellant engines. Along with that design and analysis will be discussed on the various parameters and components present in aerospace propulsive system.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basic working principles of different types of airbreathing engines and their components.
II. The ideal cycles analysis of jet engine.
III. The operation of solid and liquid propellant rocket motors.
IV. The operating principle of electric rocket motors.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Identify suitable air-breathing engine and operating system for the aircraft based on performance.
CO 2 Distinguish between the functions and performance parameters of inlets, nozzles, combustors and after burners for choosing desired devices to the aero engines.
CO 3 Identify the performance characteristics of turbo machineries for their suitable selection in aircraft engines
CO 4 Examine the working procedure of rocket propulsion system and components for selecting them based on mission profile
CO 5 Classify the propellant grain structure for solid propellants to increasing the performances level.
CO 6 Develop sub-systems and heat transfer systems in liquid propellant rocket for definitive deep space rocket propulsive design.

IV. COURSE CONTENT:

MODULE-I: JET ENGINE COMPONENT AND ANALYSIS (10)

Classification of jet engines turbojet, turbofan, turboprop, turboshaft, ramjet, scramjet, turbojet/ramjet combined cycle engine, thrust equation ;Ideal cycle analysis of turbojet with and without after burner and turbo fan engine; performance parameters, specific thrust, specific fuel consumption and specific impulse, thermal efficiency, propulsive efficiency, engine overall efficiency and its impact on aircraft;Enginecycleanalysisandperformanceanalysisforturbojet,turbojetwithafterburner,turbofanengin, turboprop engine.

MODULE-II: INLETS, NOZZLES AND COMBUSTORS PERFORMANCE (10)
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.

MODULE-III: AXIAL FLOW COMPRESSORS AND TURBINES (10)
Axial flow Compressors: Operating Principle, Velocity triangle and pressure rise equation, stage parameters, cascade aerodynamics, aerodynamic forces on compressor blades, performance maps, single stage energy analysis, compressor instability, stall and surge control.

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.

MODULE-IV: SOLID AND LIQUID PROPELLANT ROCKET MOTORS (09)
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, Types of igniters advantages of solid propellant rockets. Liquid propellant rocket: Bipropellant, monopropellant, cold gas propellant, cryogenic propellant, storable propellants, gelled propellant; Propellant Storage, different propellant tank arrangements, propellant feed system-pressure feed, turbopump feed

MODULE-V: ELECTRIC ROCKET PROPULSION (09)
Electric rocket propulsion, types of electric propulsion techniques, Ion propulsion, Nuclear rocket, comparison of performance of these propulsion systems with chemical rocket propulsion systems, future applications of electric propulsion systems, Solar sail.

V. TEXT BOOKS:

1. P Hill, P.G. and Peterson, C.R., Mechanics and Thermodynamics of Propulsion, Addison Wesley, 2nd Edition,1992.
2. George P. Sutton, Oscar Biblarz, “Rocket Propulsion Elements”, Wiley India Pvt. Ltd, 7th Edition, 2010.

VI. REFERENCE BOOKS:

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

VII. MATERIALS ONLINE

1. Course template
2. Assignments
3. Tutorial question bank
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations

COURSE CONTENT

FRACTURE MECHANICS AND FAILURE ANALYSIS								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED03	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aircraft structures								

I. COURSE OVERVIEW:

Fracture mechanics and fatigue are essential to understanding the structural performance of real-world materials. Fracture mechanics is the study of the complex stress field around the tip of a crack and can be used to determine if an existing crack will propagate or arrest. Fatigue analysis is the study of fracture behavior under repeated cyclic loading. High cycle and low cycles fatigue are used in designing machine members courseed to various fatigue load conditions. Crack growth under fatigue and realistic conditions are analyzed which is used in the industries.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The concept of Endurance limit and methods to increase the endurance limit used in design of machine elements.
II. The Low cycle and High cycle Fatigue used in design of machine members.
III. The behavior of materials under static load and fatigue loads.
IV. The Strength of a cracked bodies under fatigue and static load conditions.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Apply the concept of stress and number of cyclic loadings on a given specimen for deterring the endurance limit.
CO 2 Analyze the behavior of a specimen under High cycle and Low cycle fatigues for design against fatigue failure
CO 3 Apply the mathematical principles to High cycle and Low cycle fatigues for determining the failure loads
CO 4 Analyze the influence of crack growth under fatigue loads and surface roughness for designing the member to with stand the crack
CO 5 Analyze the various methods involved in crack detections techniques for identifying the surface cracks.
CO 6 Illustrate the various methods involved in fatigue testing for determining the Endurance limit.

IV. COURSE CONTENT:

MODULE-I: FATIGUEOFSTRUCTURES (09)

S.N. curves, Endurance limit, Effect of mean stress, Good man, Gerber and Soder berg relations and diagrams, Notches and stress concentrations, Neuber"s stress concentration factors, plastic stress concentration factors, Notched S-N curves.

MODULE-II: STATISTICALASPECTSOFFATIGUEBEHAVIOUR (10)

Low cycle and high cycle fatigue, Coffin-Manson "relation, Transition life, Cyclic Strain hardening and softening Analysis of load histories, Cycle counting techniques, Cumulative damage, Miner"s theory, other theories.

MODULE-III: PHYSICALASPECTSOFFATIGUE (10)
Phase in fatigue life, Crack initiation, Crack growth, Final fracture

Dislocations, Fatigue fracture surfaces.

MODULE-IV: FRACTUREMECHANICS (10)
Strength of cracked bodies, potential energy and surface energy, Griffith's theory, Irwin, Orwin extension of Griffith's theory to ductile materials, Stress analysis of cracked bodies, effect of thickness on fracture toughness, stress intensity factors for typical geometries.

MODULE-V: FATIGUEDESIGNANDTESTING (09)
Safe life and fail-safe design philosophies, importance of fracture mechanics in aerospace structure, application to composite materials and structures.

V. TEXT BOOKS:

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

VI. REFERENCE BOOKS:

1. W. Barrois and L. Ripley, "Fatigue of Aircraft Structures", S Pergamon Press, Oxford, 1983.
2. C. G. Sih, "Mechanics of Fracture", Vol.1 Sijth off and Noordh off International Publishing Co., Netherland, 1989.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template
2. Assignments
3. Tutorial question bank
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations

COURSE CONTENT

VIBRATION AND AEROELASTICITY								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAED04	**Elective**	3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aircraft structures								

I. COURSE OVERVIEW:

Vibration and aeroelasticity overs the study of structural dynamics and the interaction between aerodynamic forces and structural vibrations in aerospace vehicles. In simpler terms, it deals with the comprehension of elastic, aerodynamic and inertial forces on a body due to fluid flow around it. It is a combination of three distinct fields of aeronautical engineering i.e. aerodynamics, stability and control, and solid mechanics. This course, deals with static aeroelasticity as well as dynamic aeroelasticity. Each category of aeroelasticity will have specific importance and they shall take roots from one of the aforementioned three domains. Students shall go through the basics of aeroelasticity till dynamic phenomenon such as flutter

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basic aspects of vibration theory e principles of dynamics and energy methods pertaining to structure.
II. The structural dynamic and steady and unsteady aerodynamics aspects of airframe and its components and their role in aeroelasticity.
III. The theoretical basis for the solution of static aeroelastic problems an estimate loads and other critical speeds.
IV. The theoretical basis for the solution of flutter problems and estimate of flutter speeds.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Solve the single degree of freedom system using energy method for damping the vibration generated.
CO 2 Make use of Hamilton's and Lagrange Principle for vibration analysis of multi degrees of freedom system
CO 3 Illustrate the S-N diagram for estimating the endurance limit (failure point) under mean and alternating stresses.
CO 4 Apply the fracture mechanics theories for materials (Ductile, Brittle) courseed to crack(s)for determining the conditions for failure.
CO 5 Illustrate the influence of material thickness, fracture toughness, and stress intensity factors for cracked bodies of various geometries for stress and strain patterns.
CO 6 Identify various types of composite materials used for constructing modern aircraft components and structures to reduce the weight.

IV. COURSE CONTENT:

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

Simple harmonic motion, definition of terminologies, Newton's Laws, D'Alembert's principle, Energy methods. Free and forced vibrations with and without damping, base excitation, and vibration measuring instruments.

MODULE-II: MULTI-DEGREES OF FREEDOM SYSTEMS (09)

Two degrees of freedom systems, Static and dynamic couplings, eigen values, eigen vectors and orthogonality conditions of eigen vectors, Vibration absorber, Principal coordinates, Principal modes. Hamilton's Principle, Lagrange's equation and its applications.

MODULE-III: AEROELASTIC PHENOMENA (10)
Stability versus response problems; The aeroelastic triangle of forces; Aero elasticity in Aircraft Design; Prevention of aero elastic instabilities. Influence and stiffness coefficients. Coupled oscillations.

MODULE-IV: DIVERGENCE OF A LIFTING SURFACE (10)
Simple two-dimensional idealizations; Strip theory, Integral equation of the second kind Exact solutions for simple rectangular wings, Semirigid assumption and approximate solutions; Generalized coordinates, successive approximations, numerical approximations using matrix equations.

MODULE-V: FLUTTER PHENOMENON (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.

V. TEXT BOOKS:

1. Timoshenko, S. "Vibration Problems in Engineering", John Wiley & Sons, Inc., 2018
2. Y.C.Fung, "An Introduction to the Theory of Aero elasticity", John Wiley & Sons Inc., New York, 2008.
3. E.G. Broadbent, "Elementary Theory of Aeroelasticity", Bun Hill Publications Ltd, 1986.

VI. REFERENCE BOOKS:

1. Thomson W.T, Marie Dillon Dahleh, "Theory of Vibrations with Applications", Harlow, Essex Pearson 2014.
2. R.L. Bisplinghoff, H. Ashley, and R.L. Halfmann, "Aero elasticity", Edition Addison Wesley Publishing Co., Inc., 2nd Edition, 1996.
3. R. H. Scanlan and R. Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.

VII. ELECTRONICS RESOURCES:

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/

VIII. MATERIALS ONLINE

1. Course template
2. Assignments
3. Tutorial question bank
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations

COURSE CONTENT

CFD FOR AEROSPACE APPLICATIONS								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAED05	**Elective**	3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aircraft structures								

I. COURSE OVERVIEW:

This course deals with the theory behind the commercially available computational fluid dynamic softwares and numerical methods for theory of the fluid flows. The primary focus of this course is on most used, progressive numerical techniques and time dependent methods used to solve the partial differential equations. The students will learn about the boundary layer equations and its transformations. Generation of the grids and its types, various boundary conditions in a fluid flow at different conditions discussed. Philosophy of methods of characteristics for solving the supersonic flow is appreciated. Quintessential method for solving flow around an airfoil that is Panel Methods is addressed.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Advanced techniques in the numerical solution of aerodynamic problems, issues that arise in the solution of such equations in CFD.
II. The formation of boundary layer equations and the boundary conditions to solve the aerodynamics problems.
III. Different methods evolved in analyzing numerical stability of solutions and evaluate the parameters over which the stability depends and their range of values.
IV. Basic formulation of panel methods and consideration to establish the numerical solutions.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Apply the flux approach, flux vector splitting, upwind reconstruction- evolution methods for solving the compressible flow problems using Euler's equations.
CO 2 Make use of the explicit, implicit, time split methods and approximate factorization schemes for obtaining the stabilized numerical solution of subsonic and supersonic nozzle flows.
CO 3 Develop the boundary layer transformation equations for steady external flows on airfoil, wings and aircraft using finite difference method.
CO 4 Analyze the structured, unstructured grids and dummy cells using physical boundary conditions for attaining the accurate results of fluid flow problems.
CO 5 Identify the characteristic lines and compatibility equations for designing the supersonic nozzle having shock free and isentropic flow.
CO 6 Utilize the effects of compressibility and viscosity on thin airfoil for establishing the numerical solution in aerodynamic problems.

IV. COURSE CONTENT:

MODULE-I: NUMERICAL SOLUTIONS OF SOME FLUID DYNAMICAL PROBLEMS (10)

Basic fluid dynamics equations, Equations in general orthogonal coordinate system, Body fitted coordinate systems, mathematical properties of fluid dynamic equations and classification of partial differential equations - Finding solution of a simple gas dynamic problem, Local similar solutions of boundary layer equations, Numerical integration and shooting technique. Numerical solution for CD nozzle isentropic flows and local similar solutions of boundary layer equations Panel methods

MODULE-II: GRID GENERATION (10)
Need for grid generation - Various grid generation techniques - Algebraic, conformal and numerical grid generation - importance of grid control functions - boundary point control - orthogonality of grid lines at boundaries. Elliptic grid generation using Laplace's equations for geometries like aero foil and CD nozzle. Unstructured grids, Cartesian grids, hybrid grids, grid around typical 2D and 3D geometries - Overlapping grids - Grids around multi bodies.

MODULE-III: TIME DEPENDENT METHODS (10)
Stability of solution, explicit methods, FTFS, FTCS, FTBS, Leapfrog method, Lax method. Implicit methods: Euler's FTCS, Crank Nicolson method, description of Lax-Wendorff scheme, McCormack two step predictor corrector method, description of time split methods, approximate factorization schemes.

MODULE-IV: BOUNDARY CONDITIONS (09)
Boundary Layer Equations: Setting up the boundary layer equations, flat plate boundary layer solution, boundary layer transformations, explicit and implicit discretization, solution of the implicit difference equations, integration of the continuity equation, boundary layer edge and wall shear stress, Keller-box scheme. Concept of dummy cells, solid wall inviscid flow, viscous flow, far field concept to characteristic variables, modifications for lifting bodies inlet outlet boundary, injection boundary, symmetry plane, coordinate cut, periodic boundaries, interface between grid blocks, flow gradients at boundaries of unstructured grids.

MODULE-V: CFD FOR INDUSTRIAL APPLICATIONS (09)
Various levels of approximation of flow equations, turbulence modelling for viscous flows, verification and validation of CFD code, application of CFD tools to 2D and 3D configurations. CFD for kinetic heating analysis - Coupling of CFD code with heat conduction code, Unsteady flows - Grid movement method, Oscillating geometries, Computational aeroelasticity - Coupling of CFD with structural model - Aeroelasticity of airfoil geometry, Introduction to commercial CFD software for aerospace applications, High performance computing for CFD applications -Parallelization of codes -domain decomposition.

V. TEXT BOOKS:

1. Bose. TK, "Numerical Fluid Dynamics", Narosa Publishing House, 2001.
2. Tannehill John C, Anderson Dale A, Pletcher Richard H, "Computational Fluid Mechanics and Heat Transfer", Taylor & Francis, 2nd Edition,1997.
3. ChungT G, "Computational Fluid Dynamics", Cambridge University Press, 2nd Edition, 2010.
4. Katz Joseph and Plotkin Allen, "Low-Speed Aerodynamics", Cambridge University Press, 2nd Edition, 2006.

VI. REFERENCE BOOKS:

1. Sedat Biringen & Chuen -Yen Chow, "Introduction to Computational Fluid Dynamics by Example", Wiley publishers, 2nd edition, 2011.
2. Anderson J D, "Computational Fluid Dynamics", Mc Graw Hill, 1995.

VIII. MATERIALS ONLINE

1. Course template
2. Assignments
3. Tutorial question bank
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations

COURSE CONTENT

AUTONOMOUS FLIGHT CONTROL SYSTEM								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAED06	**Elective**	3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Flight Mechanics								

I. COURSE OVERVIEW:

This course is intended to study the automatic control of the flight vehicles through the air or in outer space. It concerns the forces and moments, that are acting on the air- vehicles to determine the position and attitude with respect to the time. It also develops as an engineering science throughout succeeding generations of aeronautical engineers to support increasing demands of autonomous aircraft navigation and control. It has a major role to play in the design of modern aircraft to ensure efficient, comfortable and safe flight. Modern aircraft control is ensured through automatic control systems known as autopilot in association with Fly-by- Wire, to increase safety, facilitate the pilot's task easier and improve flight qualities.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental theory of guidance and control systems of aircraft and also different augmentation systems used for aircraft and space vehicles
II. The different autopilot systems, flight path stabilization and Automatic Flare Control systems used for flight vehicles.
III. The modern automatic control systems like Fly-by-Wire, Fly-by-Optics systems and different flight control laws design using different algorithms.
IV. The advanced computational tools to design of navigation and guidance systems for automation of aircrafts, missiles, helicopters and space launch vehicles.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Explain the historical perspective of guidance and control of the aircraft for assessing the rate of progress of these systems.
CO 2 Discuss the different types of control augmentation systems used in aircraft for estimating the control performance of the flight vehicle.
CO 3 Examine the automatic gain schedule concept for airplane control by plotting the required curve for obtaining desired automatic control of the flight vehicles.
CO 4 Demonstrate the acceleration control and automated flare control system using the back step algorithm for obtaining the state of automated control.
CO 5 Apply the mathematical model for the damping of the Dutch roll by using methods of coordination for the different types of air vehicles.
CO 6 Analyze the principles of automated control on lateral beam guidance system (LBGS) for aircraft's different flight modes.

