ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
B.E. AEROSPACE ENGINEERING
REGULATIONS – 2017
CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES:

The graduates after completion of the degree will fulfil the following

PEO1. Research and development across disciplines to advance technology and foster innovation in order to compete successfully in the global economy.

PEO2. Updating and adapting their core knowledge and abilities to compete in the ever-changing global enterprise.

PEO3. Entrepreneurial ventures and fostering activities that support sustainable economic development that enhance the quality of life of people in the state, across the country, and around the world.

PROGRAMME OUTCOMES:

PO1. Ability to apply the knowledge of mathematics, science and engineering.

PO2. An engineering acumen in identifying, formulating, analysing and solving complex engineering problems.

PO3. Developing processes, solutions to the problems which are safe socially, culturally and environmentally.

PO4. Ability to model, analyse and simulate operations of aerospace vehicle components and parts.

PO5. A knowledge of aerodynamics, aerospace materials, structures, propulsion, flight mechanics, orbital mechanics, software, and stability and control.

PO6. Understanding of the impact of engineering solutions in a global, economic, environmental, and societal context.

PO7. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

PO8. Commitment to professional ethics and responsibilities and norms as prescribed by the Aviation bodies such as DGCA etc...

PO9. Ability to work in team and have practical exposure in modelling of Rockets, Re-entry Vehicles, Satellites etc...

PO10. Ability to communicate effectively with the aerospace community using reports, presentations and documentations.

PO11. Competence in the integration of aerospace science and engineering topics and their application in aerospace vehicle design.

PO12. A readiness to engage in lifelong learning and understanding of contemporary issues in aviation industry.
# PEO / PO Mapping

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| 8      | AC8512      | Space Launch Vehicle Mini Project – I             | EEC      | 4              | 0  | 0  | 4  | 2  |
| 9      | HS8581      | Professional Communication                        | EEC      | 2              | 0  | 0  | 2  | 1  |

**TOTAL**

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| 8      | AC8612      | Space Launch Vehicle Mini Project – II             | EEC      | 4              | 0  | 0  | 4  | 2  |
| 9      | AC8613      | Avionics Laboratory                                | PC       | 4              | 0  | 0  | 4  | 2  |

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### SUMMARY

**B. E., Aerospace Engineering**

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COMMUNICATIVE ENGLISH

OBJECTIVES:
- To develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop their listening skills, which will, enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills

UNIT I  SHARING INFORMATION RELATED TO ONESELF/FAMILY & FRIENDS  12
Reading: short comprehension passages, practice in skimming-scanning and predicting-
Writing: completing sentences- - developing hints. Listening: short texts- short formal and informal conversations. Speaking: introducing oneself - exchanging personal information

UNIT II  GENERAL READING AND FREE WRITING  12
Reading - comprehension-pre-reading-post reading- comprehension questions (multiple choice questions and /or short questions/ open-ended questions)-inductive reading - short narratives and descriptions from newspapers including dialogues and conversations (also used as short Listening texts)- register Writing – paragraph writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures –Listening- telephonic conversations. Speaking – sharing information of a personal kind—greeting – taking leave- Language development – prepositions, conjunctions Vocabulary development- guessing meanings of words in context.

UNIT III  GRAMMAR AND LANGUAGE DEVELOPMENT  12
Reading: short texts and longer passages (close reading) Writing- understanding text structure-use of reference words and discourse markers-coherence-jumbled sentences Listening – listening to longer texts and filling up the table- product description- narratives from different sources. Speaking- asking about routine actions and expressing opinions. Language development: degrees of comparison- pronouns- direct vs indirect questions- Vocabulary development – single word substitutes- adverbs.

UNIT IV  READING AND LANGUAGE DEVELOPMENT  12
Reading- comprehension-reading longer texts- reading different types of texts- magazines Writing- letter writing, informal or personal letters-e-mails-conventions of personal email-Listening- listening to dialogues or conversations and completing exercises based on them. Speaking- speaking about oneself- speaking about one’s friend- Language development- Tenses- simple present-simple past- present continuous and past continuous- Vocabulary development- synonyms-antonyms- phrasal verbs

UNIT V  EXTENDED WRITING  12
Reading- longer texts- close reading –Writing- brainstorming -writing short essays – developing an outline- identifying main and subordinate ideas- dialogue writing-Listening – participating in conversations- short group conversations-Language development-modal verbs- present/ past perfect tense - Vocabulary development-collocations- fixed and semi-fixed expressions

TOTAL: 60 PERIODS

OUTCOMES:
At the end of the course, learners will be able to:
- Read articles of a general kind in magazines and newspapers.
- Participate effectively in informal conversations; introduce themselves and their friends and express opinions in English.
- Comprehend conversations and short talks delivered in English
- Write short essays of a general kind and personal letters and emails in English.
TEXT BOOKS:

REFERENCES
3. Redston, Chris &Gillies Cunningham Face2Face (Pre-intermediate Student’s Book& Workbook) Cambridge University Press, New Delhi: 2005

MA8151 ENGINEERING MATHEMATICS – I

OBJECTIVES:
The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modeling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

UNIT I DIFFERENTIAL CALCULUS
Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of functions of one variable.

UNIT II FUNCTIONS OF SEVERAL VARIABLES

UNIT III INTEGRAL CALCULUS
Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

UNIT IV MULTIPLE INTEGRALS

UNIT V DIFFERENTIAL EQUATIONS

TOTAL: 60 PERIODS
OUTCOMES:
After completing this course, students should demonstrate competency in the following skills:

- Use both the limit definition and rules of differentiation to differentiate functions.
- Apply differentiation to solve maxima and minima problems.
- Evaluate integrals both by using Riemann sums and by using the Fundamental Theorem of Calculus.
- Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables.
- Evaluate integrals using techniques of integration, such as substitution, partial fractions and integration by parts.
- Determine convergence/divergence of improper integrals and evaluate convergent improper integrals.
- Apply various techniques in solving differential equations.

TEXT BOOKS:
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Ed., New Delhi, 2015. [For Units I & III - Sections 1.1, 2.2, 2.3, 2.5, 2.7(Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1(Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCES:

PH8151 ENGINEERING PHYSICS L T P C
3 0 0 3

OBJECTIVES:
- To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT I PROPERTIES OF MATTER 9

UNIT II WAVES AND FIBER OPTICS 9
UNIT III  THERMAL PHYSICS  9

UNIT IV  QUANTUM PHYSICS  9

UNIT V  CRYSTAL PHYSICS  9
Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures - crystal imperfections: point defects, line defects – Burger vectors, stacking faults – role of imperfections in plastic deformation - growth of single crystals: solution and melt growth techniques.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course,
- the students will gain knowledge on the basics of properties of matter and its applications,
- the students will acquire knowledge on the concepts of waves and optical devices and their applications in fibre optics,
- the students will have adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers,
- the students will get knowledge on advanced physics concepts of quantum theory and its applications in tunneling microscopes, and
- the students will understand the basics of crystals, their structures and different crystal growth techniques.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- Preparation, properties and applications of engineering materials.
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.

UNIT I  WATER AND ITS TREATMENT


UNIT II  SURFACE CHEMISTRY AND CATALYSIS


UNIT III  ALLOYS AND PHASE RULE


UNIT IV  FUELS AND COMBUSTION


UNIT V  ENERGY SOURCES AND STORAGE DEVICES

Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant - breeder reactor - solar energy conversion - solar cells - wind energy. Batteries, fuel cells and supercapacitors: Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H2-O2 fuel cell.

TOTAL: 45 PERIODS

OUTCOMES:

- The knowledge gained on engineering materials, fuels, energy sources and water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.
TEXT BOOKS:

REFERENCES:
OBJECTIVES:
- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures — lists, tuples, dictionaries.
- To do input/output with files in Python.

UNIT I ALGORITHMIC PROBLEM SOLVING
9
Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA, EXPRESSIONS, STATEMENTS
9
Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS
9
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES
9
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

UNIT V FILES, MODULES, PACKAGES
9
Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

OUTCOMES:
Upon completion of the course, students will be able to
- Develop algorithmic solutions to simple computational problems
- Read, write, execute by hand simple Python programs.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python Programs.

TEXT BOOKS:
REFERENCES:
OBJECTIVES:
- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination)
Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I  PLANES CURVES AND FREEHAND SKETCHING  7+12

UNIT II  PROJECTION OF POINTS, LINES AND PLANE SURFACE  6+12
Orthographic projection- principles-Principal Planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III  PROJECTION OF SOLIDS  5+12
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV  PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES  5+12
Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

UNIT V  ISOMETRIC AND PERSPECTIVE PROJECTIONS  6+12
Principles of isometric projection – Isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

OUTCOMES:
On successful completion of this course, the student will be able to
- familiarize with the fundamentals and standards of Engineering graphics
- perform freehand sketching of basic geometrical constructions and multiple views of objects.
- project orthographic projections of lines and plane surfaces.
- draw projections and solids and development of surfaces.
- visualize and to project isometric and perspective sections of simple solids.

TEXT BOOKS:

REFERENCES:

Publication of Bureau of Indian Standards:

Special points applicable to University Examinations on Engineering Graphics:
1. There will be five questions, each of either-or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day.
OBJECTIVES:
- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python.

LIST OF PROGRAMS
1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton’s method)
3. Exponentiation (power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. Merge sort
8. First n prime numbers
9. Multiply matrices
10. Programs that take command line arguments (word count)
11. Find the most frequent words in a text read from a file
12. Simulate elliptical orbits in Pygame
13. Simulate bouncing ball using Pygame

PLATFORM NEEDED
Python 3 interpreter for Windows/Linux

OUTCOMES:
Upon completion of the course, students will be able to
- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.

LIST OF EXPERIMENTS: PHYSICS LABORATORY (Any 5 Experiments)
1. Determination of rigidity modulus – Torsion pendulum
2. Determination of Young’s modulus by non-uniform bending method
3. (a) Determination of wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fibre.
5. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
6. Determination of wavelength of mercury spectrum – spectrometer grating
7. Determination of band gap of a semiconductor
8. Determination of thickness of a thin wire – Air wedge method

TOTAL: 30 PERIODS
OUTCOMES:
Upon completion of the course, the students will be able to
- apply principles of elasticity, optics and thermal properties for engineering applications.

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

OBJECTIVES:
- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by viscometry.

1. Estimation of HCl using Na₂CO₃ as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler’s method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Estimation of iron content of the water sample using spectrophotometer (1, 10-
   Phenanthroline / thiocyanate method).
10. Estimation of sodium and potassium present in water using flame photometer.
12. Pseudo first order kinetics-ester hydrolysis.
14. Determination of CMC.
15. Phase change in a solid.
16. Conductometric titration of strong acid vs strong base.

OUTCOME:
- The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

TEXTBOOK:
OBJECTIVES:
The Course prepares second semester engineering and Technology students to:
• Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
• Foster their ability to write convincing job applications and effective reports.
• Develop their speaking skills to make technical presentations, participate in group discussions.
• Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialization.

UNIT I  INTRODUCTION TECHNICAL ENGLISH  12

UNIT II  READING AND STUDY SKILLS  12
Listening- Listening to longer technical talks and completing exercises based on them-Speaking – describing a process-Reading – reading longer technical texts- identifying the various transitions in a text- paragraphing- Writing- interpreting charts, graphs- Vocabulary Development-vocabulary used in formal letters/emails and reports Language Development-impersonal passive voice, numerical adjectives.

UNIT III  TECHNICAL WRITING AND GRAMMAR  12
Listening- Listening to classroom lectures/ talks on engineering/technology -Speaking – introduction to technical presentations- Reading – longer texts both general and technical, practice in speed reading; Writing-Describing a process, use of sequence words- Vocabulary Development- sequence words- Misspelled words. Language Development- embedded sentences

UNIT IV  REPORT WRITING  12

UNIT V  GROUP DISCUSSION AND JOB APPLICATIONS  12
Listening- TED/Ink talks; Speaking –participating in a group discussion -Reading– reading and understanding technical articles Writing– Writing reports- minutes of a meeting- accident and survey-Vocabulary Development- verbal analogies Language Development- reported speech

TOTAL :60 PERIODS

OUTCOMES:
At the end of the course learners will be able to:
• Read technical texts and write area- specific texts effortlessly.
• Listen and comprehend lectures and talks in their area of specialization successfully.
• Speak appropriately and effectively in varied formal and informal contexts.
• Write reports and winning job applications.
TEXT BOOKS:

REFERENCES

Students can be asked to read Tagore, Chetan Bhagat and for supplementary reading.
OBJECTIVES:
This course is designed to cover topics such as Matrix Algebra, Vector Calculus, Complex Analysis and Laplace Transform. Matrix Algebra is one of the powerful tools to handle practical problems arising in the field of engineering. Vector calculus can be widely used for modelling the various laws of physics. The various methods of complex analysis and Laplace transforms can be used for efficiently solving the problems that occur in various branches of engineering disciplines.

UNIT I  MATRICES  12

UNIT II  VECTOR CALCULUS  12
Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

UNIT III  ANALYTIC FUNCTIONS  12
Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions \( w = z + c, \frac{1}{z}, z^2 \) - Bilinear transformation.

UNIT IV  COMPLEX INTEGRATION  12

UNIT V  LAPLACE TRANSFORMS  12

OUTCOMES:
After successfully completing the course, the student will have a good understanding of the following topics and their applications:

- Eigen values and eigenvectors, diagonalization of a matrix, Symmetric matrices, Positive definite matrices and similar matrices.
- Gradient, divergence and curl of a vector point function and related identities.
- Evaluation of line, surface and volume integrals using Gauss, Stokes and Green’s theorems and their verification.
- Analytic functions, conformal mapping and complex integration.
- Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients.