IV. COURSE CONTENT:

MODULE-I: SERVO MECHANISM AND AUTOMATIC CONTROL FUNDAMENTALS (10)

Introduction to close loop servomechanism, types of servo mechanism, the role of automatic flight control system (AFCS), components of AFCS: Sensors, Computers and output devices, types of AFCS, Operational Autopilot: System Protection, comparator, Duplex system, Cross coupled feedback, damping and types. Fundamentals of Automatic Control: Sensing, Corrections, Interlocks, Trimming and synchronization.

MODULE-II: AUGMENTATION SYSTEMS (08)

Need for automatic flight control systems, stability augmentation systems, control augmentation systems, gain scheduling concepts.

MODULE-III: LONGITUDINAL AUTOPILOT (10)

Displacement Autopilot: Pitch orientation control system, acceleration control system, glide slope coupler and automatic flare control.

Flight path stabilization, longitudinal control law design using back stepping algorithm.

MODULE-IV: LATERAL AUTOPILOT (11)

Damping of the Dutch roll, methods of obtaining coordination, yaw orientation control system, turn compensation, automatic lateral beam guidance.

MODULE-V: FLY BY WIRE FLIGHT CONTROL (09)

Introduction to Fly-by-wire flight control systems, fly-by-wire flight control features and advantages, control laws, redundancy and failure survival, digital implementation, fly-by-light flight control.

V. TEXT BOOKS:

1. E.H.J Pallet, “Automatic Control of Aircraft” 4th Edition, Blackwell Science Ltd, a Blackwell Publishing company, Oxford U.K, 1993.
2. Blake Lock, J.H, “Automatic control of Aircraft and missiles”, John Wiley Sons, New York, 1990.
3. Stevens B.L & Lewis F.L, “Aircraft control & simulation”, John Wiley Sons, New York, 1992.

VI. REFERENCE BOOKS:

1. Garnel.P. & East. D.J, “Guided Weapon control systems”, Pergamon Press, Oxford, 1st Edition 1977.
2. Bernad Etikin, “Dynamic of flight stability and control”, John Wiley, 1st Edition 1972.

VII. ELECTRONICS RESOURCES:

1. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16...aircraft.../lecture-16
2. www.fsd.mw.tum.de/research/flight-control
3. nptel.ac.in/courses/101108056/

VIII. MATERIALS ONLINE

1. Course template
2. Assignments
3. Tutorial question bank
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations

COURSE CONTENT

UNMANNED AERIAL VEHICLES								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED07	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

The course focuses on fundamentals related to powered, aerial vehicle systems that do not carry a human operator, including the terminology related to unmanned air vehicle systems (UAS), subsystems, the basic design of UAS for stealth and reliability, and also provides insight into different types of airframes and power-plants. It imparts knowledge about navigation, communications, control, and stability of UAVs. The course is aimed to obtain knowledge also in certification, testing and deployment, and future applications.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The major subsystems and the fundamental design concepts of Unmanned Air Vehicle Systems (UAS).
II. The important design concepts like reliability, stealth, and maintenance of UAS.
III. The various communication media, navigation systems, control, and stability of UAVs.
IV. The development, testing, certification, and deployment of UAS.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Apply the concept of major sub-systems, and performance Characteristics for designing the UAV/ UAS.
CO 2 Identify the appropriate communication, navigation and guidance systems for maneuvering of Unmanned Air Vehicles.
CO 3 Categorize the techniques of the stability and control of UAV for desired maneuvering of Unmanned Air Vehicles.
CO 4 Analyze the design and development of Unmanned Aircraft System for stealth, reliability and Manufacturing.
CO 5 Identify the appropriate testing and certification process for the development of UAS to meet the international standard.
CO 6 Make use of the concepts of network-centric operations for the deployment of UAS in field operations.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS (10)

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

MODULE-II: DESIGN OF UAV SYSTEMS-I (10)

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/Battle field 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.

MODULE-III: DESIGN OF UAV SYSTEMS-II (10)

Communications-Communication Media, Radio Communication, Mid-air Collision (MAC) Avoidance, Communications Data Rate and Band width 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.

MODULE-IV: THE DEVELOPMENT OF UAV SYSTEMS (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.

MODULE-V: DEPLOYMENT AND FUTURE OF UAV SYSTEMS (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.

V. TEXT BOOKS:

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

VI. 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.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template
2. Assignments
3. Tutorial question bank
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations

COURSE CONTENT

STRUCTURAL ANALYSIS OF COMPOSITE STRUCTURES								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED08	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aircraft structures								

I. COURSE OVERVIEW:

The course focuses on properties of constituent materials and composite laminates, and also provides insight into different analysis approaches of composite materials. It imparts knowledge about different theories of analysis of laminated beams and plates. The course is aimed to obtain knowledge also in different failure theories and concepts of composite materials.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The contribution of constituent materials to the mechanical properties of composite laminates.
II. The various analysis approaches of composite plates and beams.
III. The different failure theories of composite materials.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Apply the knowledge of properties of constituent materials to analyse the composite materials
CO 2 Develop stress-strain relations of isotropic, orthotropic, and anisotropic composite materials to design the composite laminates
CO 3 Apply the knowledge of classical lamination theory for analyzing various composite materials
CO 4 Explain the mechanical behavior of layered composites compared to isotropic materials
CO 5 Develop relationships of mechanical loads applied to a laminate to analyze the strains and stresses in each lamina
CO 6 Identify the failure of individual lamina in a laminate to analyze the failure criteria of composite laminates

IV. COURSE CONTENT:

MODULE-I: PROPERTIES OF CONSTITUENT MATERIALS & COMPOSITE LAMINATES (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.

MODULE-II: MICROMECHANICS OF A UNIDIRECTIONAL COMPOSITE (10)

Volume and Weight Fractions in a Composite Specimen - Longitudinal Behaviour of Unidirectional Composites - Load Sharing - Failure Mechanism and Strength - Factors Influencing Longitudinal Strength and Stiffness - Transverse Stiffness· and Strength - Prediction of Elastic Properties Using Micromechanics -Typical Unidirectional Fiber Composite Properties - Minimum and Critical Fiber Volume Fractions.

MODULE-III: METHODS OF ANALYSIS-I & METHODS OF ANALYSIS -II (10)
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.

MODULE-IV: ANALYSIS OF LAMINATED BEAMS AND PLATES (10)
Classical plate theory, Classical lamination theory - Special cases of single layer, symmetric, anti-symmetric & unsymmetric composites with cross ply, angle ply layup. Deflection analysis of laminated plates, Analysis of laminated beams and plates.

MODULE-V: SHEAR DEFORMATION ANALYSIS & BUCKLING ANALYSIS (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.

V. TEXT BOOKS:

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

VI. REFERENCE BOOKS:

1. Gupta.L, "Advanced Composite Materials, Himalayan Books, New Delhi, 1998.
2. Jones.R.M, "Mechanics of Composite Materials, Mc Graw Hill Kogakushal td. Tokyo.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template
2. Assignments
3. Tutorial question bank
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations

COURSE CONTENT

INSTRUMENTATION AND EXPERIMENTS IN FLUIDS								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED09	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

The instrumentation and experiments in fluids is the first course for graduate and undergraduate students in Aerospace Engineering. The testing methodology employed in low and high-speed aerodynamics is a new technique through which the students will learn various types of wind tunnels, tools and techniques. The experimental aerodynamics will be helpful to industrial aerodynamics study in various engineering branches like, environmental engineering, civil engineering, Automobile engineering etc., so that students get exposure to the various aspects of the course related issues to measuring techniques, wind tunnel design, method and practical applications used. This course will help the students to develop the tool by using multidisciplinary techniques.

II. COURSE OBJECTIVES:

The students will try to learn:

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

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Explain the need of wind tunnel and its measuring techniques for analysis of model using geometric similarity, kinematic similarity and dynamic similarity.
CO 2 Identify the principal components of low-speed wind tunnel and their functions for determining loss coefficients and constraints.
CO 3 Demonstrate low speed wind tunnel balances, mechanical and Strain gauge types, null displacement methods and strain method and etc for load measurement using wind tunnel balance.
CO 4 Identify the principles of probes and transducers used in pressure, velocity & temperature measurements techniques.
CO 5 Identify the necessity of streamlines, streak lines, path lines, time lines, tufts, china clay, oil film, and smoke and hydrogen bubble for flow visualization of wind in wind tunnel.
CO 6 Identify the applications of wind tunnels for the analysis of load, pressure, velocity and temperature measurements using flow visualization for the analysis of aerodynamic problems in automobile and aerospace industries.

IV. COURSE CONTENT:

MODULE-I: AERODYNAMIC EXPERIMENTS- HISTORY, MODEL TESTING AND WIND TUNNELS -TYPES, APPLICATION (10)

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 environmental, automobile, function, distinctive features, application; Major wind tunnel facilities-description, details.

MODULE-II: LOW SPEED WIND TUNNELS- CONSTRUCTION, COMPONENTS, PERFORMANCE & WIND TUNNEL CORRECTIONS (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 in accuracies, buoyancy, solid blockage, wake blockage, streamline curvature- causes, estimation, and correction; Total correction on airspeed, dynamic pressure, zero lift drag.

MODULE-III: **HIGH SPEED TUNNEL (11)**

Transonic wind tunnel - Transonic Test Section - Supersonic wind tunnels - Losses in Supersonic Tunnels - Supersonic Wind Tunnel Diffusers- Effects of Second Throat - Runtime calculation -Calculating Air Flow Rates -Calibration of Supersonic Wind Tunnels - Hypersonic wind tunnel and Calibration -Lud wieg Tube - Shock tube and shock tunnels - Gun tunnel - Plasma arc tunnels - Measurement of shock speed.

MODULE-IV: FLOWVISUALISATIONTECHNIQUES (09)

Flow visualization, 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.

MODULE-V: DATA ACQUISITION SYSTEMS AND UNCERTAINTY ANALYSIS (08)

Data acquisition and processing - Signal conditioning - Statistical analysis of experimental data -Regression analysis - Estimation of measurement errors - Uncertainty calculation - Uses of uncertainty analysis.

V. TEXT BOOKS:

1. Rathakrishnan, E, “Instrumentation, Measurements, and Experiments in Fluids”, CRC Press -Taylor & Francis, 2020.
2. Barlow,J.B., Rae,W.H., Pope, A, “Low Speed Wind Tunnel Testing, Wiley, 1999.
3. Pope, A. and Goin, K.L, “High Speed Wind Tunnel Testing, Wiley, 1965.
4. Yang, W.J, “Hand book of Flow Visualization, Taylor and Francis, 2nd Edition, 2001.

VI. REFERENCE BOOKS:

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

VII. ELECTRONICS RESOURCES:

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/

VIII. MATERIALS ONLINE

1. Course template
2. Assignments
3. Tutorial question bank
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations

COURSE CONTENT

CONTINUUM MECHANICS								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAED10	**Elective**	3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Mechanics of Solids								

I. COURSE OVERVIEW:

The major emphasis of this course is to model the mechanical behavior of materials as a continuous mass rather than as discrete particles. Mathematical concepts in higher dimensions are introduced to understand further topics. Concept of continuum applied to solid mechanics, fluid mechanics to make a clear understanding of system behavior. Nonlinear systems are linearized to understand the stability behavior of systems.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Analyse the infinite dimensional problem in a finite dimensional space with an error control.
II. Apply the concept of Cauchy Stress Tensor and Cauchy's Formula, Transformation of Stress Components and Principal Stresses on solid domains.
III. Analyse the principles of Navier equations to a fluid domain.
IV. Apply the various mathematical methods to heat transfer related domain.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Apply the concept of vector calculus and linear algebra for solving engineering related problems in a finite dimensional space.
CO 2 Utilize the Cauchy Stress Tensor and Cauchy's Formula, Transformation of Stress Components and Principal Stresses for determining stresses and strains on solids.
CO 3 Apply the concept of Reynolds Transport Theorem, Conservation of Momenta, Principle of Conservation of Linear Momentum for determining the pressure and velocity vectors in fluid domains.
CO 4 Apply the concept of Hooks law, material symmetry to Monoclinic Materials, Orthotropic Materials, and Isotropic Materials, for determining the stresses and strains.
CO 5 Apply the Navier Equations, Beltrami-Michell Equations with various boundary conditions, for obtaining the velocity and pressure distribution on a given geometry.
CO 6 Apply the various mathematical methods like Laplace transforms to Spring Mass Damper system courseed to various inputs forcing functions, for determining the displacement and velocity.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION, VECTORS AND TENSORS (10)

Background and Overview, Vector Algebra - Definition of a Vector, Scalar and Vector Products, Plane Area as a Vector, Components of a Vector, Summation Convention, Transformation Law for Different Bases; Theory of Matrices - Definition, Matrix Addition and Multiplication of a Matrix by a Scalar, Matrix Transpose and Symmetric Matrix, Matrix Multiplication, Inverse and Determinant of a Matrix; Vector Calculus - Derivative of a Scalar Function of a Vector, The del Operator, Divergence and Curl of a

Vector, Cylindrical and Spherical Coordinate Systems, Gradient, Divergence and Curl Theorems; Tensors Dyads and Polyads, Nonion Form of a Dyadic, Transformation of Components of a Dyadic, Tensor Calculus, Eigenvalues and Eigenvectors of Tensors.

MODULE-II: KINEMATICS OF CONTINUA (10)

Introduction, Description of Motion- Configurations of a Continuous Medium, Material Description, Spatial Description, Displacement Field; Analysis of Deformation- Deformation gradient tensors, Isochoric, Homogeneous and Inhomogeneous Deformations, Change of volume and surface; Strain Measures Cauchy-Green deformation tensors, Green Strain tensor, Physical Interpretation of the Strain Components, Cauchy and Euler Strain Tensors, Principal Strains; Infinitesimal Strain Tensor and Rotation Tensor- Infinitesimal Strain Tensor, Physical Interpretation of Infinitesimal Strain Tensor Components, Infinitesimal Rotation Tensor, Infinitesimal Strains in Cylindrical and Spherical Coordinate Systems; Rate of Deformation and Vorticity Tensors- Definitions, Relationship between D and E, .Polar Decomposition Theorem, Compatibility Equations, Change of Observer- Material Frame Indifference.

MODULE-III: STRESS MEASURES, CONSERVATION OF MASS, MOMENTA AND ENERGY (10)

Introduction, Cauchy Stress Tensor and Cauchy's Formula, Transformation of Stress Components and Principal Stresses- Transformation of Stress Components, Principal Stresses and Principal Planes, Maximum Shear Stress. Other Stress Measures - Preliminary Comments, First Piola- Kirchhoff Stress Tensor, Second Piola- Kirchhoff Stress Tensor, Equations of Equilibrium.

Introduction, Conservation of Mass - Preliminary Discussion, Material Time Derivative, Continuity Equation in Spatial Description, Continuity Equation in Material Description, Reynolds Transport Theorem. Conservation of Momenta - Principle of Conservation of Linear Momentum, Equation of Motion in Cylindrical and Spherical Coordinates, Principle of Conservation of Angular Momentum, Thermodynamic Principles - Introduction, The First Law of Thermodynamics: Energy Equation, Special Cases of Energy Equation, Energy Equation for One-Dimensional Flows , The Second Law of Thermodynamics..

MODULE-IV: CONSTITUTIVE EQUATIONS AND LINEARIZED ELASTICITY (10)

Introduction, Elastic Solids - Generalized Hooke's Law, Material Symmetry, Monoclinic Materials, Orthotropic Materials, Isotropic Materials, Transformation of Stress and Strain Components, Nonlinear Elastic Constitutive Relations, Constitutive Equations for Fluids - Ideal Fluids, Viscous Incompressible Fluids, Non-Newtonian Fluids, Heat Transfer - General Introduction, Fourier's Heat Conduction Law, Newton's Law of Cooling, Stefan-Boltzmann Law, Electromagnetics - Maxwell's Equation, Constitutive Relations. Governing Equations, The Navier Equations, The Beltrami-Michell Equations, Types of Boundary Value Problems and Superposition Principle. Clapeyron's theorem and Reciprocity Relations - Clapeyron's theorem, Betti's Reciprocity Relations, Maxwell's Reciprocity Relation, Solution Methods, Types of Solution Methods, Example: Rotating Thick-Walled Cylinder; Two-Dimensional Problems, Airy Stress Function, End Effects: Saint-Venant's Principle, Torsion of Noncircular Cylinders. Principle of Minimum Total Potential Energy - Total Potential Energy Principle, Derivation of Navier's Equations, Castiglian's Theorem. Hamilton's Principle-Hamilton's Principle for a Rigid Body, Hamilton's Principle for a Continuum.

MODULE-V: FLUID MECHANICS AND HEAT TRANSFER, LINEAR VISCOELASTICITY (08)

Preliminary Comments- Initial Value Problem, the Unit Impulse, and the Unit Step Function, The Laplace Transform Method, Spring and Dashpot Models - Creep Compliance and Relaxation Modulus, Maxwell Element, Kelvin-Voigt Element, Three-Element Models, Four-Element Models, Integral Constitutive Equations, Hereditary Integrals, Hereditary Integrals for Deviatoric Components, The Correspondence Principle, Elastic and Viscoelastic Analogies.

V. TEXT BOOKS:

1. An Introduction to Continuum Mechanics, J.N. Reddy, Cambridge University Press, 2007
2. George. E. Mase, Schaum's, "Continuum Mechanics" Outline Series, McGraw-Hill Book Company, 1969.
3. Ellis H. Dill, "Continuum Mechanics", CRC Press, 2006.

VI. REFERENCE BOOKS:

1. Ahmed A. Shabana, "Computational Continuum Mechanics", Cambridge University Press, 2008.
2. W. Michael Lai, David Rabin and Erhard krempl, "Introduction to Computational Mechanics", Elsevier Inc, 4th Edition, 2010.
3. Lawrence E. Malvern, "Introduction to the Mechanics of a Continuous Medium", Prentice- Hall, 1969.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template
2. Assignments
3. Tutorial question bank
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations

COURSE CONTENT

ADVANCED AERODYNAMICS LABORATORY								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED11	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		-	-	4	2	40	60	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 45**				**Total Classes: 45**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

The major emphasis of this course is to study complex flow problems in different flow regimes for those methods do not have analytical solutions. Experimental and computational analysis shall be performed to find the aerodynamic characteristics like CL, CD, CM with variation of the Reynolds number and angles of attack. Software's like ANSYS Fluent / CFX will be employed to find aerodynamic efficiency for complex geometries. Modeling of flow help the students to solve realistic problems which are common in industries. Aerodynamic analysis on aircraft models, Rocket and missiles are dealt to obtain the solution for different applied aerodynamic variables.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The utilization of ANSYS Fluent software to obtain the solution for complex flow conditions.
II. The mathematical methods involved in aerodynamic analysis of flight vehicle.
III. Computational aerodynamic modeling using ANSYS software and determine its characteristics.
IV. Experimental Aerodynamic analysis of the complex shapes by using wind tunnel and determine the flight performance and stability criteria.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Apply the philosophy behind the computational fluid dynamics for recognizing flow properties in solving fluids and heat transfer problems.
CO 2 Select the structured, unstructured mesh and multi-blocking strategy in basic, complex geometries and flow domains for computing aerodynamic characteristics.
CO 3 Identify the appropriate physical boundary conditions for attaining the precise results of fluid flow over a body.
CO 4 Choose the suitable numerical modeling and schemes for computational simulations of aerodynamics and thermo-fluid problems using ANSYS.
CO 5 Analyze the numerical solution of fluid flow problems using flow visualization Software's and wind tunnel for recognizing the flow physics in and around the supersonic intake and free jet.
CO 6 Make use of the Wind Tunnel for predicting the profile drag using boundary layer and wake momentum theory.

IV. COURSE CONTENT:

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

Week-2: INTRODUCTION TO ANSYS CFX/ FLUENT
Introduction to gambit, geometry creation, suitable meshing types and boundary conditions.

Week-3: INTRODUCTION TO SUBSONIC WIND TUNNEL
Model a subsonic wind tunnel with 50 m/s velocity in test section and carryout the fluid flow analysis to find the power required and flow characteristics in test section.

Week-4: FLOW THROUGH NOZZLE
Design a convergent nozzle with area ratio of 1.58. For inlet pressure of 5bar and temperature of 500K calculate exit velocity and momentum thrust generated by the nozzle.

Week-5: FLOW THROUGH SUPERSONIC INTAKE
Design a supersonic intake for Mach 2 free stream velocity and calculate the pressure recovery factor for inlet total pressure of 3 bar and temperature of 300K. Find the shock strength as well.

Week-6: SUPERSONIC FREE JET
Design a convergent divergent nozzle to generate Mach 2 free jet and evaluate the decay characteristics of the jet like centerline Mach number, total pressure and vortex propagation.

Week-7: SHOCK BOUNDARY LAYER INTERACTION
Design a supersonic flow over a flat plate with free stream Mach number of 2 and evaluate the effect of Shock Boundary Layer Interaction

Week-8: FLOW OVER A RE-ENTRY VEHICLE
Design a re-entry vehicle with blunt nose for Mach 10 and calculate the aerodynamic heating on the surface of vehicle and Maximum temperature at the stagnation point.

Week-9: SUPERSONIC FLOW OVER A CONE
Flow over wedge body at supersonic Mach number; observe the shock wave phenomena and change of properties across the shockwave.

Week-10: PROFILE DRAG PREDICTION
Calculate the profile drag of a circular cylinder having diameter of 50 mm using wetted area method.

Week-11: WAKE MOMENTUM DRAG MEASUREMENT
Locating the Transitional separation bubbles

Week-12: BOUNDARY LAYER MEASUREMENT
Predict the profile drag of a flat plate having length of 2000 mm and width of 600 mm for test section velocity of 40 m/s and 50m/s.

Week-13: PRESSURE DISTRIBUTION OVER SYMMETRICAL AND CAMBERED AIRFOIL
Predict the lift and drag coefficient of symmetrical and cambered airfoil at test section velocity of 40 m/s and 50m/s.

Week-14: FORCE MEASUREMENT

Predict the forces and moments of an aircraft model at different angle of attack for test section velocity of 40m/s, and 50 m/s

V. TEXT BOOKS:

1. Anderson, J.D., Jr., Computational Fluid Dynamics the Basics with Applications, McGraw-Hill Inc,1st Edition, 1998.
2. Mark Drela., "Flight Vehicle Aerodynamics", MIT Press, Cambridge, Massachusetts London, England.

VI. REFERENCE BOOKS:

1. Hirsch, C., "Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics", Vol. I, 2nd Edition, Butter worth-Heinemann (2007).
2. JAF. Thompson, Bharat K. Soni, Nigel P. Weatherill, "Grid Generation", 1st Edition, 2000.

VII. ELECTRONICS RESOURCES:

1. https://www.scribd.com/doc/311680146/eBook-PDF-Cfd-Fluent.

VIII. MATERIALS ONLINE

1. Course template
2. Lab manual

COURSE CONTENT

COMPUTATIONAL AEROSPACE ENGINEERING LABORATORY								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED12	Core	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		-	-	4	2	40	60	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 45**				**Total Classes: 45**		
Prerequisite: Aircraft Structures								

I. COURSE OVERVIEW:

This course aims to enhance the skills through a detailed introduction to the state-of-the-art computational methods and their applications for digital age aerospace engineering applications. It provides a unique opportunity for cross-disciplinary education and knowledge transfer in the computational engineering of fluid and solid mechanics for aerospace industrial applications. Focusing on fully integrated digital design for aerospace applications, you will be able to understand and implement numerical methods on various computing platforms for aerospace applications

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basic ANSYS software and use them to solve structural aero dynamic and flight control system problems.
II. Basics of plotting in ANSYS both in two dimensional and three dimensional.
III. Coding for solving structural response problems, aerodynamic simulation problems and flight control system analysis and design.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Develop the appropriate method for predicting ultimate load on wing using MATLAB.
C0 2 Make use of MATLAB and Simulink tools for solving aerospace engineering problem in designing.
CO 3 Examine the vibrational characteristics of various supported beams for obtaining structural stability.
CO 4 Make use of the structural fatigue concept for obtaining desired flexural characteristics.
CO 5 Analyze the effect of bending for failure rate of an aircraft structure.
CO 6 Determine the effect of Tortion during fracture of an aircraft component for assessing the structural stability.

IV. COURSE CONTENT:

Week-1: INTRODUCTION

MATLAB introduction, Plotting and graphics

Week-2: GENERATION OF STRUCTURES AND UNSTRUCTURED GRID

Generation of structured and unstructured grids are essential in the field of computational fluid dynamics (CFD) and finite element analysis (FEA).

Week-3: PLATE BENDING
Plate bending using finite element method.

Week-4: BEAMS ANALYSIS
Beams analysis using finite element method

Week-5: TRUSSES ANALYSIS
Trusses analysis using finite element method

Week-6: THIN SHELLS ANALYSIS
Thin shells analysis using finite element method

Week-7: FREE VIBRATION OF A CANTILEVER BEAM
Measurement of the natural frequencies of the cantilever beam, Observation of the damping effects in the beam's vibrations, Calculation of the time periods associated with each natural frequency.

Week-8: FORCED VIBRATION OF A CANTILEVER BEAM
Measurement of the frequency response of the cantilever beam, Determination of the relationship between the applied force's frequency and the beam's response amplitude at various excitation levels

Week-9: FREE VIBRATION OF A SIMPLY SUPPORTED BEAM
Measurement of the natural frequencies of the simply supported beam, Analysis of how the amplitude of vibration decays over time.

Week-10: FORCED VIBRATION OF A SIMPLY SUPPORTED BEAM
Measurement of the frequency response of the simply supported beam. Calculation of the dynamic stiffness of the simply supported beam.

Week-11: DETERMINATION OF ELASTIC CONSTANTS FOR A COMPOSITE FLEXURAL SPECIMEN
Determination of the flexural modulus, Use of strain gauges or other strain measurement devices to determine the strains experienced by the specimen during bending.

Week-12: COMBINED BENDING AND TORSION OF A HOLLOW CIRCULAR TUBE
Measurement of the load-deformation relationship for the hollow circular tube subjected to combined bending and torsion, Assessment of the combined stresses in the tube.

Week-13 SHEAR FORCE AND BENDING MOMENT DIAGRAMS- CANTILEVER BEAM
a. Calculating shear force and bending moment for point load.
b. Calculating shear force and bending moment for uniformly distributed load.
c. Calculating shear force and bending moment for uniformly varying load

Week-14 SHEAR FORCE AND BENDING MOMENT DIAGRAMS- OVER HANGING BEAM
a. Calculating shear force and bending moment for point load.
b. Calculating shear force and bending moment for uniformly distributed load.
c. Calculating shear force and bending moment for uniformly varying load

V. TEXT 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.

VI. REFERENCE BOOKS:

1. Ashish Tewari, “Atmospheric and Space Flight Dynamics”, Birkhauser Publication, 1st Edition, 2007.
2. A. Tewari, “Modern Control Design with MAT LAB and Simulink”, Wiley, 1st Edition, 2002.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template
2. Lab manual

COURSE CONTENT

RESEARCH METHODOLOGY AND IPR								
I Semester: AE, CSE, ES, EPS, & STE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BHSD01	**Core**	2	0	0	2	40	60	100
Contact Classes: 48	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: NIL								

I. COURSE OVERVIEW:

This course imparts research methodology and philosophy of intellectual property rights, including basic concepts employed in quantitative and qualitative research methods, Patents, Copyrights, and Trademarks. It provides the research framework, research methodology research design, and formulation hypothesis, sampling techniques, data analysis and report writing. It implies on research skills and intellectual property rights to encourage new creations, including technology, artwork, and inventions, that might increase economic growth.

II. COURSE OBJECTIVES:

The student will try to learn:

I. The Knowledge on formulate the research problem, characteristics of a good research and interpretation of collected data.
II. The importance of research ethics while preparing literature survey and writing thesis to achieve plagiarism free report.
III. The intellectual property rights such as patent, trademark, geographical indications and copyright for the protection of their invention done.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Interpret the technique of determining a research problem for a crucial part of the research study.
CO 2 Examine the way of methods for avoiding plagiarism in research.
CO 3 Apply the feasibility and practicality of research methodology for a proposed project.
CO 4 Make use of the legal procedure and document for claiming patent of invention.
CO 5 Identify different types of intellectual properties, the right of ownership and scope of protection to create and extract value from IP.
CO 6 Defend the intellectual property rights throughout the world with the involvement of world intellectual property organization

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION (10)

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches

of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

MODULE-II: RESEARCH ETHICS (09)
Effective literature studies approaches, analysis Plagiarism and Research ethics.

MODULE-III: RESEARCHPROPOSAL (09)
Effective technical writing, how to write report, Paper Developing a Research Proposal.

Format of research proposal, presentation and assessment..

MODULE-IV: PATENTING (10)
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

MODULE-V: PATENT RIGHTS (10)
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

V. TEXT BOOKS:

1. Panneerselvam, Ramasamy. Research methodology. PHI Learning Pvt. Ltd., 2014.
2. Goddard, Wayne, and Stuart Melville. Research methodology: An introduction. Juta and Company Ltd, 2004.
3. Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for beginners". 2nd edition, 2007

VI. REFERENCE BOOKS:

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
2. Correa, Carlos M. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed books, 2000.
3. Niebel, "Product Design", McGraw Hill, 1974.
4. Asimov, "Introduction to Design", Prentice Hall, 1962

VII. ELECTRONICS RESOURCES:

1. https://wac.colostate.edu/docs/books/try/chapter1.pdf
2. https://www.scribbr.com/dissertation/methodology/
3. http://nptel.ac.in/courses/107108011/

VIII. MATERIALS ONLINE:

1. Course Template
2. Tutorial Question Bank
3. Assignments
4. Model Question Paper – I
5. Model Question Paper - II
6. Lecture Notes
7. Early Lecture Readiness Videos
8. Power point presentation

COURSE CONTENT

FLIGHT DYNAMICS AND CONTROL								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED13	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	4	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

Flight dynamics and control is the study of the performance, stability, and control of vehicles flying through the air or in outer space. It is concern with how the forces/moments are acting on the vehicle to determine its velocity and attitude with respect to time. This course is going to develop as an engineering science throughout succeeding generations of aircraft engineer to support increasing demands of aircraft stability and control and it now has a major role to play in the design of modern aircraft to ensure efficient, comfortable and safe flight. Modern aircraft control is ensured through automatic control systems known as autopilot. Their role is to increase safety, facilitate the pilot's task and improve flight qualities. The course will introduce modern aircraft stability and control and discuss some of its objectives and applications.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental principles of flight, controls, aerodynamic flows, forces and moments related to airfoils and aircrafts.
II. The mathematical formulations of aerodynamic performance, stability and the equations of motion related to flight dynamics of a rigid body in linear and non- linear motion.
III. The essential knowledge on coupled and decoupled equations of motion and the derivatives related to longitudinal and lateral dynamic stability of the air vehicles.
IV. The advance concept of automated control and numerical simulations of aircraft stability for the development of the modern future aircrafts and flight vehicles.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Make use of the principles of flight and governing aerodynamics laws for the control of aircraft motions forgetting the desired aircraft attitude characteristics.
CO 2 Model the range, endurance and stability of equilibrium under different types of motions for calculating the aerodynamic performance of an airplane.
CO 3 Analyze the concept of aircraft dynamics, equations of motion in linear and nonlinear motion for optimal flight conditions.
CO 4 Determine the linear equations off motion and derivatives for the coupled and decoupled motion in terms of stability axis system by using small perturbation theory for obtaining the state of dynamic stability.
CO 5 Develop the mathematical model for the dynamic and static stability and its derivatives by using computational numerical simulation for the different types of aircrafts.
CO 6 Examine the flight control system by using control theories and modern computational tools system for the conventional and automatic flight of the aircraft.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION (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.

MODULE-II: MECHANICS OF EQUILIBRIUM FLIGHT (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.

MODULE-III: SMALL PERTURBATIONS AND THE LINEARISED, DECOUPLED EQUATIONS OF MOTION (10)
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.

MODULE-IV: LONGITUDINAL AND LATERAL LINEAR STABILITY AND CONTROL (11)
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.

MODULE-V: AIRCRAFT FLIGHT CONTROL (09)
Automatic flight control systems: An introduction, functions of a flight control system, integrated flight control system, flight control system design.