TEXT BOOKS:
REFERENCES:
MATERIALS SCIENCE
(Common to courses offered in Faculty of Mechanical Engineering
Except B.E. Materials Science and Engineering )

PH8251

OBJECTIVES:
- To introduce the essential principles of materials science for mechanical and related engineering applications.

UNIT I PHASE DIAGRAMS
Solid solutions - Hume Rothery's rules – the phase rule - single component system - one-component system of iron - binary phase diagrams - isomorphous systems - the tie-line rule - the lever rule - application to isomorphous system - eutectic phase diagram - peritectic phase diagram - other invariant reactions – free energy composition curves for binary systems - microstructural change during cooling.

UNIT II FERROUS ALLOYS

UNIT III MECHANICAL PROPERTIES

UNIT IV MAGNETIC, DIELECTRIC AND SUPERCONDUCTING MATERIALS

UNIT V NEW MATERIALS

TOTAL : 45 PERIODS

OUTCOMES:
Upon completion of this course,
- the students will have knowledge on the various phase diagrams and their applications
- the students will acquire knowledge on Fe-Fe₃C phase diagram, various microstructures and alloys
- the students will get knowledge on mechanical properties of materials and their measurement
- the students will gain knowledge on magnetic, dielectric and superconducting properties of materials
- the students will understand the basics of ceramics, composites and nanomaterials.
TEXT BOOKS:

REFERENCES
OBJECTIVES:
To impart knowledge on
- Electric circuit laws, single and three phase circuits and wiring
- Working principles of Electrical Machines
- Working principle of Various electronic devices and measuring instruments

UNIT I  ELECTRICAL CIRCUITS

UNIT II  AC CIRCUITS
Introduction to AC circuits – waveforms and RMS value – power and power factor, single phase and three-phase balanced circuits – Three phase loads - housing wiring, industrial wiring, materials of wiring

UNIT III  ELECTRICAL MACHINES
Principles of operation and characteristics of; DC machines, Transformers (single and three phase), Synchronous machines, three phase and single-phase induction motors.

UNIT IV  ELECTRONIC DEVICES & CIRCUITS

UNIT V  MEASUREMENTS & INSTRUMENTATION
Introduction to transducers - Classification of Transducers: Resistive, Inductive, Capacitive, Thermoelectric, piezoelectric, photoelectric, Hall effect and Mechanical - Classification of instruments - Types of indicating Instruments - multimeters –Oscilloscopes – three-phase power measurements – instrument transformers (CT and PT)

OUTCOMES:
Ability to
- Understand electric circuits and working principles of electrical machines
- Understand the concepts of various electronic devices
- Choose appropriate instruments for electrical measurement for a specific application

TEXT BOOKS

REFERENCES:
OBJECTIVES:
- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.
- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young’s modulus, Poisson’s ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

UNIT I   STANDARD ATMOSPHERE 7
History of aviation – standard atmosphere - pressure, temperature and density altitude.

UNIT II  AERODYNAMICS 10
Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline - Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

UNIT III PERFORMANCE AND PROPULSION 10
Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations - thrust/power available and thrust/power required.

UNIT IV   AIRCRAFT STABILITY AND STRUCTURAL THEORY 10

UNIT V   SPACE APPLICATIONS 8
History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler’s laws of orbits - Newtons law of gravitation.

TOTAL: 45 PERIODS

OUTCOME:
- Ability to understand aerodynamics, lift, drag, and the standard atmosphere, aircraft performance, stability, and control, propulsion, structures, rocket and spacecraft trajectories and orbits.

TEXT BOOKS:

REFERENCE:
OBJECTIVE:
- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.

UNIT I  
STATICS OF PARTICLES  

UNIT II  
EQUILIBRIUM OF RIGID BODIES  
Free body diagram – Types of supports –Action and reaction forces – stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon’s theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions

UNIT III  
PROPERTIES OF SURFACES AND SOLIDS  

UNIT IV  
DYNAMICS OF PARTICLES  

UNIT V  
FRICTION AND RIGID BODY DYNAMICS  
Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction –wedge friction- . Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

OUTCOMES:
On successful completion of this course, the student will be able to
- illustrate the vectorial and scalar representation of forces and moments
- analyse the rigid body in equilibrium
- evaluate the properties of surfaces and solids
- calculate dynamic forces exerted in rigid body
- determine the friction and the effects by the laws of friction

TEXT BOOKS:
REFERENCES:
OBJECTIVES:
To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE

Buildings:
(a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:
(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
(b) Study of pipe connections requirements for pumps and turbines.
(c) Preparation of plumbing line sketches for water supply and sewage works.
(d) Hands-on-exercise:
   Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
(e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:
(a) Study of the joints in roofs, doors, windows and furniture.
(b) Hands-on-exercise:
   Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE

Welding:
(a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
(b) Gas welding practice

Basic Machining:
(a) Simple Turning and Taper turning
(b) Drilling Practice

Sheet Metal Work:
(a) Forming & Bending:
(b) Model making – Trays and funnels.
(c) Different type of joints.

Machine assembly practice:
(a) Study of centrifugal pump
(b) Study of air conditioner

Demonstration on:
(a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.
(b) Foundry operations like mould preparation for gear and step cone pulley.
(c) Fitting – Exercises – Preparation of square fitting and V – fitting models.

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
5. Measurement of energy using single phase energy meter.
IV ELECTRONICS ENGINEERING PRACTICE

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EX-OR and NOT.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL: 60 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- fabricate carpentry components and pipe connections including plumbing works.
- use welding equipments to join the structures.
- Carry out the basic machining operations
- Make the models using sheet metal works
- Illustrate on centrifugal pump, Air conditioner, operations of smithy, foundary and fittings
- Carry out basic home electrical works and appliances
- Measure the electrical quantities
- Elaborate on the components, gates, soldering practices.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL
1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings. 15 Sets.
2. Carpentry vice (fitted to work bench) 15 Nos.
4. Models of industrial trusses, door joints, furniture joints 5 each
5. Power Tools: (a) Rotary Hammer 2 Nos
   (b) Demolition Hammer 2 Nos
   (c) Circular Saw 2 Nos
   (d) Planer 2 Nos
   (e) Hand Drilling Machine 2 Nos
   (f) Jigsaw 2 Nos

MECHANICAL
1. Arc welding transformer with cables and holders 5 Nos.
2. Welding booth with exhaust facility 5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush. 5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit. 2 Nos.
5. Centre lathe 2 Nos.
6. Hearth furnace, anvil and smithy tools 2 Sets.
7. Moulding table, foundry tools 2 Sets.
8. Power Tool: Angle Grinder 2 Nos
9. Study-purpose items: centrifugal pump, air-conditioner One each.

ELECTRICAL
1. Assorted electrical components for house wiring 15 Sets
2. Electrical measuring instruments 10 Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp 1 each
4. Megger (250V/500V) 1 No.
5. Power Tools: (a) Range Finder 2 Nos
   (b) Digital Live-wire detector 2 Nos

**ELECTRONICS**
1. Soldering guns 10 Nos.
2. Assorted electronic components for making circuits 50 Nos.
3. Small PCBs 10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply
OBJECTIVE:
- To train the students in performing various tests on electrical drives, sensors and circuits.

LIST OF EXPERIMENTS:
1. Load test on separately excited DC generator
2. Load test on Single phase Transformer
3. Load test on Induction motor
4. Verification of Circuit Laws
5. Verification of Circuit Theorems
6. Measurement of three phase power
7. Load test on DC shunt motor.
8. Diode based application circuits
9. Transistor based application circuits
10. Study of CRO and measurement of AC signals
11. Characteristics of LVDT
12. Calibration of Rotometer
13. RTD and Thermistor

Minimum of 10 Experiments to be carried out: -

TOTAL: 60 PERIODS

OUTCOMES:
- Ability to determine the speed characteristic of different electrical machines
- Ability to design simple circuits involving diodes and transistors
- Ability to use operational amplifiers

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

<table>
<thead>
<tr>
<th>S.No.</th>
<th>NAME OF THE EQUIPMENT</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>D. C. Motor Generator Set</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>D.C. Shunt Motor</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Single Phase Transformer</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Single Phase Induction Motor</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Ammeter A.C and D.C</td>
<td>20</td>
</tr>
<tr>
<td>6</td>
<td>Voltmeters A.C and D.C</td>
<td>20</td>
</tr>
<tr>
<td>7</td>
<td>Watt meters LPF and UPF</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>Resistors &amp; Breadboards</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Cathode Ray Oscilloscopes</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>Dual Regulated power supplies</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td>A.C. Signal Generators</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>Transistors (BJT, JFET)</td>
<td>-</td>
</tr>
</tbody>
</table>
OBJECTIVES:
- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier, transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I  PARTIAL DIFFERENTIAL EQUATIONS  12
Formation of partial differential equations – Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange’s linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II  FOURIER SERIES  12

UNIT III  APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS  12
Classification of PDE – Method of separation of variables - Fourier Series Solutions of one-dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction.

UNIT IV  FOURIER TRANSFORMS  12

UNIT V  Z-TRANSFORMS AND DIFFERENCE EQUATIONS  12

TOTAL: 60 PERIODS

OUTCOMES:
Upon successful completion of the course, students should be able to:
- Understand how to solve the given standard partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Appreciate the physical significance of Fourier series techniques in solving one- and two-dimensional heat flow problems and one-dimensional wave equations.
- Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z-transform techniques for discrete time systems.

TEXT BOOKS:
REFERENCES:
OBJECTIVES:

- Aero Thermodynamics study includes quantitative analysis of machine and processes for transformation of energy and between work and heat.
- Laws of thermodynamics would be able to quantify through measurement of related properties, to these energies and their interactions.
- To develop basic concept of air cycle, gas turbine engines and heat transfer.

UNIT I  FUNDAMENTAL CONCEPT AND FIRST LAW  9
Concept of continuum, macroscopic approach, thermodynamic systems – closed, open and isolated. Property, state, path and process, quasi-static process, work, internal energy, enthalpy, specific heat capacities and heat transfer, SFEE, application of SFEE to jet engine components, First law of thermodynamics, relation between pressure, volume and temperature for various processes, Zeroth law of thermodynamics.

UNIT II  SECOND LAW AND ENTROPY  9

UNIT III  AIR STANDARD CYCLES  8
Otto, Diesel, Dual, Ericsson, Atkinson, Stirling and Brayton cycles - air standard efficiency - mean effective pressure.

UNIT IV  FUNDAMENTALS OF VAPOUR POWER CYCLES  9
Properties of pure substances – solid, liquid and vapour phases, phase rule, p-v, p-T, T-v, T-s, h-s diagrams, p-v-T surfaces, thermodynamic properties of steam - calculations of work done and heat transfer in non-flow and flow processes - standard Rankine cycle, Reheat and Regeneration cycle. Heat rate, Specific steam consumption, Tonne of refrigeration.

UNIT V  BASICS OF PROPULSION AND HEAT TRANSFER  10
Classification of jet engines - basic jet propulsion arrangement – Engine station number, thrust equation – Specific thrust, SFC, TSFC, specific impulse, actual cycles, isentropic efficiencies of jet engine components, polytropic efficiency, conduction in parallel, radial and composite wall, basics of convective and radiation heat transfer.

OUTCOMES

- Able to relate laws of thermodynamics to jet engine components.
- Understands principle operation of piston engine and jet engines.
- Able to identify efficient cycle of air and jet engines.
- Capable to illustrate condition of working medium.
- Eligible to recognize and calculate heat transfer in complex systems involving several heat transfer mechanisms.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:
- The properties of fluids and concept of control volume are studied.
- The applications of the conservation laws to flow through pipes are studied.
- To understand the importance of dimensional analysis.
- To understand the importance of various types of flow in pumps.
- To understand the importance of various types of flow in turbines.

UNIT I  FLUID PROPERTIES AND FLOW CHARACTERISTICS  12
Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity. Flow characteristics – concept of control volume - application of continuity equation, energy equation and momentum equation.

UNIT II  FLOW THROUGH CIRCULAR CONDUITS  12
Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli-

UNIT III  DIMENSIONAL ANALYSIS  12
Need for dimensional analysis – methods of dimensional analysis – Similitude –types of similitude - Dimensionless parameters- application of dimensionless parameters – Model analysis.

UNIT IV  PUMPS  12
Impact of jets - Euler’s equation - Theory of roto-dynamic machines – various efficiencies–
velocity components at entry and exit of the rotor- velocity triangles - Centrifugal pumps–
working principle - work done by the impeller - performance curves - Reciprocating pump-
working principle – Rotary pumps –classification.

UNIT V  TURBINES  12
Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed
flow turbines. Pelton wheel, Francis turbine and Kaplan turbines- working principles - work done
by water on the runner – draft tube. Specific speed - unit quantities – performance curves for
turbines – governing of turbines.

TOTAL: 60 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to
- Apply mathematical knowledge to predict the properties and characteristics of a fluid.
- Can analyse and calculate major and minor losses associated with pipe flow in piping
networks.
- Can mathematically predict the nature of physical quantities
- Can critically analyse the performance of pumps
- Can critically analyse the performance of turbines.

TEXT BOOK:

REFERENCES:
OBJECTIVES:
- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To study the stresses and deformations induced in thin and thick shells.