V. TEXT BOOKS:

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

VI. REFERENCE BOOKS:

1. Wayne Durham, "Aircraft Flight Dynamics and Control", CRC Press, 2nd edition, 2013.
2. Robert F. Stengel "Flight Dynamics", CRC Press, 2nd edition, 2013.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

AIRCRAFT STRUCTURAL MECHANICS								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED14	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Mechanics of Solids								

I. COURSE OVERVIEW:

Aircraft Structural Mechanics" is a fundamental component of aerospace engineering and focuses on the principles and analysis of aircraft structures. It provides students with a deep understanding of how aircraft components and systems are designed, analyzed, and maintained to ensure safety and reliability. This course provides students with a solid foundation in the mechanics and design of aircraft structures, preparing them to contribute to the development, maintenance, and safety of aircraft systems in the aerospace industry.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental principles of aircraft structural analysis and design.
II. The stress analysis and load calculations for aircraft components.
III. Evaluate and assess the structural integrity and safety of aircraft.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Utilize the Impact Strength and Fatigue Strength concept for interpreting stresses due to axial, bending, and torsional loads.
CO 2 Choose Strain Energy and Columns concept for predicting the to axial, bending and Torsional loads, various end conditions, Euler's Column curve, Rankine's formula, and Column with initial curvature.
CO 3 Inspect the Bending of thin-walled beams to find the Mechanical Behaviors.
CO 4 Develop the torsion and shear of the thin plate for predicting the mechanical properties.
CO 5 Illustrate the concepts of stability problems of thin-walled structures.
CO 6 Make use of the concept of Aircraft Loads - Symmetric maneuver loads - Load factor determination for the aircraft structure.

IV. COURSE CONTENT:

MODULE-I: BENDING OF BEAMS (09)

Elementary theory of pure bending - Stresses in beams of symmetrical and unsymmetrical sections - Box beams - Generalized theory of bending - Methods of bending stress determination - Principal axes method - Neutral axis method - 'k' method - Deflection of unsymmetrical beams - Stresses in Composite Beams - Idealization of cross-section - Wing spar sizing.

MODULE-II: SHEAR FLOW IN THIN-WALLED SECTION (10)

General stress, strain and displacement relationships for open section thin-walled beams - Concept of shear flow - Shear flow in thin-walled open sections - Determinations of the shear centre - Symmetrical

and unsymmetrical cross-sections - Shear flow due to bending in open sections - Torsion of thin-walled open section members & determination of stresses - Design of thin-walled members

MODULE-III: SHEAR FLOW IN CLOSED SECTIONS (10)
Shear flow in thin-walled closed sections - Symmetrical and unsymmetrical sections - Flexural shear flow in two flanges, three flange and multi-flange box beams - Determinations of the shear center

Bredt-Batho theory - Torsional shear flow in multi-cell tubes - Shear flow due to combined bending and torsion - Stress analysis of aircraft components - Tapered wing spar - Introduction to shear lag

MODULE-IV: STABILITY PROBLEMS (09)
Stability problems of thin-walled structures - Buckling of sheets under compression, shear, and combined loads - Plate buckling coefficient - Inelastic buckling of plates - Sheet-stiffener panels - Effective width - Failure stress in plates and stiffened panels - Crippling stress estimation - Local Buckling - Wagner beam theory - Experimental determination of critical load for a flat plate - Principles of stiffener/web construction

MODULE-V: ANALYSIS OF AIRCRAFT STRUCTURAL COMPONENTS (10)
Aircraft Loads - Symmetric maneuver loads - Load factor determination - Inertia loads - Aerodynamic loads & Schrenk's curve - The flight envelope - Shear force, bending moment and torque distribution along the span of the wing and fuselage - Structural parts of wing and fuselage and their functions - Analysis of rings and frames -- Introduction to aeroelasticity and shells.

V. TEXT BOOKS:

1. Bruce. K. Donaldson, "Analysis of Aircraft Structures: An Introduction", Cambridge University Press, 2nd edition, 2012.
2. Bruhn. EF, "Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., 1980.
3. Megson, TMG, "Aircraft Structures for Engineering Students", Elsevier, Aerospace Engineering, Series, 7th edition, 2021.

VI. REFERENCE BOOKS:

1. Peery, DJ. And Azar, JJ, "Aircraft Structures", 2nd edition, McGraw-Hill, New York, 1993.
2. Rivello, R.M, "Theory and Analysis of Flight structures", McGraw-Hill, N.Y., 1993.
3. Sun. CT, "Mechanics of Aircraft Structures", Wiley publishers, 2nd edition, 2006.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

GUIDANCE AND CONTROLS								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED15	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

Missile guidance refers to a variety of methods of guiding a missile or a guided bomb to its intended target. The missile's target accuracy is a critical factor for its effectiveness. Guidance systems improve missile accuracy by improving its probability of guidance. These guidance technologies can generally be divided up into a number of categories, with the broadest categories being "active," "passive" and "preset" guidance. This course deals with the introduction to missile system, airframe, autopilots and the guidance laws. Also deals with strategic missile systems used for the warfare and automatic delivery systems of the modern missiles and aircrafts.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The advanced concepts of missile guidance and control.
II. Exposure on missile systems, missile airframes, autopilots, guidance laws.
III. Skills effectively in the understanding of missile guidance and control.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Understand the historical background of the development of the missile guidance system.
CO 2 Apply the knowledge of the Equations of motions to solve the missile trajectory characteristics.
CO 3 Apply the basic principles of Autopilot systems used in missile guidance and its types.
CO 4 Demonstrate the guidance laws and techniques of guidance systems and navigation system.
CO 5 Apply the concept of Lamberts theorem, on missile guidance and accuracy in strategic missile.
CO 6 Analyze the weapon delivery systems with guided and unguided weapon systems.

IV. COURSE CONTENT:

MODULE-I: MISSILE SYSTEMS INTRODUCTION (09)

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

MODULE-II: MISSILE AIRFRAMES, AUTOPILOTS AND CONTROL (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.

MODULE-III: MISSILE GUIDANCE LAWS (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.

MODULE-IV: STRATEGIC MISSILES (10)
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.

MODULE-V: WEAPON DELIVERY SYSTEMS (09)
Dynamic Performance of Spacecraft: Equations of Motion of Launch Vehicles with respect to a rotating planet, Motion of Spacecraft with respect to a rotating planet. Dynamic Performance-Atmospheric Entry: Equation of motion, Approximate analysis of gliding entry into a planetary atmosphere.

V. TEXT BOOKS:

1. G.M. Siouris, "Missile Guidance and Control Systems", Springer, 2003.
2. J.H. Blake lock, "Automatic Control of Aircraft and Missiles", John Wiley & Sons, 2nd edition, 1990.
3. Eugene L. Fleeman, "Tactical Missile Design", AIAA Education series, 1st edition, 2001.

VI. 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.

VII. ELECTRONICS RESOURCES:

1. http://www.sciencedirect.com/science/article/pii/S1000936108600217.
2. https://www.academia.edu/8521925/Atmospheric_re-entry_vehicle_mechanics.
3. http://link.springer.com/article/10.1007/s11633-010-0563-.
4. http://as.wiley.com/WileyCDA/WileyTitle/productCd-0471506516.html.

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

ROCKETS AND MISSILES								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED16	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aircraft Propulsion								

I. COURSE OVERVIEW:

This course deals in detail about rockets propulsion systems. This course includes various equation of motion and various moments of a rocket. It compares and contrasts various thrust vector control mechanisms of nozzle and cooling systems of combustion chamber. It discusses on various materials and its properties that are used for manufacturing of rocket and missiles. This course also covers the basic concepts of guidance of missile and various types of tactical guidance systems and techniques.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental concepts of various rocket propulsion systems, combustion process and forces/moments acting on the rocket under static and dynamic conditions.
II. Various components and propellants of a chemical rocket propulsion system with its characteristics and applications.
III. The various aerodynamic forces and moments acting on a rocket.
IV. Properties of different materials that are used in manufacturing of various rocket and missile components.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Apply the knowledge of combustion systems and feed systems of rockets for selecting the suitable component based on the mission requirement.
CO 2 Utilize the knowledge of aerodynamic forces and moments of Rockets and missiles for designing with optimum performance.
CO 3 Apply the concepts of 1-D, 2-D rocket motions in free space and gravitational fields for solving the problems in space.
CO 4 Analyze the combinations of trajectories, range, altitude and velocity of rockets and missiles for specific application.
CO 5 Categorize the staging and controls of planned rocket and missiles for providing sufficient capability such as speed, range, and maneuverability.
CO 6 Make use of the selection criteria of materials properties for designing new components under adverse conditions.

IV. COURSE CONTENT:

MODULE-I: ROCKET SYSTEMS (09)

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.

MODULE-II: AERODYNAMICS OF ROCKET AND MISSILES (11)
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 down wash in missiles; Rocket dispersion; Numerical problems.

MODULE-III: ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD (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.

MODULE-IV: STAGING AND CONTROL OF ROCKET AND MISSILES (10)
Rocket vector control, methods, thrust termination; Secondary injection thrust vector control system; Multistage of rockets; Vehicle optimization; Stage separation dynamics; Separation techniques.

MODULE-V: MATERIALS FOR ROCKET AND MISSILES (08)
Selection of materials; Special requirements of materials to perform under adverse conditions.

V. TEXT BOOKS:

1. 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.

VI. 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 Space craft", 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.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

GROUND VEHICLE AERODYNAMICS								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED17	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

This subject deals with automotive Aerodynamics are the study of air flows around and through the vehicle body. More generally, it can be labelled "Fluid Dynamics" because air is really just a very thin type of fluid. Above slow speeds, the air flow around and through a vehicle begins to have a more pronounced effect on the acceleration, top speed, fuel efficiency and handling. Influence of flow characteristics and improvement of flow past vehicle bodies to reduction of fuel consumption, more favorable comfort characteristics (mud deposition on body, noise, ventilating and cooling of passenger compartment) and improvement of driving characteristics (stability, handling, traffic safety)

II. COURSE OBJECTIVES:

The students will try to learn:

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

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Apply the knowledge of fluid mechanics, and aerodynamics for designing a frontal portion of a vehicle.
CO 2 Analyze the lateral stability problems of vehicle to improve the vehicle dynamics under different conditions.
CO 3 Apply the knowledge of mechanisms, and measurement techniques for the stability of ground vehicle
CO 4 Apply the knowledge of flow behavior over different components of race vehicle for designing a race car
CO 5 Apply the knowledge of wind tunnel test for optimizing the ground vehicle design.
CO 6 Apply the knowledge of measuring equipment and transducers to investigate the roadside performance of vehicle.

IV. COURSE CONTENT:

MODULE-I: OVERVIEW AND INTRODUCTION (10)

Historical developments and trends, fundamentals of fluid mechanics, flow phenomenon related to vehicles, external and internal flow problem, resistance to vehicle motion, mechanics of air flow around a vehicle, pressure distribution, aerodynamic forces, vehicle drag and types, side and lift forces, performance potential of vehicle aerodynamics.

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

MODULE-III: VEHICLE HANDLING AND STABILITY (10)
Origin, characteristics and effects of forces and moments on a vehicle, lateral stability problems.
Vehicle dynamics under sidewinds, dirt accumulation on the vehicle.

Wind noise: Mechanisms and generation design features, measurement and techniques.

MODULE-IV: RACE CAR AERODYNAMICS (09)
Basic vehicle body concepts, aerodynamics of the complete vehicle, flow over wheels, sliding seal and skirts, under body channels, simply add on: spoilers, strakes and wickers, internal flow, race car wings, most current examples in detail design.

MODULE-V: MEASUREMENT AND TEST TECHNIQUES (09)
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.

V. TEXT BOOKS:

1. Wolf-Heinrich Hucho, "Aerodynamics of Road Vehicles", SAE International, 1998.
2. Joseph Katz, "Race Car Aerodynamics Designing for Speed", Bentley Publishers, 2nd edition, 1996.

VI. REFERENCE BOOKS:

1. Alan Pope, "Wind Tunnel Testing", John Wiley & Sons, 2nd edition, 1974.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
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4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

EXPERIMENTAL METHODS OF STRESS ANALYSIS								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED18	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aircraft structures								

I. COURSE OVERVIEW:

This course deals with theory behind the experimental techniques and their process. The main focus is on principal of measurements and their uses on the practical problems. The students will learn about the electrical circuits, their sensitivity and effects. Broad knowledge on the two photo-elasticity concepts, techniques, materials used and their effects. A glimpse of three-dimensional photo elasticity will be given. Various applications of coatings will be discussed along with advantages. A view point on calibration photo elastic model materials is appreciated. Two element and three element rosettes and gauges are addressed.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The effects of force and motion while carrying out the innovative design functions of engineering. Bring awareness on experimental method of finding the response of the structure to different types of loads.
II. The relation between the mechanics theory, experimental stress analysis, and the mechanical, optical, pneumatic and electrical strain gauges for strain measurement.
III. The fundamental concepts and newly experimental techniques and able to use the experimental techniques on the practical problems.
IV. The fine presentation related to the experimental paper.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Understand the principles and range of measurements used to discover the responses of the structure
CO 2 Apply about the various extensor meters for finding the response of the structure to different types of loads.
CO 3 Analyse the strain sensitivity in metallic alloys and techniques for strain measurement
CO 4 Make a use of the two- and three-dimensional photo elasticity concepts and effects
CO 5 Apply the various photo-elastic coatings, methods and their applications to the study of stress distribution
CO 6 Explain the effect of stress model, fringe order techniques and calibration photo elastic model materials

IV. COURSE CONTENT:

MODULE-I: BASIC CONCEPTS (10)

Stresses, Strains and Displacements - Determination of Principal Values of Stresses and Strains in 2-D & 3-D - Maximum Shear Stress - Strain Measurement Using Mechanical Extensometers -Principles of Measurements - Basic Characteristics and Requirements of a Measuring System -Sources of error - Statistical Analysis of Experimental Data - Non-Contact Measurement.

MODULE-II: ELECTRICAL RESISTANCE STRAIN GAGES (10)
Strain sensitivity in metallic alloys, gage construction, adhesives and mounting techniques, gage sensitivity and gage factor, performance characteristics, environmental effects, strain gage circuits; Potentiometer, wheat stone's bridges, constant current circuits.

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

Photo elastic (Bi-refringent) coatings, effects of coating thickness, brittle coatings, types of brittle coatings, advantages and brittle coating applications, crack detection methods and Moire methods: Applications and advantages.

MODULE-IV: PHOTO-ELASTICITY (09)
Nature of light, wave theory of light, optical interference, stress optic law, effect of stressed model in plane and circular polariscopes, iso clinics and iso-chromatics, fringe order determination fringe multiplication techniques, calibration photo elastic model materials.

MODULE-V: NON-DESTRUCTIVE TESTING (09)
Different types of NDT Techniques - Acoustic Emission Technique - Ultrasonic - Pulse-Echo - Through Transmission - Eddy Current Testing - X-Ray Radiography - Challenges in Non-Destructive Evaluation - Non-Destructive Evaluation in Composites - Concepts of Image Processing Theory.

V. TEXT BOOKS:

1. Albert S. Kobayashi, "Handbook on Experimental Mechanics", Prentice Hall Publishers, 1987.
2. Sadhu Singh, "Experimental Stress Analysis", Khanna Publisher, 4th edition, 2009.
3. Srinath L.S tata, "Experimental stress Analysis", McGraw-Hill, 3rd edition, 2012.

VI. REFERENCE BOOKS:

1. M.M.Frocht, John Wiley & sons, "Photo elasticity Vol I and Vol II", McGraw Hill, 2nd edition, 1969.
2. Perry and Lissner, "Strain Gauge Primer", McGraw Hill, 2nd edition, 1969.
3. Udpa. S.S & Patrick O. Moore, "Non-destructive Testing Handbook", Electromagnetic Testing, Third edition: Volume 5, 2004.