UNIT I  STRESS, STRAIN AND DEFORMATION OF SOLIDS  9

UNIT II  TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM  9

UNIT III  TORSION  9
Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT IV  DEFLECTION OF BEAMS  9
Double Integration method – Macaulay’s method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell’s reciprocal theorems.

UNIT V  THIN CYLINDERS, SPHERES AND THICK CYLINDERS  9
Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame’s theorem.

TOTAL: 45 PERIODS

OUTCOMES:
Students will be able to
- Understand the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.
- Understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
- Apply basic equation of simple torsion in designing of shafts and helical spring
- Calculate the slope and deflection in beams using different methods.
- Analyze and design thin and thick shells for the applied internal and external pressures.

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
- The automobile components such as piston, connecting rod, crankshaft, engine block, front axle, frame and body are manufactured by various types of production processes involving casting, welding, machining, metal forming and power metallurgy.

UNIT I CASTING
Casting types, procedure to make sand mould, types of core making, moulding tools, machine moulding, special moulding processes – CO2 moulding; shell moulding, investment moulding, permanent mould casting, pressure die casting, centrifugal casting, continuous casting, casting defects.

UNIT II WELDING

UNIT III MACHINING
General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine, Universal drilling machine, Cylindrical grinding machine, Capstan and Turret lathe. Basics of CNC machines. General principles and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Plasma arc machining, Electron beam machining and Laser beam machining.

UNIT IV FORMING AND SHAPING OF PLASTICS

UNIT V METAL FORMING AND POWDER METALLURGY
Principles and applications of the following processes: Forging, Rolling, Extrusion, Wire drawing and Spinning, Powder metallurgy – Principal steps involved advantages, disadvantages and limitations of powder metallurgy.

TOTAL: 45 PERIODS

OUTCOME:
- The Students can able to use different manufacturing process and use this in industry for component production

TEXT BOOKS

REFERENCES
OBJECTIVES:
- To outline the space environment and their effects.
- To extend the origin of universe and development.
- To classify the galaxies and their evolution.
- To interpret the variable stars in the galaxies.
- To explain theory of formation of our solar system.

UNIT I INTRODUCTION

UNIT II ORIGIN OF UNIVERSE
Early history of the universe – Big-Bang and Hubble expansion model of the universe – cosmic microwave background radiation – dark matter and dark energy.

UNIT III GALAXIES
Galaxies, their evolution and origin – active galaxies and quasars – Galactic rotation – Stellar populations – galactic magnetic field and cosmic rays.

UNIT IV STARS

UNIT V SOLAR SYSTEM

OUTCOMES:
On successful completion of this course, the student will be able to
- Obtain a broad, basic knowledge of the space sciences.
- Understand the scientific concepts such as evolution by means of natural selection, age of the Earth and solar system and the Big-Bang.
- Detail the main features and formation theories of the various types of observed galaxies, in particular the Milky Way.
- Explain stellar evolution, including red giants, supernovas, neutron stars, pulsars, white dwarfs and black holes, using evidence and presently accepted theories;
- Detail the presently accepted formation theories of the solar system based upon observational and physical constraints;

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
- To enhance the basic knowledge in applied thermodynamics

LIST OF EXPERIMENTS
1. Performance test on a 4-stroke engine
2. Valve timing of a 4-stroke engine and port timing of a 2-stroke engine
3. Determination of effectiveness of a parallel flow heat exchanger
4. Determination of effectiveness of a counter flow heat exchanger
5. Determination of heating value of a fuel
6. Determination of specific heat of solid
7. Determination of thermal conductivity of solid.
8. Determination of thermal resistance of a composite wall.
9. COP test on a vapour compression refrigeration test rig
10. COP test on a vapour compression air-conditioning test rig

OUTCOMES:
- Ability to perform test on diesel/petrol engine
- Ability to explain the characteristics of the diesel/Petrol engine
- Ability to determine the properties of the fuels.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Details of Equipment</th>
<th>Qty Req.</th>
<th>Experiment No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>4 stroke twin cylinder diesel engine</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Cut section model of 4 stroke diesel engine and cut section model of 2 stroke petrol engine</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>Parallel and counter flow heat exchanger test rig</td>
<td>1</td>
<td>3,4</td>
</tr>
<tr>
<td>4.</td>
<td>Bomb Calorimeter</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>5.</td>
<td>Vapour compression refrigeration test rig</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>6.</td>
<td>Vapour compression air-conditioning test rig</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>7.</td>
<td>Conductive heat transfer set up</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>8.</td>
<td>Composite wall</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

TOTAL: 60 PERIODS

OBJECTIVE:
- To expose the students to the testing of different materials under the action of various forces and determination of their characteristics experimentally.

LIST OF EXPERIMENTS
1. Tension test on steel rod
2. Compression test on wood
3. Double shear test on metal
4. Torsion test on mild steel rod
5. Impact test on metal specimen (Izod and Charpy)
6. Hardness test on metals (Rockwell and Brinell Hardness Tests)
7. Deflection test on metal beam
8. Compression test on helical spring
9. Deflection test on carriage spring

TOTAL: 60 PERIODS
OUTCOME:
- The students will have the required knowledge in the area of testing of materials and components of structural elements experimentally.

REFERENCES:

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description of Equipment</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>UTM of minimum 400 kN capacity</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Torsion testing machine</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Izod impact testing machine</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>Hardness testing machine Rockwell</td>
<td>1 each</td>
</tr>
<tr>
<td></td>
<td>(any 2) Vicker’s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brinnel</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Beam deflection test apparatus</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>Extensometer</td>
<td>1</td>
</tr>
<tr>
<td>7.</td>
<td>Compressometer</td>
<td>1</td>
</tr>
<tr>
<td>8.</td>
<td>Dial gauges</td>
<td>Few</td>
</tr>
<tr>
<td>9.</td>
<td>Le Chatelier’s apparatus</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>Vicat’s apparatus</td>
<td>2</td>
</tr>
<tr>
<td>11.</td>
<td>Mortar cube moulds</td>
<td>10</td>
</tr>
</tbody>
</table>

CE8462 FLUID MECHANICS AND MACHINERY LABORATORY

OBJECTIVES:
- Upon Completion of this subject, the students can able to have hands on experience in flow measurements using different devices.
- Also perform calculation related to losses in pipes and also perform characteristic study of pumps, turbines.

LIST OF EXPERIMENTS
1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturi meter.
3. Calculation of the rate of flow using Rota meter.
4. Determination of friction factor for a given set of pipes.
5. Conduction experiments and drawing the characteristic curves of centrifugal pump/submersible pump.
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.
7. Conducting experiments and drawing the characteristic curves of Gear pump.
8. Conducting experiments and drawing the characteristic curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

TOTAL: 60 PERIODS

OUTCOMES:
- Ability to use the measurement equipment for flow measurement
- Ability to do performance trust on different fluid machinery
<table>
<thead>
<tr>
<th>S. NO.</th>
<th>NAME OF THE EQUIPMENT</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Orifice meter setup</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Venturi meter setup</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Rotameter setup</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Pipe Flow analysis setup</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Centrifugal pump/submergible pump setup</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Reciprocating pump setup</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Gear pump setup</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Pelton wheel setup</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Francis turbine setup</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Kaplan turbine setup</td>
<td>1</td>
</tr>
</tbody>
</table>
OBJECTIVES:

- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals in real life situations.
- To acquaint the student with understanding of numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
- To understand the knowledge of various techniques and methods of solving various types of partial differential equations.

UNIT I  SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS  12

UNIT II  INTERPOLATION AND APPROXIMATION  12
Interpolation with unequal intervals - Lagrange’s interpolation – Newton’s divided difference interpolation – Cubic Splines - Difference operators and relations - Interpolation with equal intervals - Newton’s forward and backward difference formulae.

UNIT III  NUMERICAL DIFFERENTIATION AND INTEGRATION  12

UNIT IV  INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS  12

UNIT V  BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS  12
Finite difference methods for solving second order two - point linear boundary value problems - Finite difference techniques for the solution of two-dimensional Laplace’s and Poisson’s equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

TOTAL: 60 PERIODS

OUTCOMES:

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

- Understand the basic concepts and techniques of solving algebraic and transcendental equations.
- Appreciate the numerical techniques of interpolation and error approximations in various intervals in real life situations.
- Apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.
TEXT BOOKS:

REFERENCES:
OBJECTIVES:
- To recall the governing equations of fluid mechanics.
- To understand the behaviour of airflow over bodies with particular emphasis on aerofoil sections in the incompressible and compressible flow regime.
- To illustrate the conformal transformation and to extend the wing theory.
- To compare the interactions of shocks and expansion waves in fluid flow.

UNIT I  INTRODUCTION TO LOW SPEED FLOW  9
Incompressible Bernoulli’s equation – circulation and vorticity – Green’s lemma and Stoke’s theorem – barotropic flow – Kelvin’s theorem.

UNIT II  TWO DIMENSIONAL FLOWS  9
Basic flows – Source, Sink, Free and Forced Vortex, Uniform, and Parallel Flow and their combinations – Pressure and velocity distributions on bodies with and without circulation in ideal and real fluid flows.

UNIT III  CONFORMAL TRANSFORMATION  9

UNIT IV  AIRFOIL AND WING THEORY  9

UNIT V  SHOCKS AND EXPANSION WAVES  9

TOTAL = 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Calculate the airspeed, static and dynamic pressure of the flow at any point using Continuity and Bernoulli equations.
- Explain the effect of airflow on an aircraft and its components using the laws of physics and fundamental mathematical methods
- Describe the conformal transformation and its application to fluid flow problems
- Understand the fluid flow characteristics over aerofoils, wings, and airplanes.
- Obtain the knowledge in shock phenomenon and fluid waves.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- Appreciate the roles that structures and structural materials play in aerospace vehicles.
- Understand general design concepts for aerospace structures, components, vehicles, and materials.
- Develop the analysis tools and skills needed to analyse the static and dynamic performance of aerospace structures.
- Gain experience in identifying, formulating, and solving aerospace structural engineering problems.

UNIT I  INTRODUCTION

UNIT II  BENDING, SHEAR AND TORSION OF THIN-WALLED BEAMS (TWB)
Bending and shear of open, closed, and thin-walled beams – torsion on single-cell thin-walled beams – torsion on multiple-cell thin-walled beams.

UNIT III  BUCKLING OF THIN-WALLED BEAMS
Concept of structural instability – flexural buckling analysis – bending of beams under combined axial and lateral loads – short column and inelastic buckling – Pure torsional buckling and coupled flexural-torsional buckling of open TWBs – concept of buckling of plates, local buckling of TWBs – buckling and post-buckling of stiffened skin panels – ultimate load carrying capacity of a typical semi-monocoque TW box section – tension-field beams.

UNIT IV  PLATE THEORY

UNIT V  COMPOSITE AND SANDWICH STRUCTURES

OUTCOMES:
On successful completion of this course, the student will be able to
- Recognize phenomena such as deformation, stress, and strain in simple aerospace structural elements.
- Solve the simple 1D axial deformation, torsion, and bending problems.
- Compute shear stresses and twist angles in torsion for solid sections, closed thin-walled sections and open thin-walled sections.
- Understand the shear centre of a beam and an ability to predict its location.
- Evaluate the suitability of composite materials for the simple structural elements for specific aerospace applications.

TEXT BOOKS:
REFERENCES:
OBJECTIVES:
- To describe the principle and working of flight systems and instruments.
- To interpret the basics of guided missile systems.
- To outline the basics of spacecraft systems.

UNIT I  FLIGHT CONTROL SYSTEMS  9

UNIT II  FLIGHT SYSTEMS  9

UNIT III  ENGINE SYSTEMS  9
Fuel systems for Piston and jet engines – Components of multi engines – Lubricating systems for piston and jet engines – Starting and Ignition systems – Typical examples for piston and jet engines.

UNIT IV  GUIDED MISSILE SYSTEMS  9

UNIT V  SPACECRAFT SYSTEMS  9

OUTCOMES:
On successful completion of this course, the student will be able to
- Understand the controls and operation of an aircraft.
- Understand the aircraft systems are maintained.
- Understand the systems available in the aircraft engines.
- Know the systems available in a missile.
- Know the basics of systems available in a spacecraft.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- To understand the principles in the formation of mechanisms and their kinematics.
- To understand the effect of friction in different machine elements.
- To understand the importance of balancing and vibration.

UNIT I KINEMATICS OF MACHINES

UNIT II GEARS AND GEAR TRAINS

UNIT III FRICTION
Types of friction – Friction Drives -friction in screw threads – bearings – Friction clutches – Belt drives.

UNIT IV BALANCING AND MECHANISM FOR CONTROL
Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines -Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V-engines – Partial balancing in engines- Governors and Gyroscopic effects.

UNIT V VIBRATION

OUTCOMES:
Student will be able to

- Understand the principles in the formation of mechanisms and their kinematics.
- Understand the construction features of Gears and Gear Trains.
- Understand the effect of friction in different machine elements.
- Understand the importance of balancing.
- Understand the importance of Governors and Gyroscopic effects.
- Understand the importance of vibration.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- To study the nature and facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I  ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY  14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes.

UNIT II  ENVIRONMENTAL POLLUTION  8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III  NATURAL RESOURCES  10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV  SOCIAL ISSUES AND THE ENVIRONMENT  7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization-environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

TOTAL: 45 PERIODS

OUTCOMES:
- Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.
- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge have led to misconceptions
- Development and improvement in std. of living has led to serious environmental disasters

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
To study experimentally the aerodynamic forces on different bodies at low and high speeds.

LIST OF EXPERIMENTS:
1. Calibration of subsonic wind tunnel.
2. Illustrate the Pressure distribution over smooth and rough cylinder.
3. Illustrate the Pressure distribution over symmetric aerofoils.
4. Illustrate the Pressure distribution over cambered aerofoils & thin aerofoils.
5. Measure the forces acting on a model using wind tunnel balance.
6. Demonstrate the flow over a flat plate at different angles of incidence.
7. Show the flow visualisation studies in low speed flows over cylinders.
8. Show the flow visualisation studies in low speed flows over aerofoil with different angle of incidence.
10. Show the Supersonic flow visualization with Schlieren system.

TOTAL: 60 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Critically assess the wind tunnel for wall effect, blockage and support interference on the measurements as well as determining the uncertainty in the measurement technique.
- Find the pressure distribution and forces acting over aerodynamical models.
- Understand flow over the aerodynamical model through flow visualisation.
- Understand the limits and usefulness of the experimental approach.
- Present the experimental findings in clear oral and concise report.

LIST OF EQUIPMENTS
(For a batch of 30 students)

<table>
<thead>
<tr>
<th>S. No</th>
<th>Details of Equipment</th>
<th>Qty Req.</th>
<th>Experiment No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wind Tunnel</td>
<td>1 No.</td>
<td>1, 2,3,4,5</td>
</tr>
<tr>
<td>2</td>
<td>Wings of various aerofoil sections</td>
<td>2 Nos. each</td>
<td>3, 4</td>
</tr>
<tr>
<td>3</td>
<td>Angle of incidence changing mechanism</td>
<td>1 No.</td>
<td>3, 4</td>
</tr>
<tr>
<td>4</td>
<td>Multiple Manometer stands</td>
<td>4 Nos.</td>
<td>2,3,4</td>
</tr>
<tr>
<td>5</td>
<td>U-Tube Manometer</td>
<td>1 No.</td>
<td>1,2,3,4</td>
</tr>
<tr>
<td>6</td>
<td>Static Pressure Probes</td>
<td>4 Nos.</td>
<td>1,2,3,4</td>
</tr>
<tr>
<td>7</td>
<td>Total Pressure Probes</td>
<td>4 Nos.</td>
<td>1,2,3,4</td>
</tr>
<tr>
<td>8</td>
<td>Pitot-Static Tubes</td>
<td>4 Nos.</td>
<td>1,2,3,4</td>
</tr>
<tr>
<td>9</td>
<td>Wooden Models of Three-Dimensional bodies</td>
<td>2 Nos. each</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>Wind Tunnel balances (3 or 5 or 6 components)</td>
<td>1 No.</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>Pressure Transducers with digital display</td>
<td>1 No.</td>
<td>1,2,3,4</td>
</tr>
<tr>
<td>12</td>
<td>Hele-Shaw apparatus, Smoke Tunnel, Water flow channel</td>
<td>1 each</td>
<td>6,7,8</td>
</tr>
<tr>
<td>13</td>
<td>Supersonic Wind tunnel</td>
<td>1 No.</td>
<td>9,10</td>
</tr>
<tr>
<td>14</td>
<td>Wooden models of cone, wedge and blunt body configurations of suitable size for flow visualization in a supersonic wind tunnel test section</td>
<td>1 No.</td>
<td>9,10</td>
</tr>
<tr>
<td>15</td>
<td>Schlieren System</td>
<td>1 No.</td>
<td>10</td>
</tr>
</tbody>
</table>
OBJECTIVE:
To experimentally study the unsymmetrical bending of beams, find the location of shear centre, obtain the stresses in circular discs and beams using photo-elastic techniques, calibration of photo-elastic materials and study on vibration of beams.

LIST OF EXPERIMENTS:
1. Unsymmetrical bending of beams.
2. Find the shear centre location for open sections.
3. Find the shear centre location for closed sections.
4. Experiment the constant strength beam.
5. Draw the flexibility matrix for cantilever beam.
6. Beam with combined loading.
8. Stresses in circular discs and beams using photo-elastic techniques.
10. Experiment with the Wagner beam – Tension field beam.

TOTAL: 60 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Understand the effects of bending in the aerospace structures.
- Find the shear centre of the aerospace structures.
- Conduct test on beams for the structural analysis.
- Use the photo-elastic techniques on the aerospace structures.
- Present the experimental findings in clear oral and concise report.

LIST OF EQUIPMENTS
(For a batch of 30 students)

<table>
<thead>
<tr>
<th>S. No</th>
<th>Details of Equipment</th>
<th>Qty Req.</th>
<th>Experiment No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Beam Test set –up</td>
<td>2</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>2</td>
<td>Unsymmetrical sections like ‘Z’ sections</td>
<td>2</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>3</td>
<td>Channel section and angle section</td>
<td>2</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>4</td>
<td>Dial gauges</td>
<td>12</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>5</td>
<td>Weights 1 Kg</td>
<td>10</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>6</td>
<td>Weights 2 Kg</td>
<td>10</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>7</td>
<td>Strain indicator and strain gauges</td>
<td>One set</td>
<td>4, 5, 6</td>
</tr>
<tr>
<td>8</td>
<td>Photo – elastic apparatus</td>
<td>1</td>
<td>7, 8</td>
</tr>
<tr>
<td>9</td>
<td>Amplifier</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>Exciter</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>Pick – up</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>12</td>
<td>Oscilloscope</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>13</td>
<td>Wagner beam</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>14</td>
<td>Hydraulic Jack</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>
OBJECTIVE:
To train the students with hands-on experience in maintenance of various systems in Flight and rectification of common snags.

LIST OF EXPERIMENTS:
1. Experiment the Flight “Jacking Up” procedure.
2. Experiment the Flight “Levelling” procedure.
3. Experiment the Control System “Rigging check” procedure.
4. Experiment the Flight “Symmetry Check” procedure.
5. Demonstrate the “Flow test” to assess of filter element clogging.
6. Demonstrate the “Pressure Test” To assess hydraulic External/Internal Leakage.
7. Demonstrate the “Functional Test” to adjust operating pressure.
8. Demonstrate the “Pressure Test” procedure on fuel system components.
9. Demonstrate the “Brake Torque Load Test” on wheel brake units.
10. Maintenance and rectification of snags in hydraulic and fuel systems.

TOTAL: 60 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Understand the procedure of ground level checking.
- Conduct test on the various systems available in the spacecraft.
- Understand the procedures of maintenance and rectification.
- Present the experimental findings in clear oral and concise report.

LIST OF EQUIPMENTS
(For a batch of 30 students)

<table>
<thead>
<tr>
<th>S. No</th>
<th>Details of Equipment</th>
<th>Qty Req.</th>
<th>Experiment No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Serviceable Flight with all above systems</td>
<td>1</td>
<td>1,2,3,4,5,6,7,8,9,10</td>
</tr>
<tr>
<td>2</td>
<td>Hydraulic Jacks (Screw Jack)</td>
<td>5</td>
<td>1,2,4,8</td>
</tr>
<tr>
<td>3</td>
<td>Trestle adjustable</td>
<td>5</td>
<td>1,2,4,8</td>
</tr>
<tr>
<td>4</td>
<td>Spirit Level</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Levelling Boards</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Cable Tensiometer</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Adjustable Spirit Level</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>Plumb Bob</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>
OBJECTIVE:
- To introduce concepts of satellite injection and satellite perturbations, trajectory computation for interplanetary travel and flight of ballistic missiles based on the fundamental concepts of orbital mechanics.

UNIT I SPACE ENVIRONMENT 8
Peculiarities of space environment and its description—effect of space environment on materials of spacecraft structure and astronauts—manned space missions—effect on satellite life time

UNIT II BASIC CONCEPTS AND THE GENERAL N-BODY PROBLEM 10

UNIT III SATELLITE INJECTION AND SATELLITE PERTURBATIONS 10
General aspects of satellite injection—satellite orbit transfer—various cases—orbit deviations due to injection errors—special and general perturbations—Cowell’s method and Encke’s method—method of variations of orbital elements—general perturbations approach.

UNIT IV INTERPLANETARY TRAJECTORIES 8
Two-dimensional interplanetary trajectories—fast interplanetary trajectories—three dimensional interplanetary trajectories—launch of interplanetary spacecraft—trajectory estimation about the target planet—concept of sphere of influence—Lambert’s theorem

UNIT V BALLISTIC MISSILE TRAJECTORIES 9
Introduction to ballistic missile trajectories—boost phase—ballistic phase—trajectory geometry—optimal flights—time of flight—re-entry phase—position of impact point—influence coefficients.

TOTAL: 45 PERIODS

OUTCOMES:
- Ability to perform satellite injection, satellite perturbations and trajectory control
- Apply orbital mechanics to control ballistic missile.
- Estimate the trajectory/orbit of a space vehicle or a satellite in a suitable coordinate system.
- Calculate the delta-v required for transferring a spacecraft from one orbit to another.
- Perform orbit perturbation analysis for satellite orbits.

TEXT BOOKS:

REFERENCE:
OBJECTIVES:
- To understand the principles of operation of aircraft propulsion systems.
- To extend the performances of aircraft propulsion systems.
- To understand the basics of integral ram-rocket and its performance.

UNIT I  SUBSONIC AND SUPERSONIC INTAKES  9

UNIT II  CENTRIFUGAL AND AXIAL FLOW COMPRESSORS  9
Principle of operation – Work done and pressure rise – diffuser – Compressibility effects – Non-dimensional quantities for plotting compressor characteristics – Centrifugal compressor characteristics.
Basic operation – Elementary theory – Factors affecting stage pressure ratio – Blockage in the compressor annulus – Degree of reaction – Three-dimensional flow – Calculation of stage performance – Compressibility effects – Axial compressor characteristics.

UNIT III  AXIAL AND RADIAL FLOW TURBINES  9

UNIT IV  COMBUSTION CHAMBERS AND NOZZLES  9

UNIT V  RAMJET PROPULSION  9

TOTAL = 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Acquire the fundamentals in internal flow, turbomachinery aerodynamics, and air-breathing propulsion system design.
- Understand the performance characteristics of the compressors.
- Understand the performance characteristics of the turbines.
- Develop physical insight into the phenomena which characterize the fluid dynamic behaviour of air-breathing propulsion systems.
- Determine the approximate use parameters of an existing gas turbine engine.

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
To study the performance of airplanes under various operating conditions and the static and
dynamic response of aircraft for both voluntary and involuntary changes in flight conditions

UNIT I  CRUISING FLIGHT PERFORMANCE  9+6
Forces and moments acting on a flight vehicle – Equation of motion of a rigid flight vehicle –
Different types of drag – estimation of parasite drag co-efficient by proper area method – Drag polar
of vehicles from low speed to high speeds – Variation of thrust, power with velocity and altitudes
for air breathing engines. Performance of airplane in level flight – Power available and power
required curves. Maximum speed in level flight – Conditions for minimum drag and power required

UNIT II  MANOEUVERING FLIGHT PERFORMANCE  9+6
Range and endurance – Climbing and gliding flight (Maximum rate of climb and steepest angle of
climb, minimum rate of sink and shallowest angle of glide) – Take-off and landing – Turning
performance (Turning rate turn radius). Bank angle and load factor – limitations on turn – V-n
diagram and load factor.

UNIT III  STATIC LONGITUDINAL STABILITY  9+6
Degree of freedom of rigid bodies in space – Static and dynamic stability – Purpose of controls in
airplanes -Inherently stable and marginal stable airplanes – Static, Longitudinal stability – Stick
fixed stability – Basic equilibrium equation – Stability criterion – Effects of fuselage and nacelle –
Influence of CG location – Power effects – Stick fixed neutral point – Stick free stability-Hinge
moment coefficient – Stick free neutral points-Symmetric manoeuvres – Stick force gradients –
Stick force per ‘g’ – Aerodynamic balancing.

UNIT IV  LATERAL AND DIRECTIONAL STABILITY  9+6
Dihedral effect – Lateral control – Coupling between rolling and yawing moments – Adverse yaw
effects – Aileron reversal – Static directional stability – Weather cocking effect – Rudder
requirements – One engine inoperative condition – Rudder lock.

UNIT V  DYNAMIC STABILITY  9+6
Introduction to dynamic longitudinal stability: - Modes of stability, effect of freeing the stick – Brief
description of lateral and directional. Dynamic stability – Spiral, divergence, Dutch roll, auto rotation
and spin.

OUTCOMES:
- Know about the forces and moments that are acting on an aircraft, the different types of
drag, drag polar, ISA, variation of thrust, power, SFC with velocity and altitude.
- Have understanding about performance in level flight, minimum drag and power
required, climbing, gliding and turning flight, v-n diagram and load factor.
- Knowledge about degrees of stability, stick fixed and stick free stability, stability criteria,
effect of fuselage and CG location, stick forces, aerodynamic balancing.
- Understanding about lateral control, rolling and yawing moments, static directional
stability, rudder and aileron control requirements and rudder lock.
- Understanding about dynamic longitudinal stability, stability derivatives, modes and
stability criterion, lateral and directional dynamic stability.

TEXT BOOKS:
REFERENCES:
OBJECTIVES:
- To understand the basic concepts of Aerospace control systems.
- To construct the root locus and to analyse the effect of gain in the feedback path.
- To illustrate the plots related to the frequency responses.
- To design the space vehicles control systems.

UNIT I INTRODUCTION AND SYSTEM RESPONSE
Control objectives and tasks – open and closed-loop control structures – negative and positive feedback – Impulse response – convolution integral – response of higher order systems to arbitrary and standard inputs in Laplace and time domains – qualitative dependence on poles and zeros – dominant poles.