VII. ELECTRONICS RESOURCES:

1. https://www.youtube.com/playlist?list=PLUl4u3cNGP62esZEwffjMAsEMW_YArxYC
2. www.nptel.ac.in/syllabus/syllabus.php?subjectId=112106068www.textofvideo.nptel.iitm.ac.in/112106068/lec1.pdf

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

COMPUTATIONAL HEAT TRANSFER								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED19	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Computational Aerodynamics								

I. COURSE OVERVIEW:

Computational Heat Transfer focuses on the numerical methods and techniques used to simulate and analyze heat transfer phenomena in various engineering applications. It Introduces the governing equations for heat transfer, including the heat conduction equation, Navier-Stokes equations for fluid flow, and the energy equation. This course equips students with the computational skills and knowledge necessary to tackle heat transfer problems in diverse engineering fields, allowing them to contribute to the design and optimization of thermal systems and processes.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Understand the fundamental principles of heat transfer and its mathematical modeling.
II. Apply computational tools to solve complex heat transfer problems in engineering applications.
III. The types of PDE's and its boundary conditions to arrive at its solution
IV. To developing numerical codes for solving heat transfer Problems

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Choose appropriate discretization methodologies for solving heat transfer problems
CO 2 Apply appropriate boundary condition for solving 2D and 3D conductive heat transfer problems
CO 3 Make use of implicit, explicit and crank-Nicolson schemes for solving unsteady heat conduction problems
CO 4 Develop numerical solutions for transient heat conduction in simple geometries.
CO 5 Make use of numerical treatment of steady and unsteady 1-D and 2-d heat convection for solving thermal and Velocity boundary layer flows
CO 6 Develop numerical code using radiosity and- absorption Method for radiative heat transfer problem

IV. COURSE CONTENT:

MODULE-I: OVERVIEW AND INTRODUCTION (10)

Finite Difference Method-Introduction-Taylor's series expansion-Discretization Methods Forward, backward and central differencing scheme for first order and second order Derivatives - Types of partial differential equations-Types of errors-Solution to algebraic equation-Direct Method and Indirect Method-Types of boundary condition-FDM - FEM - FVM.

MODULE-II: CONDUCTIVE HEAT TRANSFER (10)

General 3D-heat conduction equation in Cartesian, cylindrical and spherical coordinates. Computation (FDM) of One -dimensional steady state heat conduction -with Heat generation without Heat generation-2D-heat conduction problem with different boundary conditions Numerical treatment for extended

surfaces- Numerical treatment for 3D- Heat conduction Numerical treatment to 1D-steady heat conduction using FEM.

MODULE-III: TRANSIENT HEAT CONDUCTION (10)
Introduction to Implicit, explicit Schemes and crank-Nicolson Schemes Computation (FDM) of One-dimensional un-steady heat conduction -with heat Generation-without Heat generation.

2D-transient heat conduction problem with different boundary conditions using Implicit, explicit Schemes-Importance of Courant number- Analysis for I-D,2-D transient heat Conduction problems.

MODULE-IV: CONVECTIVE HEAT TRANSFER (09)
Convection- Numerical treatment (FDM) of steady and unsteady 1-D and 2-d heat convection diffusion steady-unsteady problems- Computation of thermal and Velocity boundary layer flows. Upwind scheme-Stream function-vorticity approach-Creeping flow.

MODULE-V: **RADIATIVE HEAT TRANSFER (09)**
Radiation fundamentals-Shape factor calculation-Radiosity method- Absorption Method -Monte Carlo Method-Introduction to Finite Volume Method- Numerical treatment of radiation enclosures using finite Volume method. Developing a numerical code for 1D, 2D heat transfer problems

V. TEXT BOOKS:

1. Holman, JP, "Heat Transfer", McGraw-Hill Book Co, Inc., McGraw-Hill College; 10th edition, 2017.
2. Richard H. Pletcher, John C. Tannehill & Dale Anderson, "Computational Fluid Mechanics and Heat Transfer", 4th edition, CRC Press, 2021.
3. Frank J. Regan "Dynamics of Atmospheric Re-Entry" American Institute of Astronautics and Aeronautics Publications, 1st edition, 1993.

VI. REFERENCE BOOKS:

1. Chung, TJ, "Computational Fluid Dynamics", Cambridge University Press, 2002.
2. Sachdeva, SC, "Fundamentals of Engineering Heat & Mass Transfer", New age publisher, 4th edition Internationals, 2017.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

HIGH ENTHALPY GAS DYNAMICS								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED20	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

This particular course has been deigned to cover aerodynamic features of hypersonic flows with their basic governing equations and their applications in various flow fields. It also provides a comprehensive training experience in the basic principles, technologies and methodologies pertaining to the multi-disciplined realm of hypersonic flight. Participants will acquire a sound understanding of hypersonic aero physics and the effects of the hypersonic flight environment on vehicle loads and performance, including a consideration of both continuum flow and rarefied flow aerodynamic effects.

II. COURSE OBJECTIVES:

The students will try to learn:

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

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Summarize the fundamental aspect of hypersonic flow and their characteristics for solving the hypersonic flow over arbitrary shape.
CO 2 Construct the equation for variation flow properties for shock and expansion waves in hypersonic flow.
CO 3 Make a use of equivalence principle and various theories to model shock interaction in hypersonic flow field.
CO 4 Build the governing equation for viscous hypersonic laminar and turbulent boundary layer.
CO 5 Select suitable computational fluid dynamic model to solve hypersonic viscous flow.
CO 6 Construct the governing equation for high temperature inviscid equilibrium and non-equilibrium flow over an arbitrary body.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION TO HYPERSONIC AERODYNAMICS (08)

Peculiarities of Hypersonic flows - thin shock layers - entropy layers - low density and high-density flows - hypersonic flight similarity parameters - shock wave and expansion wave relations of inviscid hypersonic flows - velocity vs altitude map for hypersonic vehicles.

MODULE-II: SURFACE INCLINATION METHODS AND THEORIES (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 flow fields: 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 flow fields: Exact methods: method of characteristics, time-marching finite difference method, correlations for hypersonic shock-wave shapes, shock-shock interactions, space-marching finite difference method.

MODULE-III: VISCOUS FLOW AND HYPERSONIC VISCOUS INTERACTIONS (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 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.

MODULE-IV: HIGH ENTHALPY GAS DYNAMICS (10)
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.

MODULE-V: INVISCID HIGH ENTHALPY EQUILIBRIUM FLOWS AND NON-EQUILIBRIUM FLOWS (10)
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.

V. TEXT BOOKS:

1. Ethirajan Rathakrishnan," High Enthalpy Gas Dynamics", Wiley; 1st edition 2015
2. John D. Anderson, "Hypersonic and High Temperature Gas Dynamics", McGraw Hill, 2nd edition, 1989.
3. John J. Berlin, "Hypersonic Aerodynamics", AIAA Education series,1st edition, 1994.

VI. 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.

VII. WEB REFERENCES:

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

VIII. MATERIALS ONLINE

1. Course template.

2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

AERODYNAMICS OF TURBO MACHINERY								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED21	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

This course provides an introduction to the working principles, performance and design of turbo machinery. The course first covers a review of essential fluid and thermo-dynamics. Concepts relevant to all turbo machines are then introduced. Axial turbines and compressors are studied in depth, including their kinematics, performance and design. The three-dimensional effects in turbo machinery, centrifugal machines, propellers, hydraulic turbines and wind turbines.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The working principles of turbines and pumps/compressors
II. The basic loading and performance analysis for a variety of machines
III. The fluid-thermodynamic mechanisms associated with performance degradation
IV. The basic operating principles of centrifugal machines, propellers, hydraulic turbines and wind turbines

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Relate the working principles of turbo machines for predicting its thermodynamic.
CO 2 Demonstrate typical designs of turbo machines and differentiate from positive displacement machines.
CO 3 Illustrate the off-design behavior of turbines and compressors and relate it to changes in the velocity triangles.
CO 4 Analyze the relations between choices made early in the turbo machinery design process and the final components and operability.
CO 5 Apply the Euler's equations for turbomachinery to analyze energy transfer in turbomachines
CO 6 Analyze the performance of turbo machinery by using the preliminary designs of pumps, compressors and turbines.

IV. COURSE CONTENT:

MODULE-I: ENERGY TRANSFER IN TURBO MACHINES (10)

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.

MODULE-II: AXIAL FLOW COMPRESSORS AND FANS (10)

Introduction; Aero-Thermodynamics of flow through an Axial flow Compressor stage; Losses in axial flow compressor stage; Losses and Blade performance estimation; Secondary flows (3-D); Tip leakage flow and scrubbing; Simple three dimensional flow analysis; Radial Equilibrium Equation; Design of compressor blades; 2-D blade section design : Airfoil Data; Axial Flow Track Design; Axial compressor

characteristics; Multi-staging of compressor characteristics; Transonic Compressors; Shock Structure Models in Transonic Blades; Transonic Compressor Characteristics; 3-D Blade shapes of Rotors and Stators; Instability in Axial Compressors; Loss of Pressure Rise; Loss of Stability Margin; Noise problem in Axial Compressors and Fans

MODULE-III: **AXIAL AND RADIAL FLOW TURBINES (10)**
Introduction; Turbine stage; Turbine Blade 2-D (cascade) analysis Work Done; Degree of Reaction; Losses and Efficiency; Flow Passage; Subsonic, transonic and supersonic turbines, Multi-staging of Turbine; Exit flow conditions; Turbine Cooling; Turbine Blade design - Turbine Profiles: Airfoil Data and Profile construction.

Radial Turbine: Introduction; Thermodynamics and Aerodynamics of radial turbines; Radial Turbine Characteristics; Losses and efficiency; Design of radial turbine.

MODULE-IV: ROTARY FANS, BLOWERS AND COMPRESSORS (10)
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.

MODULE-V: USE OF CFD FOR TURBOMACHINERY ANALYSIS AND DESIGN (08)
Computer aided blade profile generation, Cascade Analysis; Periodicity and boundary Conditions, 3-D blade generation and 3-D flow analysis, Flow track and inter-spool duct analysis and design

V. TEXT BOOKS:

1. Yahya S.H., Turbines, "Compressor and Fans", TMH, 2nd edition, 2008.
2. Venkanna B.K., "Fundamentals of Turbo Machines", PHI Learning Private Limited, 5th edition, 2005.
3. Nicholas Cumpsty, Compressor Aerodynamics, 2004, Kreiger Publications, USA.

VI. REFERENCE BOOKS:

1. Johnson I.A., Bullock R.O. NASA-SP-36, Axial Flow Compressors, 2002 (re-release), NTIS.
2. Kadambi V Manohar Prasad; "An Introduction to EC Turbo Machinery" Vol. III, Wiley Eastern, 1st edition, 1999.

VII. ELECTRONICS RESOURCES:

1. https://archive.nptel.ac.in/content/syllabus_pdf/101101058.pdf
2. http://www.slideshare.net/asifzhcet/fluid-mechanics-and-hydraulic-machines-dr-r-k-bansal

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

ADVANCED FINITE ELEMENT METHODS								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED22	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Mechanics of Solids								

I. COURSE OVERVIEW:

The course covers principles of finite element method as applied to linear and non-linear problems. The course will start by reviewing fundamentals of finite element method including discretization, element formulation, assembling process, boundary conditions, solving system of equations, and post processing. The focus will then shift to non-linear FEM. A brief summary of variational calculus and the classical theory of plasticity will be followed by the theory of non-linear FEM including various numerical integration schemes. This course will also include use of software/programming with available codes/in-house codes in solving nonlinear problems.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The theory and characteristics of finite elements that represent engineering structures.
II. The finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses.
III. The application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Understand the concepts behind the weak formulation methods in FEM.
CO 2 Identify the application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.
CO 3 Illustrate the element characteristic equation and generation of global equation.
CO 4 Analyze the solution obtained for various boundary conditions suitable to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axisymmetric and dynamic problems and solve them displacements, stress and strains induced.
CO 5 Apply the numerical methods on heat transfer problems for developing thermal stiffness matrix and thermal load vector.
CO 6 Understand the concepts behind the weak formulation methods in FEM.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION (10)

Review of various approximate methods - Rayleigh-Ritz and Galerkin - Stiffness matrices for simple cases - Basic concepts of finite element method - Formulation of governing equations and convergence criteria.

MODULE-II: DISCRETE ELEMENTS (10)

Structural analysis of bar and beam elements for static and dynamic loadings. Bar of varying section - Temperature effects in bar elements.

MODULE-III: CONTINUUM ELEMENTS (10)
Plane stress, Plane strain and Axi-symmetric problems - CST Element - LST Element. Consistent and lumped load vectors.

Use of local co-ordinates. Numerical integration. Application to heat transfer problems. Solution for 2-D problems (static analysis and heat transfer).

MODULE-IV: ISOPARAMETRIC ELEMENTS (09)
Definition and use of different forms of 2-D and 3-D elements. - Formulation of element stiffness matrix and load vector. Solution for 2-D problems.

MODULE-V: SOLUTION SCHEMES (09)
Virtual work principle, Formulation of governing equation based on virtual work principle for static and dynamic problems.

V. TEXT BOOKS:

1. Segerlind, L.J. "Applied Finite Element Analysis", Second edition, John Wiley and Sons Inc., New York, 1984.
2. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 2002
3. S.S.Rao, "Finite Element Method in Engineering", Butterworth, Heinemann Publishing, 3rd edition, 1998
4. Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt "Concepts and Applications of Finite Element Analysis", 4th edition, John Wiley & Sons, 2002.

VI. REFERENCE BOOKS:

1. K.J. Bathe and E.L. Wilson, "Numerical Methods in Finite Elements Analysis", Prentice Hall of India Ltd., 1983
2. C.S. Krishnamurthy, "Finite Elements Analysis", Tata McGraw-Hill, 1987

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

FLIGHT SIMULATION AND CONTROLS LABORATORY								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED23	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		-	-	4	2	40	60	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 45**				**Total Classes: 45**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

The major emphasis of this course is to study the various flight maneuvering performance. The problems in different conditions of flight performance are demonstrated through either MATLAB-SIMULINK or Flight-Simulator. These tasks are performed to find the aerodynamic performance characteristics with variation of dependent parameters. SIMULINK Aerospace block set and tool kits are used to test various dependent parameters. Solid rocket propellant grain design will be simulated to test various burn rate and mission thrust reequipment.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The utilization of MATLAB-SIMULINK and Flight-Simulator software to obtain the solution for complex and simple performance parametric conditions.
II. The involvement of various mathematical conditions.
III. The complex performance by using MATLAB-Simulator to determine the flight performance and stability criteria.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Apply the philosophy behind the flight performance and condition for recognizing the impacting parameters.
CO 2 Select the optimized condition for best performance.
CO 3 Identify the appropriate conditions for attaining the precise results aerospace vehicle.
CO 4 Choose the suitable numerical techniques and provide the economical solutions by using FLIGHT-SIMULATOR and MATLAB-SIMULINK.
CO 5 Analyze mission critical problems using MATLAB/SIMULINK Software's and FLIGHT SIMULATOR.
CO 6 Make use of MATLAB/SIMULINK Software's and FLIGHT SIMULATOR.

IV. COURSE CONTENT:

Week-1: INTRODUCTION

Introduction to various mission and aircraft performance theories, conditions and methodologies used in SIMULINK and FLIGHT-SIMULATOR. Applications of mission critical operation for classical problems.

Week-2: INTRODUCTION TO MATLAB-SIMULINK AND FLIGHT SIMULATOR

Introduction to MATLAB features, Aerospace block set, aerospace tool kit and simulator's suitable conditions

Week-3: INTRODUCTION TO MATLAB/SIMULINK SOFTWARE'S AND FLIGHT SIMULATOR

Various menu items, functions and features availability in MATLAB/SIMULINK Software's and FLIGHT SIMULATOR.

Week-4: SIMULATION THROUGH MATLAB/SIMULINK SOFTWARE'S AND FLIGHT SIMULATOR

Building required block set for certain operation in MATLAB-SIMULINK and operation of sticks and pedal in FLIGHT-SIMULATOR.

Week-5: SIMULATION OF STEADY LEVEL FLIGHT AND SIMULATION OF ACCELERATED LEVEL FLIGHT (USING FLIGHT-SIMULATOR)

Runway activity, taxing, take-off and making level flight will be performed in FLIGHT-SIMULATOR.

Week-6: SOLID ROCKET PROPELLANT MOTOR BURNING ANALYSIS (USING MATLAB-SIMULINK)

Design of block set, fixing the burning rate and thrust obtain the thrust computation plot are the major activity.

Week-7: PERFORM THE OPERATION OF SPIN RECOVERY (USING FLIGHT-SIMULATOR)

Analyze the aerodynamic principles behind spins and stalls recovery which is crucial for pilots to make informed decisions during real-world scenarios.

Week-8: PERFORM THE LEVEL TURN AT GIVEN TURN RATE & PERFORM THE LEVEL TURN AT GIVEN TURN RADIUS (USING FLIGHT-SIMULATOR)

Investigate the effects of different turn rates and turn radii on the flight characteristics of an aircraft during level turns and analyze the collected data to observe trends and relationships between turn rate, turn radius, bank angle, and other relevant parameters.

Week-9: PERFORM FLIGHT SIMULATION FOR GIVEN MISSION PROFILES (USING FLIGHT-SIMULATOR)

Create the scenarios that align with the different mission profiles of scenarios that include emergency situations, search and rescue missions, or precision landing.