UNIT II STABILITY AND ROOT LOCUS ANALYSIS

UNIT III FREQUENCY RESPONSE

UNIT IV STANDARD CONTROL ACTIONS

UNIT V ASPECTS OF SPACE VEHICLE CONTROL DESIGN

TOTAL: 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Characterise the behaviour of elementary feedback control systems.
- Synthesise feedback controllers using root locus, Nyquist and Bode techniques.
- Analytically quantify the time and frequency domain behaviour of dynamic systems.
- Specify steady state control system requirements and select prototype controller structures to achieve these requirements.
- Formulate dynamic feedback controller design specifications in the frequency domain.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- To describe the historical evolution of different types of flight vehicles with classifications.
- Know the basic principles on which the development of aerodynamics and other principal sub disciplines of aerospace engineering are made.

UNIT I   HISTORICAL EVOLUTION  9
Early airplanes, biplanes, monoplanes, Launch vehicles and Missiles – Developments in aerodynamics, materials, structures and propulsion over the years – Different types of flight vehicles, classifications – Conventional control and Powered control.

UNIT II PRINCIPLES OF FLIGHT  9

UNIT III SPACECRAFT STRUCTURES  10

UNIT IV POWER PLANTS USED IN AEROSPACE VEHICLES  9
Principles of operation of IC engine, turboprop and jet engines – use of propeller and jets for thrust production – Comparative merits – Principles of operation of rocket, types of rockets and missiles - typical applications – Exploration into space.

UNIT V   BASICS OF SPACE DYNAMICS  8
Overview of astronomy – reference coordinate system in space, telescopes, flux, magnitudes – Satellite Missions and introduction to orbital mechanics – Different types of satellites and their applications.

OUTCOMES:
On successful completion of this course, the student will be able to

- Summarise the historical evaluation of aviation.
- Explain the forces and moments acting on a space flight.
- Understand the materials used in the manufacturing of aerospace structures.
- Identify the suitable power plant for the aerospace vehicles.
- Explain the governing dynamics of spaceflight, with emphasis on rocket dynamics and basic orbital mechanics.

TOTAL: 45 PERIODS

TEXT BOOK:

REFERENCES:
OBJECTIVE:
To understand the basic concepts of aerodynamic and thermodynamic characteristics of major engine components and to carryout experiments in Aerospace Propulsion.

LIST OF EXPERIMENTS:
1. Conduct the performance test on a propeller.
2. Measure the wall pressure of subsonic diffuser.
3. Measure the wall pressure of supersonic nozzles.
4. Conduct the wall pressure study of Single Expansion Ramp Nozzle (SERN).
5. Show the flow visualisation of shock waves at the lip of supersonic intake.
6. Show the flow visualisation of secondary injection in a supersonic flow.
7. Experimental study of supersonic free jet.
8. Experimental study of supersonic wall jet.
9. Conduct the cold flow studies in a Ramjet duct.
10. Experiment with the cascade Testing of turbine blades.

OUTCOMES:
On successful completion of this course, the student will be able to
- Analyse the performance of the propeller.
- Measure the wall pressure of the engine components.
- Visualize the flow pattern in the engine components.
- Explain the concepts of free jet and wall jet.

LIST OF EQUIPMENT
(for a batch of 30 students)

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Equipment</th>
<th>Qty</th>
<th>Experiments No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Subsonic Wind Tunnel</td>
<td>1</td>
<td>1,2</td>
</tr>
<tr>
<td>2</td>
<td>Supersonic Wind Tunnel</td>
<td>1</td>
<td>3 – 10</td>
</tr>
<tr>
<td>3</td>
<td>Propeller Blade</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Pressure Probe Rack</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Multi-tube Manometers</td>
<td>3 Sets</td>
<td>2,3,4,9,10</td>
</tr>
<tr>
<td>6</td>
<td>Pressure Scanner</td>
<td>2 Sets</td>
<td>2,3,4,9,10</td>
</tr>
<tr>
<td>7</td>
<td>High Resolution CCD Camera for Flow Visualization</td>
<td>1</td>
<td>5,6</td>
</tr>
<tr>
<td>8</td>
<td>Shadowgraph Technique</td>
<td>1</td>
<td>5,6</td>
</tr>
<tr>
<td>9</td>
<td>2D Traversing Mechanism with Pressure Probe holder and Pressure Scanner</td>
<td>1</td>
<td>7,8</td>
</tr>
</tbody>
</table>
OBJECTIVE:
This course is intended to provide basic knowledge and practice in the design skills for initial sizing of vehicles for powered flight to orbit.

TASKS:
2. Current & future launch vehicles, Orbit/trajectory requirements and missions.
3. Rocket propulsion: generation of thrust, the rocket equation. Specific impulse, types of engines, Launch vehicle parameters & performance.
4. Staging, Structure & propulsion design trades.
6. Application of software in trajectory calculation, Optimization principles, Introduction to GPOPS2 program & application to launch optimization, Structures: tanks, inter-tank & inter-stage structure, thrust structure, separation systems.

OUTCOMES:
On successful completion of this course, the student will be able to
- Translate a design brief for a complex, indeterminate aerospace system into a set of well-defined engineering requirement.
- Generate, using creative techniques, credible design concepts for aerospace systems based on a set of engineering requirements.
- Evaluate design concepts for aerospace systems using analysis, experiment or simulation methods.
- Demonstrate effective teamwork and project management skills.

REFERENCES:
OBJECTIVES: The course aims to:
- Enhance the Employability and Career Skills of students
- Orient the students towards grooming as a professional
- Make them Employable Graduates
- Develop their confidence and help them attend interviews successfully.

UNIT I

UNIT II
Self-Introduction-organizing the material - Introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice— presenting the visuals effectively – 5 minute presentations.

UNIT III
Introduction to Group Discussion – Participating in group discussions – understanding group dynamics – brainstorming the topic – questioning and clarifying – GD strategies – activities to improve GD skills.

UNIT IV
Interview etiquette – dress code – body language – attending job interviews – telephone/skype interview – one to one interview &panel interview – FAQs related to job interviews.

UNIT V

TOTAL : 30 PERIODS

OUTCOMES: At the end of the course Learners will be able to:
- Make effective presentations
- Participate confidently in Group Discussions.
- Attend job interviews and be successful in them.
- Develop adequate Soft Skills required for the workplace

Recommended Software
1. Globearena
2. Win English

REFERENCES:
OBJECTIVES:

- To learn the principles of operation and design of spacecraft power plants.
- To explain the basics of hypersonic propulsion.
- To compare the solid and liquid rocket propulsion.
- To show the advantages and applications of electrical rocket propulsion.

UNIT I  BASICS OF HYPERSONIC PROPULSION  9

UNIT II  SOLID ROCKET PROPULSION  9

UNIT III  LIQUID ROCKET PROPULSION  9

UNIT IV  HYBRID ROCKET PROPULSION  9

UNIT V  ELECTRICAL ROCKET PROPULSION  9

TOTAL: 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to

- Explain hypersonic propulsion systems and their application to aerospace vehicles.
- Understand the traditional propulsion concepts, including liquid, solid, hybrid, ion, and thermal rockets.
- Know the applications and principles of solid, liquid, and hybrid rocket propulsion systems.
- Understand the performances of various rocket propulsion systems.
- Apply the concepts of electrical propulsion in rocket.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:
- To study the effect of time dependent forces on mechanical systems and to get the natural characteristics of system with more degree of freedom systems.
- To study the aeroelastic effects of aircraft wing.

UNIT I SINGLE DEGREE OF FREEDOM SYSTEMS 10

UNIT II MULTI DEGREE OF FREEDOM SYSTEMS 10
Two degrees of freedom systems - static and dynamic couplings - vibration absorber- Multi degree of freedom systems - principal co-ordinates - principal modes and orthogonal conditions - Eigen value problems - Hamilton’s principle - Lagrangean equations and application.

UNIT III CONTINUOUS SYSTEMS 8
Vibration of elastic bodies - vibration of strings – longitudinal, lateral and torsional vibrations

UNIT IV APPROXIMATE METHODS 9
Approximate methods - Rayleigh’s method - Dunkerley’s method – Rayleigh-Ritz method, matrix iteration method.

UNIT V ELEMENTS OF AEROELASTICITY 8
Vibration due to coupling of bending and torsion - aeroelastic problems - Collars triangle - wing divergence - aileron control reversal – flutter – buffeting. – elements of servo elasticity

TOTAL: 45 PERIODS

OUTCOMES
- Gaining understanding of single and multi-degree vibrating systems
- Ability to use numerical techniques for vibration problems
- Knowledge acquired in aero elasticity and fluttering.
- Differentiate types of vibrations according to dampness and particle motion.
- Solve Rayleigh and Holzer method to find natural frequency of an object.
- Understand the formation of Aileron reversal, flutter and wing divergence.

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
- To give exposure various methods of solution and in particular the finite element method. Gives exposure to the formulation and the procedure of the finite element method and its application to varieties of problems.

UNIT I INTRODUCTION 8

UNIT II DISCRETE ELEMENTS 10
Bar elements, uniform section, mechanical and thermal loading, varying section, 2D and 3D truss element. Beam element - problems for various loadings and boundary conditions – 2D and 3D Frame elements - longitudinal and lateral vibration. Use of local and natural coordinates.

UNIT III CONTINUUM ELEMENTS 8
Plane stress, plane strain and axisymmetric problems. Derivation of element matrices for constant and linear strain triangular elements and axisymmetric element.

UNIT IV ISOPARAMETRIC ELEMENTS 9
Definitions, Shape function for 4, 8 and 9 nodal quadrilateral elements, stiffness matrix and consistent load vector, evaluation of element matrices using numerical integration.

UNIT V FIELD PROBLEM AND METHODS OF SOLUTIONS 10

TOTAL (L:45): 45 PERIODS

OUTCOMES:
- Write flow chart of finite element steps and understand the convergence of the problem
- Solve stiffness matrix for bar, beam and frame problems using suitable boundary condition.
- Plane stress and plane strain condition are used to understand 2d structures.
- Modelling of 2d and 3d structures using isoparametric elements
- Apply the concepts of finite element methods to solve fluid flow and heat transfer problems.

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
- To understand the modern spacecraft attitude dynamics and control.
- To study the rotational kinematics and dynamics of the spacecraft in orbit and different methods to passively or actively control the attitude.
- To interpret the implementation of nonlinear control laws for reaction wheels and variable speed control moment gyroscopes.

UNIT I ORBITAL MECHANICS
Types of spacecraft – present-day satellites and launch vehicles – orbit determination from injection conditions, position and velocity prediction from orbital elements.

UNIT II SATELLITE OPERATIONS
Geostationary orbit – Hohmann transfer – Inclination change manoeuvres – launch windows for rendezvous missions – perturbation effects due to earth oblateness – sun synchronous orbits.

UNIT III MECHANICS
Kinematics relative to moving frames – rotations and angular velocity – angular momentum of a system of particles – rotational dynamics for a system of particles.

UNIT IV GYRODYNAMICS

UNIT V ATTITUDE MEASUREMENT AND SPACECRAFT ATTITUDE RESPONSE

OUTCOMES:
On successful completion of this course, the student will be able to
- Develop math models of flight vehicles.
- Understand the operations of the satellite.
- Analyse dynamics and control of flight vehicles.
- Make effective use of gyroscopes.
- Demonstrate knowledge on the attitude dynamics of aerospace flight vehicles.

TEXTS:

REFERENCES:
OBJECTIVES:
- To introduce the basic of avionics and its need for civil and military aircrafts
- To impart knowledge about the avionic architecture and various avionics data buses
- To gain more knowledge on various avionics subsystems

UNIT I INTRODUCTION TO AVIONICS
Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies – Introduction to digital computer and memories.

UNIT II DIGITAL AVIONICS ARCHITECTURE

UNIT III FLIGHT DECKS AND COCKPITS
Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.

UNIT IV INTRODUCTION TO NAVIGATION SYSTEMS

UNIT V AIR DATA SYSTEMS AND AUTO PILOT
Air data quantities – Altitude, Air speed, Vertical speed, Mach Number, Total air temperature, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot.

TOTAL: 45 PERIODS

OUTCOMES:
- Ability to build Digital avionics architecture
- Ability to Design Navigation system
- Ability to design and perform analysis on air system.
- Integrate avionics systems using data buses.
- Analyze the performance of various cockpit display technologies.
- Design autopilot for small aircrafts using MATLAB

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
To make the students familiarize with computational fluid dynamics and structural analysis software tools. By employing these tools for Aerospace applications students will have an opportunity to expose themselves to simulation software.

LIST OF EXPERIMENTS
2. Computer aided design of a compressor blade.
4. Computer aided design of typical aircraft wing.
5. Computer aided design of typical fuselage structure.
7. Computer aided design of a launch vehicles.
8. Computer aided design of a re-entry vehicles.
9. Computer aided design of a Missiles.

OUTCOMES:
On successful completion of this course, the student will be able to

- Use commercial design software and understand its structure.
- Design the aircraft and spacecraft components and solve engineering problems.
- Write formal technical report and convey engineering.

LIST OF EQUIPMENT
(for a batch of 30 students)

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Name of the Equipment</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Computer nodes</td>
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</tr>
<tr>
<td>2</td>
<td>CATIA – CAD Packages</td>
<td>30 Licenses</td>
</tr>
<tr>
<td>3</td>
<td>UPS</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Printer</td>
<td>1</td>
</tr>
</tbody>
</table>
OBJECTIVE:
To enhance the knowledge in continuation of the space launch vehicle mini project–I, each student is assigned with following assignments to be carried out.

TASKS:
1. $\Delta v$ & initial sizing, inboard profile & layout, Engine selection, Preliminary mass estimation.
2. Loads from ground winds, loads during flight: thrust, aero, & inertial forces, Trimmed flight, Max-$q$, Calculation of internal forces, moments, shears.
3. Calculation of stresses due to external loads, internal pressurization, Tank & inter-stage structural design, Vibration, shock, acoustic, and thermal effects.
5. Structural flexibility effects, Instabilities, Manufacturing, Launch pad & facilities.
6. Ground testing, Safety & flight termination systems.

TOTAL: 60 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- execute the conceptual stage of a spacecraft design in respect of its stability.
- plan and co-ordinate the activities of a mini project.
- implement the necessary phases in the design process and produce the required outcomes of each phase.
- communicate design outcomes to technical and lay readers.
- apply a number of standard methods to various phases of the design process.

REFERENCES:
OBJECTIVE:
This laboratory is divided into three parts to train the students to learn about basic digital electronics circuits, programming with microprocessors, design and implementation of data buses in avionics with MIL-Std. 1553B and remote terminal configuration and their importance in different applications in the field of Avionics.

LIST OF EXPERIMENTS
MATLAB
1. Working with Matrices
2. Expressions
3. Relational and Logical Operations

MICROPROCESSORS
4. Addition and Subtraction of 8-bit and 16-bit numbers.
5. Sorting of Data in Ascending & Descending order.
6. Sum of a given series with and without carry.
7. Greatest in a given series & Multi-byte addition in BCD mode.
8. Interface programming with 4-digit 7 segment Display & Switches & LED’S.
9. 16 Channel Analog to Digital Converter & Generation of Ramp, Square, Triangular wave by Digital to Analog Converter.

AVIONICS DATA BUSES
10. Study of Different Avionics Data Buses.
11. MIL-Std – 1553 Data Buses Configuration with Message transfer.

TOTAL: 60 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Research at the lab deals with the different aspects of the Guidance, Navigation and Control loop which is instrumental to all modern aerospace ventures.
- Understand the applications of current activities include rendezvous and docking between spacecraft, grasping and deorbiting of space debris, command of rovers.
- Understand the significant heritage on formation flying, large and deployable space systems and structures and swarm-like, behavioural controlled systems, Global Navigation Satellite Systems (GPS, Galileo), inertial and optical navigation is present.
- Know the lab stresses, whenever possible, real world testing with the available experimental setups.

LIST OF EQUIPMENT
(for a batch of 30 students)

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Equipment</th>
<th>Qty</th>
<th>Experiments No.</th>
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<tbody>
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<td>MATLAB Software</td>
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<tr>
<td>2</td>
<td>Microprocessor 8085 Kit</td>
<td>10</td>
<td>5,6,7,8</td>
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<tr>
<td>3</td>
<td>Computers and</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>Analog to Digital Converter</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>MIL-Std – 1553 Data Bus</td>
<td>10</td>
<td>11,12,13</td>
</tr>
</tbody>
</table>
OBJECTIVES:
- To learn basics of hypersonic flow, shock wave, boundary layer interaction and aerodynamic heating.
- To extend the surface inclination methods for hypersonic inviscid flows.
- To explain the approximate methods for inviscid hypersonic flows.

UNIT I  BASICS OF HYPERSONIC AERODYNAMICS  8
Thin shock layers – entropy layers – low density and high-density flows – hypersonic flight paths – hypersonic flight similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT II  SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS  9
Local surface inclination methods – modified Newtonian Law – Newtonian theory – tangent wedge or tangent cone and shock expansion methods – Calculation of surface flow properties.

UNIT III  APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS  9

UNIT IV  VISCOS HYPERSONIC FLOW THEORY  10
Navier-Stokes equations – boundary layer equations for hypersonic flow – hypersonic boundary layer – hypersonic boundary layer theory and non-similar hypersonic boundary layers – hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating – heat flux estimation.

UNIT V  VISCOS INTERACTIONS IN HYPERSONIC FLOWS  9
Strong and weak viscous interactions – hypersonic shockwaves and boundary layer interactions – Estimation of hypersonic boundary layer transition – Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow.

OUTCOMES:
On successful completion of this course, the student will be able to
- Analyse the trajectories of ballistic missiles, space planes, and air-breathing hypersonic vehicles.
- Have a basic understanding of real gas effects such as vibrational activation, dissociation, ionization, and molecular transport phenomena.
- Perform perfect and real gas analyses of shock waves.
- Determine the stagnation properties of a hypersonic vehicle.
- Determine profiles of pressure, skin friction, and heat transfer around a vehicle.

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:
OBJECTIVES:
- Understand the basic flow equations, characteristics of mathematical models for a given flow.
- Know the importance and significance of panel methods
- Familiarize with Finite Volume techniques in Computational fluid analysis.

UNIT I  FUNDAMENTAL CONCEPTS

UNIT II GRID GENERATION

UNIT III PANEL METHODS
Elements of two and three-dimensional panels, panel singularities – Application of panel methods to incompressible, compressible, subsonic and supersonic flows – Numerical solution of flow over a cylinder using 2D panel methods using both vertex and source panel methods for lifting and non-lifting cases respectively.

UNIT IV TIME DEPENDENT METHODS

UNIT V FINITE VOLUME TECHNIQUES

TOTAL = 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Explain and calculate the governing equations for fluid flow.
- Explain how grids are generated and conduct a grid-convergence assessment.
- Understand the issues about two-phase flow modelling.
- Understand the concept of discretization, upwind differencing and implicit, explicit solutions.
- Apply finite difference and finite volume methods to fluid flow problems.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- To compute and analyse the various forces and moments acting on a rocket.
- To formulate the equations of motions for flight and separation phases.
- To understand the combustion and propulsion systems in rocket.
- To select suitable materials for the rockets and launch vehicles.
- To understand the design, performance and testing aspects.

UNIT I  ROCET DYNAMICS

UNIT II  SOLID PROPULSION AND PYROTECHNICS

UNIT III  LIQUID PROPULSION AND CONTROL SYSTEMS
Liquid propellant rockets – classification and components – thrust chamber, feed systems, propellant tanks, turbo-pumps, types of valves and applications – their design considerations – Different bipropellant systems like cryogenics and their characteristics – pogo and slosh engine gimbal systems and thrusters for control – Thrust control systems – Design problems.

UNIT IV  MULTI-STAGING OF ROCKET AND SEPARATION DYNAMICS

UNIT V  DESIGN, MATERIALS AND TESTING OF ROCKETS

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Learn about the different systems of rockets and launch vehicles, formulation of the equation of motion and about the advanced rockets for future missions.
- Understand the function of the solid propellant propulsion and pyrotechnic systems and the design principles.
- Understand the function of the liquid propellant propulsion and control systems and the design principles.
- Formulate the equation of motions for a mission and spent stage separation dynamics, understanding the principles of navigation, guidance and control of rockets and launch vehicles, and design of a multistage rocket.
- Understand the system design, construction, function, performance and testing aspects. and to familiarize with the selection of suitable materials for different rocket systems.

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
To familiarize with the Structural analysis, Flow analysis, and Thermal analysis.

LIST OF EXPERIMENTS:
1. Inspect the Static & Dynamic analysis of beams.
2. Inspect the Structural analysis of wing structure.
3. Construct the 2D design and conduct flow analysis of subsonic and supersonic wind tunnels.
4. Construct the 2D design and conduct flow analysis of subsonic and supersonic flow over bluff body and streamlined body.
5. Construct the 3D design and conduct flow analysis of subsonic and supersonic wind tunnels.
6. Construct the 3D design and conduct flow analysis of subsonic flow over bluff body and streamlined body.
7. Construct the 3D design and conduct flow analysis of supersonic flow over blunt body and slender body.
8. Conduct the thermal analysis of structural components.
9. Conduct the simulation of combustion process.
10. Conduct the simulation of heat transfer process.

TOTAL: 60 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Effectively employ solid modelling and simulation tools.
- Read a specification and create a simple trade diagram.
- Choose appropriate structural models.

LIST OF EQUIPMENTS
(for a batch of 30 students)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Items</th>
<th>Quantity</th>
</tr>
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<tr>
<td>1.</td>
<td>Internal server (or) Work station</td>
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<tr>
<td>2.</td>
<td>Computers</td>
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<tr>
<td>3.</td>
<td>Modelling and Analysis packages</td>
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<td></td>
<td>(i) CATIA</td>
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<td>(ii) ANSYS</td>
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<td>(iv) NASTRAN</td>
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<td>5.</td>
<td>Printer</td>
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</tbody>
</table>
OBJECTIVES
Students have to undergo two – week practical training in Aerospace Engineering related industry / project site or design / planning office so that they become aware of the practical application of theoretical concepts studied in the class rooms.

ASSESSMENT PROCESS
This course is mandatory and the student has to pass the course to become eligible for the award of degree. The student shall make a presentation before a committee constituted by the department which will assess the student based on the report submitted and the presentation made. Marks will be awarded out of 100 and appropriate grades assigned as per the regulations.

OUTCOMES:
2-week practical training in industry
On successful completion of this course, the student will be able to
• Work in actual working environment.
• Utilize technical resources.
• Write technical documents and give oral presentations related to the work completed.

OBJECTIVES:
Students have to do a project work either single or in a group for a period of one semester and submit a project report.

Hardware / Numerical / Theoretical research and development work is to be allotted. A maximum number of three students may be involved in each project. However, the contribution of the individuals in the project should be clearly brought out. The combined project report is to be submitted as per the university regulations. A seminar has to be presented on the allotted topic. All the students involved in the project will be examined for their contribution.

OUTCOMES:
On successful completion of this course, the student will be able to
• Demonstrate a sound technical knowledge of their selected project topic.
• Undertake problem identification, formulation, and solution.
• Design engineering solutions to complex problems utilising systems approach.
• Conduct an engineering project
• Communicate with engineers and the community at large in written and oral forms.
• Demonstrate the knowledge, skills and attitudes of a professional engineer.
OBJECTIVES:
To familiarize with
- Concepts of modelling of 2D and 3D geometrical elements.
- Concepts of computer graphics.
- CAD Packages and its features.

UNIT I  INTRODUCTION  9

UNIT II  GRAPHIC CONCEPTS (2D and 3D)  9

UNIT III  SOFTWARE PACKAGES AND RECENT TECHNOLOGY  9
All about popular commercial solid modelling packages — their salient features- technical comparison- modules and Tools available- brief outline of Data exchange standards. Brief outline of feature technology - classification of features- design by features- applications of features- its advantages- and limitations

UNIT IV  FEM FUNDAMENTALS  9
Introduction to finite element method - principle- Steps involved in FEA - nodes- element and their types- shape function-constraints, forces and nodal displacements-stiffness matrix- solution techniques. Analysis of spring element. Simple problems involving stepped bars subjected to axial loading and simple structural members for triangular element

UNIT V  ANALYSIS  9

TOTAL: 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Prepare and read engineering drawings.
- Visualize an engineering object.
- Understand solid models created in computer.
- Understand the relation between 2D drafting and 3D models.
- Understand the graphical models for further engineering applications.
TEXT BOOKS

REFERENCES
OBJECTIVES:
- To analyse cryogenic systems
- To calculate the efficiency of cryogenic systems
- To know cryogenic applications in aerospace engineering

UNIT I  INTRODUCTION
Historical Background - Introduction to cryogenic propellants - Liquid hydrogen, liquid helium, liquid nitrogen and liquid oxygen and their properties

UNIT II  PRODUCTION OF LOW TEMPERATURE

UNIT III  EFFICIENCY OF CRYOGENIC SYSTEMS

UNIT IV  CYCLES OF CRYOGENIC PLANTS
Classification of cryogenic cycles - structure of cycles - Throttle expansion cycles - Expander cycles - Thermodynamic analysis - Numerical problems

UNIT V  CRYOGENICS IN AEROSPACE APPLICATIONS
Cryogenic liquids in Rocket launching and space simulation Storage of cryogenic liquids - Effect of cryogenic liquids on properties of aerospace materials – Cryogenic loading problems - Zero gravity problems associated with cryogenic propellants - Phenomenon of tank collapse - Elimination of Geysering effect in missiles

TOTAL: 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Describe various methods to produce low temperature and phenomena at cryogenic temperature.
- Understand the working principle of different cryogenic refrigeration and liquefaction system.
- Understand the functions and working principles of insulations and various low temperature measuring and storage devices.
- Understand the application of Cryogenic technology in engineering research and Industry.

TEXT BOOKS

REFERENCES:
OBJECTIVE:
- To study the various experimental techniques involved for measuring displacements, stresses, strains in structural components.

UNIT I EXTENSOMETERS AND DISPLACEMENT SENSORS
Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical, Acoustical and Electrical extensometers and their uses, Advantages and disadvantages, Capacitance gauges, Laser displacement sensors.

UNIT II ELECTRICAL RESISTANCE STRAIN GAUGES
Principle of operation and requirements, Types and their uses, Materials for strain gauges, Calibration and temperature compensation, cross sensitivity, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators, Rosette analysis, stress gauges, load cells, Data acquisition, six component balance.

UNIT III PHOTOELASTICITY
Two-dimensional photo elasticity, Photo elastic materials, Concept of light - photoelastic effects, stress optic law, Transmission photoelasticity, Jones calculus, plane and circular polariscopes, Interpretation of fringe pattern, Calibration of photoelastic materials, Compensation and separation techniques, Introduction to three-dimensional photo elasticity.