Week-10: PERFORM THE STABILIZATION OF LONGITUDINAL PERTURBED AIRCRAFT (USING FLIGHT-SIMULATOR)

Evaluate the severity and nature of the perturbation and determine whether it's a transient disturbance or a sustained deviation that requires immediate correction. Confirm that the aircraft has returned to straight and level flight, and assess whether any additional adjustments are needed to maintain stability.

Week-11: PERFORM THE STABILIZATION OF LATERAL PERTURBED AIRCRAFT (USING FLIGHT-SIMULATOR)

Choose an aircraft in your flight simulator that is designed for aerobatics or has the capability to perform rolls. This could be a high-performance, aerobatic, or stunt plane.

Week-12: UNDAMPED STABILITY (USING MATLAB-SIMULINK)

Examine the pole and zero locations of a dynamic system using MATLAB. Examine the effect of stability margins on closed-loop response characteristics of a control system by assessing Gain and Phase Margins.

Week-13: PERFORM THE SPIN RECOVERY (USING FLIGHT-SIMULATOR)

Create the scenarios where spin happens and recover from spin.

Week-14: PERFORM THE DUTCH ROLL RECOVERY (USING FLIGHT-SIMULATOR)

Create the scenarios where Dutch roll happens and recover from it.

V. TEXT BOOKS:

1. Brian L. Stevens, Frank L. Lewis - Aircraft Control and Simulation-Wiley 3rd Edition- (2016).
2. An interactive introduction to MATLAB, The University of Edinburgh, School of Engineering (2016).

VI. REFERENCE BOOKS:

1. A MATLAB Exercise Book by Ludmila I. Kuncheva and Cameron C. Gray, ISBN 978-0-244-25328-8 2nd edition, 2016.

VII. ELECTRONICS RESOURCES:

1. https://in.mathworks.com/support/learn-with-matlab-tutorials.html

VIII. MATERIALS ONLINE

1. Course template
2. Lab manual

COURSE CONTENT

ADVANCED STRUCTURAL ANALYSIS LABORATORY								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED24	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		-	-	4	2	40	60	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 45**				**Total Classes: 45**		
Prerequisite: Aerospace Structure								

I. COURSE OVERVIEW:

The course encourages introducing analytical tools from an Engineering perspective. The course efforts to provide the basic knowledge of analytical methodology outline the importance of aircraft structures. The aircraft structural laboratory is used to enhance the learning of the Postgraduate students by encouraging them to undertake projects in the area of structural analysis of thin-walled structural components, wings, fuselage, and landing gears. The major emphasis of this course is to solve a complex geometrical structure under a given load, these methods do not have analytical solutions. Software like ANSYS is utilized to interpret results for complex geometries.

II. COURSES OBJECTIVES:

The students will try to learn:

I. Provide basic knowledge on the mechanical behaviour of materials like aluminium, mild steel, and cast iron.
II. Visualize the crack detection using various NDT methods and also discuss the changing strength due to these defects.
III. Modelling a structural crack in ANSYS and determining its failure loads.
IV. Modelling complex composite structures in ANSYS and determining the stresses and strains.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Demonstrate the properties of Composite materials subjected to tensile loads using the magnitude of stress and strain for engineering applications
CO 2 Demonstrate the deflections of beams subjected to transverse loads under various end conditions for aerospace structural design
CO 3 Determine the failure mode during the fracture of an aircraft component for assessing crack propagation.
CO 4 Illustrate the critical buckling loads of columns subjected to Compression loads for efficient design of structures under various end conditions.
CO 5 Develop an appropriate method for predicting the ultimate load on the wing using ANSYS.
CO 6 Explain the Unsymmetrical Bending behavior of a Beam for designing aerospace structures.

IV. COURSE CONTENT:

Week-1: AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-I
Determination of Structural analysis of aircraft wing

Week-2: AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-II
Determination of Structural analysis of aircraft wing (composite material)

Week-3: AEROSPACESTRUCTURALANALYSISUSINGANSYS-III
Determination of Structural analysis of fuselage.

Week-4: AEROSPACESTRUCTURALANALYSISUSINGANSYS-IV
Determination of Structural analysis of Rocket motor case

Week-5: AEROSPACESTRUCTURALANALYSISUSINGANSYS-IV
Determination of Structural Analysis of Rocket Nozzle

Week-6: BUCKLING TEST
Determination of Critical buckling loads by Compression tests on long columns

Week-7: COMPRESSION TEST
Determination of Critical buckling loads, Southwell plot by Compression tests on short columns

Week-8: BENDING TEST
Determine the unsymmetrical Bending of a Beam

Week-9: SHEAR CENTRE FOR OPEN SECTION
Determination of Shear Centre of an Open Section Beam.

Week-10: SHEAR CENTRE FOR CLOSED SECTION
Determination of Shear Centre of a Closed Section Beam.

Week-11: SHEAR STRESS OF RIVETED JOINTS
Determination of Shear strength of riveted joint (double riveted Zig-Zag lap joint) between two given metals

Week-12: SANDWICH PANEL TENSION TEST (COMPOSITE MATERIALS)
Fabrication and determination of young's Modulus of Sandwich Panel (Composite Materials)

Week-13: NON-LINEAR ANALYSIS
Non-linear behavior with large deflections
Non-linear behavior with materials

Week-14: HARMONIC RESPONSE ANALYSIS
Random Vibration Analysis of a deep simply-supported beam
Harmonic response of a spring-mass system

V. TEXTBOOKS:

1. R.K Bansal, "Strength of Materials", Laxmi publications, 5th edition, 2012.
2. T. H. G. Megson, "Aircraft Structures for Engineering Students", Butterworth-Heinemann Ltd, 5th edition, 2012.
3. Gere, Timoshenko, "Mechanics of Materials", McGraw Hill, 3rd edition,1993

VI. REFERENCE BOOKS:

1. Peery, D.J. and Azar, J.J., Aircraft Structures, 2nd Ed., McGra-Hill,1982, ISBN0-07-049196-8
2. Bruhn. E.H, Analysis and Design of Flight Vehicles Structures, Tri-state Off-set Company, USA,1965

3. Lakshmi Narasaiah, G., Aircraft Structures, BS Publications, 2010.

VII. ELECTRONICS RESOURCES:

1. https://akanksha.iare.ac.in/index?route=course/details&course_id=88

VIII. MATERIALS ONLINE

1. Course Template
2. Laboratory Manual

COURSE CONTENT

MISSILE AERODYNAMICS								
III Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED26	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

The Missile Aerodynamics course is intended for the aerospace professional seeking expert instruction in the fundamentals of missile aerodynamics as applied to airframe design, analysis and test. The course provides students with a focused training experience in the aerodynamics of tactical missiles, ballistic missiles, launch vehicles, sounding rockets and projectiles. Participants will learn about vehicle 6-DOF aerodynamic force and moment models, airframe component air loads, atmospheric models, and mass property models. The course also includes a consideration of the unique aspects of projectile aerodynamics with particular emphasis on vehicle static, dynamic, and gyroscopic stability.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental aspects of aerodynamic characteristics and performance of various missiles.
II. The lateral, directional stability, control and their maneuverability.
III. The various design criteria and their modeling

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Classify various missiles and their control for the suitable selection in real world applications.
CO 2 Describe the aerodynamic characteristics of airframe components for different missile configurations
CO 3 Calculate the performance of various missile configurations for different operational envelops
CO 4 Compare the longitudinal stability of various missiles for forward and rear control
CO 5 Choose the appropriate wing, body and tail configuration for better directional stability
CO 6 Apply the formation of induced roll and their control for improving lateral stability of missile

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION (09)

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, mono-wing, triform, and cruciform.

MODULE-II: AERODYNAMIC CHARACTERISTICS OF AIRFRAME COMPONENTS & MISSILE PERFORMANCE (11)

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 un powered flight and design consideration.

MODULE-III: LONGITUDINAL STABILITY AND CONTROL, MANEUVERING FLIGHT (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, trim form, pull-ups; Relation between maneuverability and load factor; Stability margin.

MODULE-IV: DIRECTIONAL & LATERAL STABILITY AND CONTROL (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.

MODULE-V: AIRLOADS: DESIGN CRITERIA (09)
Forward control; Rear control; Component air loads: Body, aerodynamic surfaces; Component load distribution: Body and lifting surfaces; Aerodynamic hinge moments and aerodynamic heating.

V. TEXT BOOKS:

1. S.S.Chin, "Missile Configuration Design", Mc Graw Hill, 1st edition, 1960.
2. Jack N. Neilson, "Missile Aerodynamics", Mc Graw Hill, 1st edition, 1960.

VI. REFERENCE BOOKS:

1. M.J. Hemsch, J.N. Nielsen, "Tactical Missile Aerodynamics", AIAA, 2006.
2. J. H. Blacklock, "Automatic Control of Aircraft and Missiles", John Wiley & Sons, 2nd edition, 1991.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

FLIGHT SIMULATION								
III Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED27	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

Flight simulation and Control is the science that investigates the stability and control of aircrafts and all other flying vehicles. From the advent of the first flight by the Wright Brothers, it was observed that flight without knowledge of stability and control was not viable. Since then, several different concepts for controlling aircraft flight have been devised including control surfaces, deformable surfaces, morphing of wings etc. This course introduces some of these concepts and describes their operation, as well as the degree of stability that these devices can provide. Modern aircraft control is ensured through automatic control systems known as autopilot. Their role is to increase safety, facilitate the pilot's task and improve flight qualities. The course will introduce modern aircraft stability and control and discuss some of its objectives and applications.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basics simulation of un-accelerated and accelerated level flight for climb and descend.
II. The takeoff and landing performance and ground roll for different modes of aircraft.
III. The basic controls and maneuver of in complex flight Path
IV. The fundamental knowledge on static stability of aircraft in multiple directional motions with their relationship for critical applications in flight vehicles.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Recognize the aircraft components contributing to the stability of different aircraft models like Military, Civil and transport aircrafts.
CO 2 Identify stick fixed and stick free conditions for neutral points with an appropriate static margin, control force and CG limitation.
CO 3 Interpret the specific coupling between lateral and directional static stability of the aircraft and its influence on other motion of a typical aircraft.
CO 4 Construct the mathematical model of aircraft motion in longitudinal, lateral and directional cases for establishing the status of the flight vehicles stability.
CO 5 Explain qualitatively about motion in three-dimensions, Euler angles and rates, full 6-DOF equations for rigid symmetrical aircraft, state space formulation, and solution in the time domain and flight simulation.
CO 6 Apply the advances of flight dynamics and controls in design of modern airplane control system.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION (10)

Historical Perspective, the first 40 years of flight 1905-1945, analogue computing, 1945-1965, digital computing1965-1985, the microelectronics revolution, 1985 present, the case for simulation, safety, financial benefits, training transfer, engineering flight simulation, the changing role of simulation, the organization of a flight simulator, equations of motion, aerodynamic model, engine model, data acquisition, gear model, weather model, visual system, sound system, motion system, control loading, instrument displays, navigation systems, maintenance, the concept of real-time simulation, pilot cues, visual cueing, motion cueing, training versus simulation, examples of simulation, commercial flight training, military flight training, Ab initio flight training, land vehicle simulators, engineering flight simulators aptitude testing, computer-based training, maintenance training.

MODULE-II: PRINCIPLES OF MODELLING (10)

Modeling 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, area l-time protocol, problems in modeling,

MODULE-III: AIRCRAFT DYNAMICS (10)

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

MODULE-IV: SIMULATION OF FLIGHT CONTROL SYSTEMS (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.

MODULE-V: MODEL VALIDATION AND VISUAL SYSTEMS (09)

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 data base management, projection systems, problems in visual systems.

V. TEXT BOOKS:

1. David Allerton, “Principles of Flight Simulation”, John Wiley & Sons, Ltd Publication, 1st edition, 1999.
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 Strick land, “Missile Flight Simulation”, Lulu press, Inc, 2nd edition, 2012.
5. Jonathan M. Stern, “Microsoft Flight Simulator Handbook”, Brady Publishing, 1st edition, 1995.

VI. 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.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

COMPRESSIBLE JET FLOWS								
III Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED28	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

This course explores the principles, theories, and practical applications of high-speed jet flows in the context of aerospace engineering and fluid dynamics. It focuses on understanding the behavior of supersonic and hypersonic flows, including their aerodynamic characteristics, propulsion systems, and applications in aerospace technology.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental concepts of fluid dynamics and compressible flow theory.
II. The behavior of high-speed jet flows, including supersonic and hypersonic regimes. Thefacilitieswithinanairportterminalthatfacilitatethetransferofpassengersandbaggagetoandfro maircraft.
III. The various jet flow control techniques.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Identify the properties of compressible turbulent jets for assessing their application in aerospace.
CO 2 Analyze the characteristics of submerged and co-flowing jets for their control.
CO 3 Classify the types of compressible jet flows for assessing their application in aerospace.
CO 4 Select suitable active control technique for their efficient diffusion into the surrounding environment.
CO 5 Make use of suitable passive control technique for their efficient diffusion into the surrounding environment.
CO 6 Examine the acoustic characteristics of compressible jet flow for suppressing jet noise.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION (10)

Properties of Turbulent Jets-Fundamental Concepts, Submerged Jets- Velocity Profiles in a Submerged Jet- Spread of a turbulent submerged jet- Lines of Constant Velocity in a Submerged Jet. Velocity Variation along the Axis of a Submerged jet, Velocity, Temperature, and Concentration Profiles in a Turbulent Jet Spreading into an External Stream of Fluid- Spread of a Turbulent Jet into a Co-flowing or Counter-flowing External Stream- Turbulence Characteristics in a Free Jet.

MODULE-II: JETS (10)

Types of Jets-Plane free-jets. Round jets. Plane jets in a co-flowing stream. Round jet in Co flowing stream- Swirling Jets-Radial jets- Wall jets- Jet Characteristics & Entrainment, Mathematical treatment of

jet profiles- Semi-empirical Theories. Mixing Layers- Computational and Experimental Techniques for Studying the Jets.

MODULE-III: ACTIVE JETCONTROL METHODS (10)
Active control methods- Actuators-Fluidic, Thermal, Acoustic, Piezoelectric.

Electromagnetic, MEMS, Synthetic Jets, Controls and Sensors, Applications.

MODULE-IV: PASSIVE JET CONTROL METHODS (09)
Passive control techniques- Tabs, Grooves, Chevrons, non-circular nozzles, Notches & wires, vortex generators. Optical Flow Visualization, Applications.

MODULE-V: JET ACOUSTICS (09)
Introduction to Jet Acoustics - Types of jet noise - Source of generation- Travelling wave solution, standing wave solution - multi-dimensional acoustics-Theoretical Concepts of Jet Noise Generation and Suppression-Jet Noise suppression techniques - applications.

V. TEXT BOOKS:

1. Ethirajan Rathakrishnan, "Applied Gas Dynamics", John Wiley, New York, 2010
2. Liepmann and Roshko, "Elements of Gas Dynamics", Dover Publishers, 2017

VI. REFERENCE BOOKS:

1. Rathakrishnan E., "Gas Dynamics", Prentice Hall of India, New Delhi, 5th edition, 2014.
2. Shapiro, AH, "Dynamics and Thermodynamics of Compressible Fluid Flow, Vols. I & II", Ronald Press, New York, 1953.

VII.ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

AEROSPACE OPTIMIZATION TECHNIQUES								
III Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED29	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

This course emphasizes on application of various mathematical techniques for obtaining the best outputs (minima or maxima) for an engineering problem. Enumerate the fundamental knowledge of Linear Programming and Dynamic Programming problems along with classical optimization techniques and numerical methods of optimization. Explain Integer programming techniques and apply different optimization techniques to solve various models arising from engineering areas.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The theory of optimization methods and algorithms developed for solving various types of optimization problems.
II. Research interest in applying optimization techniques in problems of Engineering and Technology.
III. The mathematical results and numerical techniques of optimization theory to concrete Engineering problems.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Apply the concept of optimization dealing with singe variables for deterring the best output to a given engineering problem.
CO 2 Analyze the behavior of nonlinear systems using Local minima and Global minima for designing the system for better outputs.
CO 3 Apply the numerical methods to a nonlinear problem for determining the solutions in absence for analytical methods.
CO 4 Apply the gradient methods to an engineering problem involving multiple variables for designing a system with optimized performance.
CO 5 Understanding the Multivariable constrained problems involved in engineering systems for better designs.
CO 6 Illustrate the constraints involved in engineering systems for optimized solutions.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION TO OPTIMIZATION (10)

Introduction: Optimal problem formulation, design variables, constraints, objective function, variable bounds; engineering optimization problems: Classification and Some examples (just theory and discussion): truss structure, ammonia structure, transit schedule and car suspension.

MODULE-II: SINGLE VARIABLE OPTIMIZATION (10)
Single variable non-linear optimization problems: Local minimum global minimum and inflection point, necessary and sufficient conditions theorems, some problems based on this; Numerical methods: Exhaustive search methods, Fibonacci method, golden section method and comparison, interpolation methods: quadratic.

MODULE-III: MULTI VARIABLE UNCONSTRAINED OPTIMIZATION (10)
Multivariable unconstrained non-linear optimization problems: Numerical methods direct search methods: Univariate method, Pattern Search methods: Powell, Hook-Jeeve's, Rosen Brock's search and Simplex methods, multivariable unconstrained non-linear optimization problems.

Gradient methods: Gradient of a function, importance, gradient direction search based methods: Steepest descent/ascent method, conjugate gradient method and variable meteric method.

MODULE-IV: MULTI VARIABLE CONSTRAINED OPTIMIZATION (09)
Multivariable constrained non-linear optimization problems classical optimization techniques: Constraints equations, Lagrangian method, inequalities-Kuhn-Tucker necessary and sufficient conditions, quadratic problem, Statement, Wolfe's and Beale's methods.

MODULE-V: GEOMETRIC AND INTEGER PROGRAMMING (09)
Geometric programming: polynomials, arithmetic, geometric inequality, unconstrained G.P, constrained G.P(≤ type only) integer Programming; Introduction, formulation, Gomory cutting plane algorithm, branch and bound method.

V. TEXT BOOKS:

1. Kalyanmoy Deb, "Optimization for Engineering Design", Prentice-Hall of India (Pvt) Ltd, New Delhi, 1st edition, 2005.
2. S.S.Rao, "Engineering Optimization: Theory & Practice", New Age International Publications, 3rd edition, 2003.

VI. REFERENCE BOOKS:

1. S. D. Sharma, "Operations Research", Kedar Nath & Ran Nath Co., New Delhi, 1st edition, 2013.
2. Beveridge, Schechter, "Optimization Theory & Practice", McGraw-Hill, 1st edition, 2010.
3. Mohan C. Joshi, K.M Moudgalya, "Optimization Theory & Practice", Narosa Publishing House, 1st edition, 2013.

VII. ELECTRONICS RESOURCES:

1. http://www.sandia.gov/~ktcarlb/opt_class/OPT_Lecture1.pdf
2. http://www.ifp.illinois.edu/~angelia/optimization_one.pdf
3. http://www3.imperial.ac.uk/pls/portallive/docs/1/7288263.PDF

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

ELEMENTS OF AEROSPACE ENGINEERING								
III Semester: OE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED30	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite:								

I. COURSE OVERVIEW:

Aeronautical engineering is the specialized branch of engineering and study of science that deals with design, construction, maintenance of various aircrafts and their components. Candidates who have an inclination towards airplanes and their mechanisms can opt to study aeronautical engineering.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The Historical evaluation of Airplanes.
II. The different component systems and functions.
III. The various types of power plants used in aircrafts.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Learn the history of aircraft & developments over the years
CO 2 Understand ability to identify the types & classifications of components and control systems
CO 3 Understand the basic concepts of flight & Physical properties of Atmosphere
CO 4 Understand the different Newtonian law and its application in aerospace domain
CO 5 Explain the Different types of Engines and principles of Rocket
CO 6 Understandability to differentiate the types of fuselage and constructions

IV. COURSE CONTENT:

MODULE-I: HISTORY OF FLIGHT (10)

Balloon flight-ornithopters-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

MODULE-II: AIRCRAFT CONFIGURATIONS AND ITS CONTROLS (10)

Different types of flight vehicles, classifications-Components of an airplane and their functions-Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation.

MODULE-III: BASICS OF AERODYNAMICS (10)

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships.

Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aero foils, Mach number, Maneuvers.

MODULE-IV: BASICS OF PROPULSION (09)

Basic ideas about piston, turboprop and jet engines - use of propeller and jets for thrust production- Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

MODULE-V: BASICS OF AIRCRAFT STRUCTURES (09)

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminum alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke's law- stress-strain diagrams-elastic constants-Factor of Safety.

V. TEXT BOOKS:

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition, 2015
2. Stephen. A. Brandt, Introduction to aeronautics: A design perspective, AIAA Education Series, 2nd edition 2004.

VI. REFERENCE BOOKS:

1. Kermode, A.C. "Flight without Formulae", Pearson Education, 11th edition, 2011.

VII. 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

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

FUNDAMENTALS OF AEROSPACE PROPULSION								
III Semester: OE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAED31	**Elective**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite:								

I. COURSE OVERVIEW:

The Fundamentals of Aerospace Propulsion is a crucial course in aerospace engineering that covers the principles and technologies related to propulsion systems used in aircraft and spacecraft. This course provides students with a comprehensive understanding of the key concepts, components, and operating principles of propulsion systems.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The Historical evaluation of propulsion systems.
II. The different component systems in gas turbine engines and their functions.
III. The various types of power plants used in aircraft propulsion.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Classify the various gas turbine engines for their suitable section.
CO 2 Understand the basic concepts of propeller theory for calculating thrust generated by the propeller.
CO 3 Understand the basic concepts of inlet and nozzle operation under different operating conditions.
CO 4 Classify the various combustion chambers used in gas turbine engines for their suitable selection.
CO 5 Explain the operating principles of compressor and turbine for their efficient design.
CO 6 Illustrate thermal and electric rocket motors for describing their operating principle.

IV. COURSE CONTENT:

MODULE-I: ELEMENTS OF AIRCRAFT PROPULSION (9)

Classification of power plants – Methods of aircraft propulsion – Propulsive efficiency – Specific fuel consumption – Thrust and power- Factors affecting thrust and power- Illustration of working of piston engines and Gas turbine engines – Characteristics of piston engine, turboprop, turbofan and turbojet engines, Ram jet, Scram jet – Methods of Thrust augmentation.

MODULE-II: PROPELLER THEORY (09)

Momentum theory, Blade element theory, combined blade element and momentum theory, propeller power losses, propeller performance parameters, prediction of static thrust- and in flight, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts.

MODULE-III: INLETS, NOZZLES AND COMBUSTION CHAMBERS (10)

Subsonic and supersonic inlets – Relation between minimum area ratio and external deceleration ratio-

Starting problem in supersonic inlets - Modes of inlet operation, jet nozzle- Efficiencies - Over expanded, under and optimum expansion in nozzles - Thrust reversal.

Classification of Combustion chambers - Combustion chamber performance - Flame tube cooling – Flame Stabilization

MODULE-IV: AXIAL FLOW COMPRESSORS, FANS AND TURBINES (10)

Introduction to centrifugal compressors- Axial flow compressor- geometry- twin spools- three spools- stage analysis- velocity polygons- degree of reaction - radial equilibrium theory performance maps- axial flow turbines- geometry- velocity polygons- stage analysis- performance maps- thermal limit of blades and vanes.

MODULE-V: ROCKET AND ELECTRIC PROPULSION (10)

Introduction to rocket propulsion – Reaction principle - Thrust equation - Classification of rockets based on propellants used - solid, liquid and hybrid - Comparison of these engines with special reference to rocket performance - electric propulsion - classification- electro thermal – electro static - electromagnetic thrusters- geometries of Ion thrusters- beam/plume characteristics - hall thrusters

V. TEXT BOOKS:

1. Cohen, H, Saravanamuttoo, HIH., Rogers, GFC, Paul Straznicky and Andrew Nix, "Gas Turbine Theory", Pearson Education Canada; 7th edition, 2017.
2. Gill,WP, Smith, HJ & Ziurys, JE, "Fundamentals of Internal Combustion Engines as applied to reciprocating, Gas turbine & Jet Propulsion Power Plants", Oxford & IBH Publishing Co., 1980.
3. Hill, PG. & Peterson, CR. "Mechanics & Thermodynamics of Propulsion" Pearson education, 2nd edition, 2014.

VI. REFERENCE BOOKS:

1. Oates, GC, "Aerothermodynamics of Aircraft Engine Components", AIAA Education Series, 2007.
2. Sutton, GP, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 9th edition, 2017.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

COMPOSITE MATERIALS FOR AEROSPACE STRUCTURE								
III Semester: OE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAED32	**Elective**	3	-	-	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite:								

I. COURSE OVERVIEW:

A course on composite materials typically covers the study of materials that are engineered from two or more constituent materials to obtain specific and enhanced properties. Composite materials are widely used in various industries, including aerospace, automotive, construction, and sports. The course provides students with a comprehensive understanding of the principles, properties, manufacturing processes, and applications of composite materials.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The types of composite materials
II. The various manufacturing process of composite materials
III. The various types of laminates used in composite materials

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 Classify the various composite materials for their suitable section.
CO 2 Understand the basic concepts of composite material manufacturing methods for various applications.
CO 3 Understand the mechanical characteristics of composite materials for their characterization.
CO 4 Illustrate the various composite materials manufacturing process for their suitable selection.
CO 5 Classify the various types of laminates for their suitable selection in manufacturing composite materials.
CO 6 Understand the various joining methods of composite materials.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION (10)

Definitions, Composites, Reinforcements and matrices, Types of reinforcements, Types of matrices, Types of composites, Carbon Fibre composites, Properties of composites in comparison with standard materials, Applications of metal, ceramic and polymer matrix composites.

MODULE-II: MANUFACTURING METHODS (10)

Hand and spray lay - up, injection molding, resin injection, filament winding, pultrusion, centrifugal casting and prepregs. Fibre/Matrix Interface, mechanical. Measurement of interface strength. Characterization of systems; carbon fibre/epoxy, glass fibre/polyester, etc.

MODULE-III: MECHANICAL PROPERTIES -STIFFNESS AND STRENGTH (10)
Geometrical aspects – volume and weight fraction. Unidirectional continuous fibre, discontinuous fibers, short fiber systems, woven reinforcements.

Mechanical Testing: Determination of stiffness and strengths of unidirectional composites; tension, compression, flexure and shear.

MODULE-IV: LAMINATES (09)
Plate Stiffness and Compliance, Assumptions, Strains, Stress Resultants, Plate Stiffness and Compliance, Computation of Stresses, Types of Laminates -, Symmetric Laminates, Antisymmetric Laminate, Balanced Laminate, Quasi-isotropic Laminates, Cross-ply Laminate, Angle ply Laminate. Orthotropic Laminate, Laminate Moduli, Hygrothermal Stresses.

MODULE-V: JOINING METHODS AND FAILURE THEORIES (09)
Joining –Advantages and disadvantages of adhesive and mechanically fastened joints. Typical bond strengths and test procedures.

V. TEXT BOOKS:

1. Jones, R M, "Mechanics of Composite Materials", Scripta Book Co.
2. Agarwal, B D and Broutman, J. D, "Analysis and Performance of Fiber Composites", New York, John Willey and Sons, 1990

VI. REFERENCE BOOKS:

1. Mallik, P. K, "Fiber Reinforced Composites: Materials, Manufacturing and Design", New York-Marcel and Dekker, 1993.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

LOW SPEED AERODYNAMICS								
III Semester: OE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAED33	**Elective**	3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite:								

I. COURSE OVERVIEW:

Aerodynamics course focuses on the study of the flow of air about a body, and the body can be an airplane, but many of the concepts explored are relevant to a wide variety of applications from sail- boats, automobiles and birds. This course will enable learners to gain a fundamental understanding of concepts and models used to aerodynamically analyze and some classical theories which are useful for design of aircraft components. As this course is an introduction to aerodynamics, it is prerequisite course for high-speed aerodynamics as well as can be an advanced subject for students with aerodynamics as specialization

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental knowledge on basics of aerodynamics and aerodynamic characteristics of wings, airfoils.
II. The mathematical model for lift and drag coefficient of finite wing and wing of infinite aspect ratio.
III. The flow over non-lifting bodies from method of singularities and investigate the interference effect
IV. The effect of viscosity and boundary layer growth over various shaped geometry and its control.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1 The mathematical model of non-lifting, lifting flow over circular cylinder for identifying relation between lift and circulation.
CO 2 The lift characteristics of wing of infinite aspect ratio from classical thin airfoil for selecting suitable airfoil.
CO 3 The flow over finite wing using the concept of Prandtl's lifting line theory for determining the effect of span wise flow on the lift distribution.
CO 4 The effect of wing twist, wing taper and wing sweep for perceiving the aerodynamic characteristics of finite wing.
CO 5 The effect of propeller slipstream flow on the wing and tail unit for identifying its effect on their aerodynamic characteristics.
CO 6 The regimes and separation of boundary layer over external fluid flow systems for identifying the effect of viscosity on the drag force.

V. COURSE CONTENT:

MODULE-I: INTRODUCTORY TOPICS FOR AERODYNAMICS (10)

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

MODULE-II: THIN AEROFOIL THEORY (10)
Aerofoil nomenclature, aerodynamic characteristics, centre of pressure and aerodynamic centre; Wing of infinite aspect ratio, CL-α- diagram for a wing of infinite aspect ratio, generation of lift, starting Vortex, Kutta's trailing edge condition; Thin aerofoil theory; Elements of panel method; High lift airfoils, High lift devices.

MODULE-III: FINITE WING THEORY (10)
Vortex motions, vortex line, vortex tube, vortex sheet; Circulation; Kelvin and Helmhotz theorem; Biot-Savart's law, applications, Rankine's vortex; Flow past finite wings, vortex model of the wing and bound vortices; Induced drag; Prandtl's lifting line theory; Elliptic wing.

Influence of taper and twist applied to wings, effect of sweep back wings; Delta wings, primary and secondary vortex; Elements of lifting surface theory. Source Panel Vortex panel and Vortex lattice methods.

MODULE-IV: FLOW PAST NON-LIFTING BODIES AND INTERFERENCE EFFECTS (09)
Flow past non lifting bodies, method of singularities; Wing-body interference; Effect of propeller on wings and bodies and tail unit; Flow over airplane as a whole.

MODULE-V: BOUNDARY LAYER THEORY (09)
Introduction to boundary layer, laminar and turbulent boundary layer, transition, boundary layer on flat plate, displacement thickness, momentum thickness, energy thickness, effect of curvature, temperature boundary layer.

V. TEXT BOOKS:

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

VI. REFERENCE BOOKS:

1. L. J. Clancy, "Aerodynamics", Pitman, 1st edition, 1986.

VII. ELECTRONICS RESOURCES:

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

VIII. MATERIALS ONLINE

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5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.

COURSE CONTENT

ENGLISH FOR RESEARCH PAPER WRITING								
III Semester: AE, CSE, ES, EPS, CAD/CAM & STE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BHSD02	**Audit**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		-	-	-	-	-	-	-
Contact Classes: Nil	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: Nil**		
Prerequisite: NIL								

I. COURSE OVERVIEW:

In this course, students will be equipped with the necessary tools to effectively communicate their research findings in a scholarly manner. They will develop the ability to write clear, concise, and well-structured research papers that adhere to academic standards. These skills will not only benefit them in their academic pursuits but also in their future professional careers as researchers, scholars, and professionals in various fields

II. COURSE OBJECTIVES:

The students will try to learn:

I. How to improve the writing skills and level of readability.
II. The methodology that what to write in each section the skills needed when writing a Title Ensure the good quality of paper at very first-time submission.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Interpret the technique of determining a research problem for a crucial part of the research study

CO 2 Examine the way of methods for avoiding plagiarism in research

CO 3 Apply the feasibility and practicality of research methodology for a proposed project.

CO 4 Make use of the legal procedure and document for claiming patent of invention.

CO 5 Identify different types of intellectual properties, the right of ownership, scope of protection to create and extract value from IP

IV. SYLLABUS:

MODULE – I: PLANNING AND PREPARATION

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

MODULE – II: ABSTRACT

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

MODULE – III: DISCUSSION AND CONCLUSIONS

Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check.

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

MODULE – IV: DISCUSSION AND CONCLUSIONS

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

MODULE – V: QUALITY AND TIME MAINTENANCE

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

V. TEXT BOOKS:

1. Goldbort R, "Writing for Science", Yale University Press. 2011.
2. Adrian Wallwork, "English for Writing Research Papers", Springer New York Dordrecht Heidelberg London, 2011.

VI. REFERENCE BOOKS:

1. Highman N, "Handbook of Writing for the Mathematical Sciences", SIAM Highman's Book.

VII. WEB REFERENCES:

http://saba.kntu.ac.ir/eecd/ecourses/Seminar90/2011%20English%20for%20Writing%20Research%20Papers.pdf

VIII. E-TEXT BOOKS:

1. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.