UNIT IV BRITTLE COATING AND MOIRE TECHNIQUES
Relation between stresses in coating and specimen, use of failure theories in brittle coating, Moire method of strain analysis.

UNIT V NON–DESTRUCTIVE TESTING
Fundamentals of NDT, Acoustic Emission Technique, Radiography, Thermography, Ultrasonics, Eddy Current testing, Fluorescent Penetrant Testing,

OUTCOMES
- Knowledge of stress and strain measurements in loaded components.
- Acquiring information’s, the usage of strain gauges and photo elastic techniques of measurement.
- Formulate and solve general three-dimensional problems of stress-strain analysis especially fundamental problems of elasticity.
- Analyse the strain gauge data under various loading condition by using gauge rosette method.
- Experimentally evaluate the location and size of defect in solid and composite materials by using various Non-destructive Testing methods.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:
- To Emphasis on design and performance of precision machinery for manufacturing.
- To show the errors during the manufacturing.
- To develop the student’s skills and knowledge in precision engineering.

UNIT I MACHINE DESIGN AND PRINCIPLES OF MEASUREMENT 8
Background; philosophy; sources of error - Measurement basics; Abbe error - Metrology techniques - Metrology techniques, subsurface damage.

UNIT II ERRORS 12
Intro to mechanical error; Kinematic design - Review; Macro/micro-scale compliance; Bearings and spindles - Thermal effects; transfer parameters; specific examples; enclosures - Error budgets and mapping - Error mapping review; Intro to compliance errors - Deformation errors; structural effects - Vibrational errors.

UNIT III SENSORS 8
Intro to sensors - Need for sensors; technology; signal processing - Applications; integration - Tool/material effects; scale effects.

UNIT IV PROCESSES 8
Diamond milling/turning; Micromachining - Ultraprecision abrasive methods; CMP; non-traditional - Semiconductor processes; nanotechnology; MEMS; microfluidics.

UNIT V PROCESS PLANNING 9
Process planning; capability; systems - Role of CAD/CAM in precision manufacturing - Metrics; measurement methods; energy consumption in processes.

TOTAL: 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Understand the machine tool elements and structure, sources of error.
- Understand the precision machining processes and process models.
- Understand the sensors for process monitoring and control, metrology, actuators, and machine design case studies.
- Understand the precision component manufacture, role of CAD/CAM in precision manufacturing, and aspects of sustainable manufacturing and design for sustainability.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:
- To minimize the number of defects which are undetected at a particular stage and surface at next levels of processes due to deficiencies in the Reliability Assurance Processes.
- To aim for Zero non-conformances in Reliability Assurance Processes.

UNIT I  STATISTICAL QUALITY CONTROL  9
Methods and Philosophy of statistical process control – Control charts for variables Attributes – Cumulative sum and Exponentially weighted moving average control charts – Other SPC Techniques – Process – Capability analysis.

UNIT II  ACCEPTANCE SAMPLING  9

UNIT III  INTRODUCTION TO TQM  9
Need for quality – Definition of quality – Continuous process improvement – Contributions of Deming, Juran and Crosby - Basic concepts of TQM – Six Sigma: concepts, methodology, application to manufacturing.

UNIT IV  FAILURE DATA ANALYSIS RELIABILITY PREDICTION  9

UNIT V  QUALITY SYSTEMS  9

OUTCOMES:
On successful completion of this course, the student will be able to
- Understand the advanced concepts of reliability and quality assurance manned space missions to the engineers.
- Provide the necessary mathematical knowledge that are needed in understanding their significance and operation.
- Deploy the skills effectively in the understanding of reliability and quality assurance.

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
• To give an idea about IPR, registration and its enforcement.

UNIT I INTRODUCTION 9
Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II REGISTRATION OF IPRs 10
Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT III AGREEMENTS AND LEGISLATIONS 10

UNIT IV DIGITAL PRODUCTS AND LAW 9

UNIT V ENFORCEMENT OF IPRs 7
Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

TOTAL :45 PERIODS

OUTCOME:
• Ability to manage Intellectual Property portfolio to enhance the value of the firm.

TEXT BOOKS

REFERENCES
OBJECTIVE:
To learn about basis of nanomaterial science, preparation method, types and application

UNIT I INTRODUCTION
Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering:
Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION
Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS

UNIT IV CHARACTERIZATION TECHNIQUES

UNIT V APPLICATIONS

OUTCOMES:
- Will familiarize about the science of nanomaterials
- Will demonstrate the preparation of nanomaterials
- Will develop knowledge in characteristic nanomaterial

TEXT BOOKS:

REFERENCES:
OBJECTIVES:
- To understand the elements of aerospace materials, mechanical behaviour of materials, ceramics and composites.
- To explain the theory, concepts, principles and governing equations of solid mechanics.
- To analyse the stresses in simple structures as used in the aerospace industry.

UNIT I ELEMENTS OF AEROSPACE MATERIALS

UNIT II MECHANICAL BEHAVIOUR OF MATERIALS
- Linear and non-linear elastic properties – Yielding, strain hardening, fracture, Bauchinger’s effect – Notch effect testing and flaw detection of materials and components – Comparative study of metals, ceramics plastics and composites.

UNIT III CORROSION & HEAT TREATMENT OF METALS AND ALLOYS
- Types of corrosion – Effect of corrosion on mechanical properties – Stress corrosion cracking – Corrosion resistance materials used for space vehicles.

UNIT IV CERAMICS AND COMPOSITES
- Fabrication processes involved in metal matrix composites - shape memory alloys – applications in aerospace vehicle design.

UNIT V HIGH TEMPERATURE MATERIALS & CHARACTERIZATION
- Classification, production and characteristics – Methods and testing – Determination of mechanical and thermal properties of materials at elevated temperatures – Application of these materials in Thermal protection systems of Aerospace vehicles – super alloys – High temperature material characterization.

OUTCOMES:
On successful completion of this course, the student will be able to
- Understand the advanced concepts of aerospace materials.
- Provide the necessary mathematical knowledge that are needed in understanding their significance and operation.
- Have an exposure on various topics such elements of aerospace materials, mechanical behaviour of materials, ceramics and composites.
- Deploy the skills effectively in the understanding of aerospace materials.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- To learn the concept of high-speed aerodynamics and configurations of launch vehicles.
- Understanding of aerodynamics in competitive design.
- Testing and analysis methods in different speed regimes.
- Design trade-offs between aerodynamics and other considerations.

UNIT I  BASICS OF HIGH-SPEED AERODYNAMICS  9
Compressible flows-Isentropic relations-mathematical relations of flow properties across shock and expansion waves-fundamentals of Hypersonic Aerodynamics.

UNIT II  BOUNDARY LAYER EFFECTS  9
Basics of boundary layer theory-compressible boundary layer-shock shear layer interaction-Aerodynamic heating-heat transfer effects on launch vehicle.

UNIT III  LAUNCH VEHICLE CONFIGURATIONS AND DRAG ESTIMATION  9
Types of Rockets and missiles-various configurations-components-forces on the vehicle during atmospheric flight-nose cone design and drag estimation.

UNIT IV  AERODYNAMICS OF SLENDER AND BLUNT BODIES  9
Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles- determination of aero elastic effects.

UNIT V  AERODYNAMIC ASPECTS OF LAUNCHING PHASE  9
Booster separation-cross wind effects-specific considerations in missile launching -missile integration and separation-methods of evaluation and determination- Stability and Control Characteristics of Launch Vehicle Configuration- Wind tunnel tests – Comparison with CFD Analysis.

TOTAL: 45 PERIODS

OUTCOME:
On successful completion of this course, the student will be able to
- Learn the concept of high-speed aerodynamics and configurations of launch vehicles.
- Understand the effects of boundary layer while launching.
- Know the forces on the vehicle during atmospheric flight.
- Understand the flow characteristics of launch vehicles.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- To know the principle, methods, possibilities and limitations as well as environmental effects of Additive Manufacturing technologies.
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing technologies.

UNIT I INTRODUCTION

UNIT II DESIGN FOR ADDITIVE MANUFACTURING

UNIT III PHOTOPOLYMERIZATION AND POWDER BED FUSION PROCESSES

UNIT IV EXTRUSION BASED AND SHEET LAMINATION PROCESSES

UNIT V PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES

TOTAL: 45 PERIODS

OUTCOME:
- On completion of this course, students will learn about a working principle and construction of Additive Manufacturing technologies, their potential to support design and manufacturing, modern development in additive manufacturing process and case studies relevant to mass customized manufacturing.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- To understand the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of launch vehicle configuration design.

UNIT I  FUNDAMENTAL ASPECTS  9
Energy and Efficiencies of power plants for launch vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicle integrity.

UNIT II  SELECTION OF ROCKET PROPULSION SYSTEMS  9
Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

UNIT III  ENGINE SYSTEMS, CONTROLS, AND INTEGRATION  9

UNIT IV  THRUST VECTOR CONTROL  9

UNIT V  NOSE CONE CONFIGURATION  9
Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism.

TOTAL: 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to

- Know exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.
- Gain knowledge in selecting the appropriate rocket propulsion systems.
- Understand the air-breathing propulsion suitable for initial stages and fly-back boosters.
- Have an aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.
- Conversion training for aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.

TEXT BOOKS:

REFERENCE:
OBJECTIVES:

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyse and arrive at requirements for new product development and convert them in to design specification
- To understand system modelling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT


UNIT II REQUIREMENTS AND SYSTEM DESIGN


UNIT III DESIGN AND TESTING


UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT


UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY


TOTAL: 45 PERIODS
OUTCOMES: Upon completion of the course, the students will be able to:

- Define, formulate and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

TEXTBOOKS:
1. Book specially prepared by NASSCOM as per the MoU.

REFERENCES:

GE8071 DISASTER MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:
- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT I INTRODUCTION TO DISASTERS
Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial - Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR)
Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority (SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT
Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use - Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.
UNIT IV  DISASTER RISK MANAGEMENT IN INDIA  9
Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V  DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS  9
Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

OUTCOMES:
The students will be able to
• Differentiate the types of disasters, causes and their impact on environment and society
• Assess vulnerability and various methods of risk reduction measures as well as mitigation.
• Draw the hazard and vulnerability profile of India, Scenarios in the Indian context, Disaster damage assessment and management.

TEXT BOOKS:

REFERENCES
1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005

GE8077  TOTAL QUALITY MANAGEMENT  L T P C  3 0 0 3

OBJECTIVE:
• To facilitate the understanding of Quality Management principles and process.

UNIT I  INTRODUCTION  9

UNIT II  TQM PRINCIPLES  9
Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.
UNIT III TQM TOOLS AND TECHNIQUES I 9
The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES II 9
Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY MANAGEMENT SYSTEM 9

OUTCOME:
• The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

TEXT BOOK:

REFERENCES:
4. ISO 9001-2015 standards

RO8401 AUTOMATIC CONTROL SYSTEMS L T P C 3 0 0 3
OBJECTIVES:
• To study the basics of control system and its response, stability of mechanical and electrical systems. Use of MATLAB to design a stable control system.
• To introduce the elements of control system and their modeling using various Techniques.
• To introduce methods for analyzing the time response.
• To impart knowledge about the frequency response and the stability of systems
• To introduce the state variable analysis method

UNIT I INTRODUCTION 9
Open loop and closed loop systems - Examples - Elements of closed loop systems - Transfer function - Modeling of physical systems – Mechanical, Thermal, Hydraulic systems and Electric Networks - Transfer function of DC generator, DC servomotor, AC servomotor ,Potentiometer, Synchros, Tacho-generator, Stepper motor - Block diagram - reduction techniques, Signal flow graph – Mason” gain formula. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)
UNIT II            TIME DOMAIN ANALYSIS  

UNIT III            FREQUENCY DOMAIN ANALYSIS  
Frequency domain specifications - Time and frequency response correlation – Polar plot – Bode plot – All pass minimum phase and non-minimum phase systems. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

UNIT IV           SYSTEM STABILITY  

UNIT V             ROOT LOCUS METHOD  

TOTAL: 45 PERIODS

OUTCOMES:
- To understand the basic of the control system
- Ability to know about the time and frequency domain analysis
- To know about the different stability of the systems
- To expose students to the state space representation and its analysis.
- To introduce non-linear systems and their control and to impart knowledge on advanced control techniques

TEXT BOOKS:
2. Richard C Dorf and Robert H Bishop, "Modern Control Systems.", Addison-Wesley -2007

REFERENCES:
OBJECTIVE:

- To make the student understand the analysis of composite laminates under different loading conditions and different environmental conditions.

UNIT I  MICROMECHANICS  10

UNIT II  MACROMECHANICS  10

UNIT III  LAMINATED PLATE THEORY  10
Governing differential equation for a laminate. stress – strain relations for a laminate. different types of laminates. in plane and flexural constants of a laminate. hygrothermal stresses and strains in a laminate. failure analysis of a laminate. impact resistance and interlaminar stresses. netting analysis

UNIT IV  FABRICATION PROCESS AND REPAIR METHODS  8
Various open and closed mould processes, manufacture of fibres, importance of repair and different types of repair techniques in composites – autoclave and non-autoclave methods.

UNIT V  SANDWICH CONSTRUCTIONS  7
Basic design concepts of sandwich construction - materials used for sandwich construction - failure modes of sandwich panels - bending stress and shear flow in composite beams.

TOTAL: 45 PERIODS

OUTCOMES

- Understanding the mechanics of composite materials
- Ability to analyse the laminated composites for various loading eases
- Knowledge gained in manufacture of composites.
- Should analyse sandwich and laminated plates
- Should be able to construct and analysis different composite technique

TEXT BOOKS:

REFERENCES:
OBJECTIVES:
- To understand the applications of heat transfer in space.
- To explain the thermal properties of spacecraft components.
- To interpret the thermal control testing of spacecraft components.

UNIT I INTRODUCTION TO SPACECRAFT THERMAL CONTROL

UNIT II SPACECRAFT THERMAL ANALYSIS

UNIT III SPACECRAFT THERMAL ENVIRONMENTS
Launch and ascent – earth bound orbits – interplanetary mission and re-entry mission.

UNIT IV DEVICES AND HARDWARE FOR SPACECRAFT

UNIT V DESIGN AND ANALYSIS OF SPACECRAFT
Application of principles described above for development of spacecraft Thermal Control System.

TOTAL = 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Apply the mechanisms for different heat transfer modes and their relevance to a wide range of mechanical engineering themes
- Use the engineering practices for enhancing heat transfer or increasing thermal insulation.
- Have mathematical underpinning of heat transfer analysis and corresponding problem-solving techniques.
- The relevant thermal properties of materials and working fluids and the considerations for material selection according to the application requirements
- The use commercial software for heat transfer analysis.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- To understand the advanced concepts of missile systems, missile airframes, autopilots, guidance laws.
- To find the key drivers in the missile guidance design and system engineering process.
- To explain the critical trade-offs, methods, and technologies in missile guidance sizing.
- To illustrate the targeting system, launch platform, and-missile guidance integration.

UNIT I  INTRODUCTION TO MISSILE SYSTEMS  8
History of guided missile for defence applications- Classification of missiles—Generalized Missile Equations of Motion- Coordinate Systems- Lagrange’s Equations for Rotating Coordinate Systems- Rigid-Body Equations of Motion-missile system elements, missile ground systems.

UNIT II  MISSILE AIRFRAMES, AUTOPILOTS AND CONTROL  9

UNIT III  MISSILE GUIDANCE LAWS  10

UNIT IV  STRATEGIC MISSILES  10
Introduction, 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, Terrain-Contour Matching (TERCOM) Concept.

UNIT V  WEAPON DELIVERY SYSTEMS  8

TOTAL: 45 PERIODS

OUTCOME:

On successful completion of this course, the student will be able to

- Understand the advanced concepts of missile guidance and control to the engineers.
- Provide the necessary mathematical knowledge that are needed in understanding the physical processes.
- Have an exposure on various topics such as missile systems, missile airframes, autopilots, guidance laws and will be able to deploy these skills effectively in the understanding of missile guidance and control
- Develop linear guidance, control, and navigation laws.
- Analyse performance of the integrated guidance and navigation controller.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- To understand the various Power system elements, energy storage technology and power converters in a spacecraft.
- Design driving requirements for a space power system.
- Solar cell technology and environmental susceptibility.
- Battery technologies, including battery selection and sizing.
- Design Example: Sample power system concept design of a LEO mission.

UNIT I  SPACECRAFT ENVIRONMENT & DESIGN CONSIDERATION  9

UNIT II  POWER GENERATION  9

UNIT III  ENERGY STORAGE TECHNOLOGY  9

UNIT IV  POWER CONVERTERS  9

UNIT V  POWER CONTROL, CONDITIONING AND DISTRIBUTION  9
Solar Array Regulators – Battery changing schemes – Protection Schemes - Distribution – Harness - Thermal Design - EMI/EMC/ESD/Grounding schemes for various types of circuits and systems.

OUTCOME:
On successful completion of this course, the student will be able to

- Understand the advanced concepts of Spacecraft power systems.
- Provide the necessary mathematical knowledge that are needed in modelling the power systems.
- Have an exposure on various Power system elements, energy storage technology and power converters.
- Deploy these skills effectively in the analysis and understanding of power systems in a spacecraft.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- The course gives an exposure to the satellite navigation and control.
- To introduce students in engineering and the sciences to the methods of satellite radio navigation.
- The key physical principles will be described in terms of their application to make a complete navigation system work.
- The specific architecture of the Global Positioning System (GPS) will be emphasized.

UNIT I NAVIGATION CONCEPTS 9

UNIT II CONTROL ACTUATORS 9
Thrusters, Momentum Wheel, Control Moment Gyros, Reaction wheel, Magnetic Torquers, Reaction Jets, Ion Propulsion, Electric propulsion, solar sails.

UNIT III INERTIAL NAVIGATION SYSTEMS 9

UNIT IV GPS & HYBRID NAVIGATION SYSTEMS 9

UNIT V ATTITUDE STABILIZATION SCHEMES & ORBIT MANEUVERS 9
Spin, Dual spin, Gravity gradient, Zero momentum system, Momentum Biased system, Reaction control system, Single and Multiple Impulse orbit Adjustment, Station Keeping and fuel Budgeting.

TOTAL: 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to

- Get a thorough introduction to classical control theory, including analysis and design.
- Apply concepts of aircraft autopilot design emphasizing the relevance of the topics discussed in the class.
- Introduce modern control theory which can be useful in taking advanced courses offered in the controls stream.
- Know the radar theory and applications, navigation principles and guidance laws

TEXT BOOKS:
REFERENCES:
OBJECTIVE:
- To sensitize the Engineering students to various aspects of Human Rights.

UNIT I

UNIT II

UNIT III
Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.

UNIT IV
Human Rights in India – Constitutional Provisions / Guarantees.

UNIT V

TOTAL: 45 PERIODS

OUTCOME:
- Engineering students will acquire the basic knowledge of human rights.

REFERENCES:
OBJECTIVES:
- To know the concepts in combustion, make combustion calculations, and to know supersonic combustion.
- This course starts with a review of chemical thermodynamics, statistical mechanics, equilibrium chemistry, chemical kinetics, and conservation equations.
- To explain the chemical and dynamic structure of laminar premixed, diffusion, and partially premixed flames; turbulent premixed combustion; turbulent diffusive combustion.

UNIT I
FUNDAMENTAL CONCEPTS IN COMBUSTION
Thermo-chemical equations - Heat of reaction first order, second order and third order reactions – premixed flames - Diffusion flames

UNIT II
CHEMICAL KINETICS AND FLAMES

UNIT III
COMBUSTION IN GAS TURBINE ENGINES

UNIT IV
COMBUSTION IN ROCKETS

UNIT V
SUPERSONIC COMBUSTION
Introduction - Supersonic combustion controlled by mixing, diffusion and heat convection - Analysis of reaction and mixing processes - Supersonic burning with detonation shocks.

OUTCOMES:
On successful completion of this course, the student will be able to
- Understand the concept of gaseous fuels.
- Differentiate solid, gaseous, and liquid fuels.
- Relate the thermo chemistry and kinetics of combustion to evolve mathematical models for combustion.
- Apply the different principles of flame stabilization and ignition to design combustor.
- Understands the fundamentals in combustion of fuels and propellants.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:

- To know the different engineering economic principles and strategies.
- Principles of organizational management.
- Behaviour of human at organizations with modern management concepts.

UNIT I ENGINEERING ECONOMICS
Introduction - Economics - Scope and Definition - Importance of Economics in Engineering - Economic optimization - Demand and Revenue Analysis - Law of Demand - Demand Forecasting - Methods of Demand Forecasting - Demand curves - Factors affecting Demand - Demand Elasticity - Production Analysis - simple problems.

UNIT II SUPPLY, COST AND OUTPUT

UNIT III MANAGEMENT AND ITS ENVIRONMENT
Management - Definition - Functions - Evolution of Modern Management movement - Different Schools of Management - Types and Forms of Business Organization - Designing effective organizations - Individual ownership - Partnership - Joint stock companies - Cooperative enterprises - Public Sector Undertakings.

UNIT IV MANAGEMENT OF HUMAN AT WORK

UNIT V MODERN MANAGEMENT CONCEPTS
Management by Objectives (MBO) - Principles and Steps - Advantages and Disadvantages - Management by Exception (MBE) - Strategic management - SWOT analysis - Enterprise Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (ABM).

TOTAL: 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to

- Define and explain how basic concepts of microeconomics (such as elasticity, scarcity or choice) can be used to explain the behaviour of individuals, household or firms.
- Represent supply and demand, in graphical form, including the downward/upward slope of the curves and what shifts/moves along the curves.
- Describe and explain how basic macroeconomic policies (such as fiscal or monetary) can be used to analyse the economy as a whole.
- Explain basic management, business and marketing principles to be able to continue studies on a higher level.
- Understand the role of PESTLE factors on the SWOT of corporations, in the domestic and the international business environment.

TEXT BOOKS:
REFERENCES:
OBJECTIVES:

- To understand the life support systems, mission logistics and planning.
- Fundamental laws of mechanics, orbital mechanics, and Orbital manoeuvres.
- Types of space missions and their objectives in the Space environment.
- General concepts of space vehicle architecture, Attitude determination, and control.

UNIT I INTRODUCTION  8
The physics of space - Current missions: space station, Moon mission, and Mars missions - Engineering challenges on Manned vs. unmanned missions - Scientific and technological gains from space programs - Salient features of Apollo and Space station missions – space shuttle mission.

UNIT II SPACE VS EARTH ENVIRONMENT  10

UNIT III LIFE SUPPORT SYSTEMS AND COUNTERMEASURES  8

UNIT IV MISSION LOGISTICS AND PLANNING  10

UNIT V ALLIED TOPICS  9

OUTCOMES:
On successful completion of this course, the student will be able to

- Understand the advanced concepts of manned space missions.
- Provide the necessary mathematical knowledge that are needed in understanding their significance and operation.
- Have an exposure on various topics such as missile space stations, space vs earth environment, life support systems, mission logistics and planning.
- Deploy these skills effectively in the understanding of manned space missions.

TEXT BOOKS:
REFERENCES:
OBJECTIVES:

- To provide an overview of the different types of sensors and instruments flown on spacecraft.
- To provide students with an appreciation and understanding of the development of the design processes involved for different instruments.
- To explain, how the sensors and instruments interface with the spacecraft platform.

UNIT I INTRODUCTION
Scientific Background – Parameters to be observed – Sensing platforms (rocket engine, satellites) – introduction to various sensors and instrumentation needed for satellite mission function.

UNIT II MEASUREMENTS OF CHARGED AND NEUTRAL PARTICLES

UNIT III MEASUREMENT OF MAGNETIC AND ELECTRIC FIELDS
Fluxgate magnetometer – Search coil magnetometer – Optical absorption magnetometer. Electric Fields: Double probe technique – Beam experiments – Observation of electric fields parallel to the magnetic field.

UNIT IV PHOTON COUNTING SENSORS AND IMAGERS

UNIT V SPACECRAFT SYSTEMS AND SATELLITE ORBITS

OUTCOMES:
On successful completion of this course, the student will be able to
- Explains how mathematics, physics, and engineering-based concepts are used to develop and design a sensor which complies with a set of specific requirements.
- Discusses essential topics such as cost estimation, signal processing, noise reduction, filters, phased arrays, radars, optics, and radiometers used in space operation.
- Covers a range of typical sensors used in the spacecraft industry such as infrared, passive microwave, radars and space-based GPS sensors.
- Spacecraft Sensors is an invaluable resource for engineers, technical consultants, those in the business division, and research scientists associated with spacecraft projects.

TEXT BOOKS:

REFERENCE:
OBJECTIVES:
- The main objective of the course is to introduce the concept of space system design and engineering.
- To describe the various subsystems involved in the design of a satellite and Launch Vehicle.
- To describe the techniques of systems engineering that are used to obtain a coherent satellite design.

UNIT I SPACECRAFT STRUCTURES

UNIT II SPACECRAFT POWER SYSTEMS

UNIT III SPACECRAFT COMPUTER SYSTEMS

UNIT IV SATELLITE COMMUNICATION SYSTEM

UNIT V LAUNCH SYSTEMS

TOTAL: 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Analyse the issues in the spacecraft structures.
- Understand the functions of spacecraft power systems.
- Detect the error and correct in the spacecraft computer systems.
- Learn system engineering by designing, building, and testing a small satellite in laboratory.
- Understand the selection process of the launch systems.
TEXT BOOKS:

REFERENCES:
OBJECTIVES:
- The course gives an exposure to the Spacecraft structural requirements.
- Structural configuration concepts and trade-offs
- Types of environmental loading during launch
- Factors to consider in material selection and types of structural tests

UNIT I SPACECRAFT DESIGN LOADS

UNIT II DESIGN OF SPACECRAFT STRUCTURE

UNIT III SPACECRAFT MASS AND MODAL EFFECTIVE MASS

UNIT IV FATIGUE LIFE PREDICTION

UNIT V DAMAGE TO SPACECRAFT BY METEOROIDS AND ORBITAL DEBRIS

TOTAL: 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Identify simplifying assumptions and applicability of 1 structural element theories.
- Solve by hand simple 1-D axial deformation, torsion, and bending problems.
- Solve more complex structural mechanics problems using commercial finite element software.
- Solve simple discrete degree of freedom structural stability problems.
- Solve simple structural dynamics problems.

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
- To enable the students to create an awareness on Engineering Ethics and Human Values to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I  HUMAN VALUES

UNIT II  ENGINEERING ETHICS

UNIT III  ENGINEERING AS SOCIAL EXPERIMENTATION
Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV  SAFETY, RESPONSIBILITIES AND RIGHTS

UNIT V  GLOBAL ISSUES

TOTAL: 45 PERIODS

OUTCOME:
- Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

TEXT BOOKS:

REFERENCES:
Web sources:
1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org