COURSE CONTENT

DISASTER MANAGEMENT								
III Semester: AE, CSE, ES, EPS, CAD/CAM & STE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BHSD03	**Audit**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		-	-	-	-	-	-	-
Contact Classes: Nil	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: Nil**		
Prerequisite: NIL								

I. COURSE OVERVIEW:

In the course on disaster management, students will explore a range of important topics and gain valuable knowledge and skills to effectively address and mitigate the impact of disasters and covers areas like Repercussions of Disasters and Hazards, Disaster-Prone Areas in India, Risk Assessment and Disaster Mitigation

II. COURSE OBJECTIVES:

The students will try to learn:

I. How to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
II. How critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
III. The understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
IV. The strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Understand to describe the basic types of Environmental hazards and disasters. Understand how to react effectively to natural, manmade, and technological threats.
CO 2 Understand how to react effectively to natural, manmade, and planetary hazards
CO 3 Explore the history of the field and comprehend how past events are earthquake, landslides, and volcanic hazards.
CO 4 Describe the basic concepts of the emergency management cycle mitigation, preparedness, response, and recovery
CO 5 Recognizes the stakeholders in disaster management system, their jurisdiction and responsibilities

IV. SYLLABUS

MODULE – I: INTRODUCTION

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

MODULE – II: REPERCUSSIONS OF DISASTERS AND HAZARDS

Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease And Epidemics, War And Conflicts.

MODULE – III: DISASTER PRONE AREAS IN INDIA

Study of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.

MODULE – IV: DISASTER PREPAREDNESS AND MANAGEMENT

Preparedness: Monitoring of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

MODULE – IV: RISK ASSESSMENT & DISASTER MITIGATION

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival. Disaster Mitigation: Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

V. TEXT BOOKS:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal
Book Company.

VI. REFERENCE BOOKS:

1. Sahni, PardeepEt.Al, "Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.
2. Goel S. L. "Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

VII. WEB REFERENCE:

1. http://nptel.ac.in/courses/105101010/downloads/Lecture37.pdf

VIII. E-TEXT BOOKS:

1. Disaster management by Vinod k. Sharma

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

SANSKRIT FOR TECHNICAL KNOWLEDGE								
III Semester: AE, CSE, ES, EPS, CAD/CAM & STE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BHSD04	**Audit**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		-	-	-	-	-	-	-
Contact Classes: Nil	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: Nil**		
Prerequisite: NIL								

I. COURSE OVERVIEW:
In this course, Studying Sanskrit enhances students' analytical thinking and problem-solving abilities. The intricate grammar and logical structure of Sanskrit nurture their analytical skills, enabling them to dissect complex concepts and extract profound insights. This heightened analytical thinking can be applied across different technical disciplines, fostering innovative solutions to contemporary challenges

II. COURSE OBJECTIVES:
The students will try to learn:

I. A working knowledge in illustrious Sanskrit, the scientific language in the world.
II. The Sanskrit to improve brain functioning.
III. The Sanskrit language to develop the logic in mathematics, science & other courses enhancing the memory power.
IV. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

III. COURSE OUTCOMES:
After successful completion of the course, students should be able to

CO 1 Understand the basic Sanskrit grammar

CO 2 Formulate simple sentences

CO 3 Apply order and roots

CO 4 Understand Ancient Sanskrit literature about science & technology

CO 5 Develop logical thinking being a logical language in technical concepts

IV. SYLLUBUS:
MODULE – I: INTRODUCTION
Alphabets in Sanskrit, Past/Present/Future Tense.

MODULE – II: SENTENCES
Simple Sentences

MODULE – III: ROOTS
Order, Introduction of roots

MODULE – IV: SANSKRIT LITERATURE
Technical information about Sanskrit Literature

MODULE – V: TECHNICAL CONCEPTS
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

V. TEXT BOOKS:
1. Suresh Soni, "India's Glorious Scientific Tradition", Ocean books (P) Ltd., New Delhi.

VI. REFERENCE BOOKS:
1. Dr.Vishwas, "Abhyaspustakam", Samskrita-Bharti Publication, New Delhi.

VII. WEB REFERENCES:
1. http://learnsanskritonline.com/

VIII. E-TEXT BOOKS:
1. Prathama Deeksha-Vempati Kutumb Shastri, "Teach Yourself Sanskrit", Rashtriya Sanskri Sansthanam, New Delhi Publication.

COURSE CONTENT

VALUE EDUCATION								
III Semester: AE, CSE, ES, EPS, CAD/CAM & STE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BHSD05	**Audit**	-	-	-	-	-	-	-
Contact Classes: Nil	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: Nil**		
Prerequisite: NIL								

I. COURSE OVERVIEW:

In the course on value education, students emerge with a heightened sense of self-awareness, a strong moral foundation, and the skills necessary for personal and professional success. They are equipped with the knowledge and tools to navigate ethical challenges, contribute positively to society, and lead a purposeful and fulfilling life based on their core values and principles.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The value of education and self- development.
II. Imbibe good values in students.
III. The importance of character.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Understand the significance of ethical human conduct and self-development
CO 2 Adopt value-based living and holistic technologies to save nature
CO 3 Inculcate positive thinking, dignity of labor and religious tolerance
CO 4 Develop the overall Character and Competence through self-management
CO 5 Practice Self-control. Honesty through Studying effectively all religious messages

IV. SYLLABUS:

MODULE – I: VALUES AND SELF-DEVELOPMENT

Values and self-development. Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgments.

MODULE – II: CULTIVATION OF VALUES

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline.

MODULE – III: PERSONALITY AND BEHAVIOR DEVELOPMENT

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labor. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth.

Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

MODULE – IV: CHARACTER AND COMPETENCE

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women.

MODULE – V: SELF CONTROL

All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

V. TEXT BOOKS:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press,
New Delhi.

VI. WEB REFERENCES:

1. http://www.best-personal-development-books.com/personal-value-development.html
2. http://nptel.ac.in/courses/109104068/

VII. E-TEXT BOOKS:

1. R.P. Shukla, “Value education and human rights”.

COURSE CONTENT

CONSTITUTION OF INDIA								
III Semester: AE, CSE, ES, EPS, CAD/CAM & STE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BHSD06	**Audit**	-	-	-	-	-	-	-
Contact Classes: Nil	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: Nil**		
Prerequisite: NIL								

I. COURSE OVERVIEW:

The course on the Constitution of India provides students with a comprehensive understanding of the historical context, principles, and structure of the Indian Constitution. It explores the journey and philosophy behind the making of the Indian Constitution, highlighting the vision and ideals of the founding fathers.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The premises informing the twin themes of liberty and freedom from a civil right perspective.
II. The growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
III. The role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Describe historical background of the constitution making and its importance for building a democratic India.
CO 2 Understand the Constitutional Rights and duties
CO 3 Explain the functioning of three wings of the government i.e., executive, legislative and judiciary
CO 4 Analyse the decentralization of power between central, state and local self-government.
CO 5 Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy

IV. SYLLABUS:

MODULE – I: HISTORY OF MAKING OF THE INDIAN CONSTITUTION & PHILOSOPHY OF THE INDIAN CONSTITUTION

History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble, Salient Features.

MODULE – II: CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES (04)

Fundamental Rights, Right to Equality, Right to Freedom, right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

MODULE – III: ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive President, Governor, Council of Minister, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

MODULE – IV: LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zilla Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

MODULE – V: ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

V. TEXT BOOKS:

1. Dr. S. N. Busi, "Dr. B. R. Ambedkar framing of Indian Constitution", 1st Edition, 2015.
2. M. P. Jain, "Indian Constitution Law", Lexis Nexis, 7th Edition, 2014.

VI. REFERENCE BOOKS:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.

VII. WEB REFERENCES:

1. http://www.constitution.org/cons/india/p18.html

VIII. E-TEXT BOOKS:

1. https://www.india.gov.in/my-government/constitution-india/constitution-india-full-text

COURSE CONTENT

PEDAGOGY STUDIES								
III Semester: AE, CSE, ES, EPS, CAD/CAM & STE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BHSD07	**Audit**	-	-	-	-	-	-	-
Contact Classes: Nil	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: Nil**		
Prerequisite: NIL								

I. COURSE OVERVIEW:

In this course in pedagogy studies, students gain a solid foundation in educational principles and practices. They develop a deep understanding of effective teaching and learning strategies, empowering them to create engaging and meaningful learning experiences for their future students. Whether pursuing a career in teaching or any other field that involves knowledge transfer, students emerge with the knowledge and skills to inspire and facilitate learning, making a positive impact on the lives of others.

II. COUSE OBJECTIVES:

The students will try to learn:

I. Review existing evidence on the review topic to inform program design and policy making undertaken by the DFID, other agencies and researchers.
II. The critical evidence gaps to guide the development.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Identify the Methodology and conceptual framework of teacher's education
CO 2 Understand pedagogical practices are being used by teachers in formal and informal classrooms in developing countries
CO 3 Interpret the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners
CO 4 Classify the importance of class room practice, curriculum and learning in Professional Development.
CO 5 Summarize teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy

IV. SYLLABUS:

MODULE – I: INTRODUCTION

Introduction And Methodology: Aims and rationale, Policy background, Conceptual framework and terminology. Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and searching.

MODULE – II: THEMATIC OVERVIEW

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

MODULE – III: PEDAGOGICAL PRACTICES

Evidence on the effectiveness of pedagogical practices. Methodology for the in-depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change.

Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

MODULE – IV: PROFESSIONAL DEVELOPMENT

Professional Development: alignment with classroom practices and follows up Support. Peer support. Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources
and large class sizes.

MODULE – V: RESEARCH GAPS

Research gaps and future directions, Research design**,** Contexts**,** Pedagogy**.** Teacher education**.** Curriculum and assessment**.** Dissemination and research impact.

V. TEXT BOOKS:

1. Ackers J, Hardman F, "Classroom interaction in Kenyan primary schools", Compare, 31 (2), 245-261.
2. Agrawal M, "Curricular reform in schools: The importance of evaluation", Journal of Curriculum Studies, 36 (3): 361-379.

VI. REFERENCE BOOKS:

1. AkyeampongK, "Teacher training in Ghana - does it count?" Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
2. Akyeampong K, Lussier K, Pryor J, Westbrook J, "Improving Teaching and Learning of Basic Maths and
   Rreading in Africa: Does teacher preparation count?" International Journal Educational Development, 33 (3): 272–282.

VII. WEB REFERENCE:

1. www.pratham.org/images/resource%20working%20paper%202.pdf.
2. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education Oxford and Boston: Blackwell

VIII. E-TEXT BOOKS:

1. www.pratham.org/images/resource%20working%20paper%202.pdf.

COURSE CONTENT

STRESS MANAGEMENT BY YOGA								
III Semester: AE, CSE, ES, EPS, CAD/CAM & STE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BHSD08	**Audit**	-	-	-	-	-	-	-
Contact Classes: Nil	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: Nil**		
Prerequisite: NIL								

I. COURSE OVERVIEW:

In a course on stress management by yoga, engineering students learn a variety of yoga techniques and principles that promote physical, mental, and emotional well-being. These techniques include yoga postures (asanas), breathing exercises (pranayama), meditation, and relaxation techniques.

II. COURSE OBJECTIVES:

The students will try to learn:

I. How to achieve overall health of body and mind.
II. How to overcome stress.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Understand Ashtanga yoga and its importance

CO 2 Identify the Dos and Do nots of Life by practicing the Yam and Niyam

CO 3 Interpret the Shaucha and its components

CO 4 Make use of breathing techniques and Asan and Pranayam

CO 5 Develop healthy mind in a healthy body thus improving social health also

IV. SYLLABUS:

MODULE – I: INTRODUCTION

Definitions of Eight parts of yoga. (Ashtanga)

MODULE – II: YAM AND NIYAM

Yam and Niyam. Do`s and Don't's in life. Ahinsa, satya, astheya, bramhacharya and aparigraha.

MODULE – III: SHAUCHA

Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

MODULE – IV: ASAN AND PRANAYAM

Asan and Pranayam. Various yog poses and their benefits for mind & body

MODULE – V: BREATHING TECHNIQUES

Regularization of breathing techniques and its effects-Types of pranayam

V.TEXT BOOKS:

1. Swami Vivekananda, “Rajayoga or conquering the Internal Nature”, Advaita Ashrama (Publication Department), Kolkata.

VI.REFERENCE BOOKS:

1. Janardan Swami, “Yogic Asanas for Group Tarining-Part-I”, Yogabhyasi Mandal, Nagpur.

VII. WEB REFERENCES:

1. https://americanyoga.school/course/anatomy-for-asana/
2. https://www.yogaasanasonline.com/

VIII. E-TEXT BOOKS:

1. Todd A. Hoover, M. D. D., Ht, “Stress Management by Yoga”.

COURSE CONTENT

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS								
III Semester: AE, CSE, ES, EPS, CAD/CAM & STE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BHSD09	**Audit**	-	-	-	-	-	-	-
Contact Classes: Nil	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: Nil**		
Prerequisite: NIL								

I. COURSE OVERVIEW:

In this course, students delve into various aspects of personal development and self-awareness. They learn techniques to improve self-confidence, self-esteem, and self-awareness, which are vital for thriving in their engineering careers. Students explore their strengths, weaknesses, values, and beliefs, enabling them to develop a clearer understanding of themselves and their goals.

II. COURSE OBJECTIVES:

The students will try to learn:

I. How to achieve the highest goal happily.
II. How a person become with stable mind, pleasing personality and determination.
III. Awaken wisdom in students.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Summarize steps to develop personality with stable mind, pleasing manners and determination.

CO 2 Identify day to day work and duties for developing peace and prosperity as depicted in Geeta.

CO 3 Formulate the daily life style by depicting the verses from Bhagavatgeetha.

CO 4 Outline the verses of Shrimad Bhagavad Geetha for holistic development.

CO 5 Demonstrates personality development by verses of Bhagavatgeetha.

IV. SYLLUBUS:

MODULE – I: HOLISTIC DEVELOPMENT

Neetisatakam-Holistic development of personality, Verses- 19,20,21,22 (wisdom), Verses- 29,31,32 (pride & heroism), Verses- 26,28,63,65 (virtue),Verses- 52,53,59 (dont's),Verses- 71,73,75,78 (do's)

MODULE – II: BHAGWAD GEETA

Approach to day to day work and duties. Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48. Chapter 3-Verses 13, 21, 27, 35.

MODULE – III: BHAGWAD GEETA

Shrimad BhagwadGeeta: Chapter 6-Verses 5, 13, 17, 23, 35, Chapter 18-Verses 45, 46, 48.

MODULE – IV: BASIC KNOWLEDGE

Statements of basic knowledge. Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68. Chapter 12 -Verses 13, 14, 15, 16,17, 18

MODULE – V: ROLE MODEL

Personality of Role model. Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39. Chapter18 – Verses 37,38,63

V. TEXT BOOKS:

1. P.Gopinath, “Bhartrihari’s Three Satakam (Niti-sringar-vairagya)”, Rashtriya Sanskrit Sansthanam, New Delhi.

VI. REFERENCE BOOKS:

1. Swami Swarupananda, “Srimad Bhagavad Gita”, Advaita Ashram (Publication Department), Kolkata.

VII. WEB REFERENCES:

1. http://openlearningworld.com/section_personality_development.html

VIII. E-TEXT BOOKS:

1. http://persmin.gov.in/otraining/UNDPProject/undp_UNITs/Personality%20Dev%20N%20DLM.pdf

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 2023-2024 in Institute of Aeronautical Engineering, Hyderabad, do hereby undertake and abide by the following terms, and I will bring the ACKNOWLEDGEMENT duly signed by me and my parent and submit it to the Dean of Academic.

1. I will attend all the classes as per the timetable from the starting day of the semester specified in the institute Academic Calendar. In case, I do not turn up even after two weeks of starting of classes, I shall be ineligible to continue for the current academic year.
2. I will be regular and punctual to all the classes (theory/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 75% 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 concerned HOD / Principal.
11. I hereby acknowledge that I have received a copy of MT23 Academic Rules and Regulations, Syllabus copy and hence, I shall abide by all the rules specified in it.

ACKNOWLEDGEMENT

I have carefully gone through the terms of the undertaking mentioned above and I understand that following these are for my/his/her own benefit and improvement. I also understand that if I/he/she fail to comply with these terms, shall be liable for suitable action as per Institute/JNTUH/AICTE/UGC rules and the law. I undertake that I/he/she will strictly follow the above terms.

Signature of Student with Date

Signature of Parent with Date
Name & Address with Phone Number