SYLLABUS AND COURSE SCHEME
Aerospace Engineering (B.Tech.)
Punjab Engineering College (Deemed to be University), Chandigarh
July, 2021

CREDITS BREAK-UP FOR B.TECH. PROGRAMME (2020-21 onwards)

CURRICULAR COMPONENTS	Credits
(A) Institute Core Courses (ICC) a) Basic Sciences (BSC) b) Engineering Sciences (ES) **c)** General Science (GS)	 16 17 04
Total	**37**
(B) **Humanities, Communication and Management Elective Courses (HSSMEC)**	**12**
(C) Department Core Courses (DCC) (including 3 credits of Minor Project)	**39**
(D) Departmental Elective Courses (DEC)	**20**
(E) Institute Open Elective Courses (GSE/ HSEC) a) Courses b) Project (Compulsory Major Project)- Inter disciplinary	 **24** **06**
Total	**30**
(F)Internship/ Course Work* (4 credits of Deptt. Elective + 4 credits of Open Elective+ 4 credits of Project Work) *** Optional**	**12**
(G) Non Academic Courses (CCA)	**10**
Grand Total (For those who **do not opt** for Honours)	**160**
(H) Honours	**16**
Grand Total (For those who **opt** for degree with Honours)	**160 + 16**

Note: Minor Specialization will be given to a student who earns 16 credits from the basket of Open Elective courses offered by any one department (outside the parent department). Major Specialization will be given to a student who earns 16 credits in any one domain of Department Elective courses offered by parent department. To get Honours, the student will have to complete additional 16 credits of discipline Electives.

Semester wise UG Scheme to be implemented w.e.f. 2020-21 session

	SEMESTER-I	
S. No.		**Credits**
1	Orientation (including Introduction to Discipline course-1 credit 14 hours)	2
2	BS-I (Mathematics)	4
3	BS-II/ BS-IV (Physics/ Chemistry)	4
4	GS-I & GS-II/ ES-I	4
5	HS-I/ ES-II	3
6	ES-III/ ES-IV	3 / 2
	TOTAL	**20 / 19**

	SEMESTER-II	
S. No.		**Credits**
1	BS-III (Mathematics)	4
2	BS-IV/ BS-II (Chemistry/ Physics)	4
3	ES-I/ GS-I & GS-II	4
4	ES-II/ HS-I	3
5	ES-IV/ ES-III	2 / 3
6	ES-V/ ES-VI	2
	TOTAL	**19/ 20**

	SEMESTER-III	
S. No.		**Credits**
1	ES-VII/ HS-II	3
2a	Fluid Mechanics (DCC)	4
2b	Aerospace Propulsion (DCC)	4
2c	Solid Mechanics (DCC)	4
3	OE-I	4
4	Industrial Tour	2
	TOTAL	**21**

	SEMESTER-IV	
S. No.		**Credits**
1	HS-II/ ES-VII	3
2a	Aircraft Performance, Stability and Control (DCC)	4
2b	Aerodynamics (DCC)	4
2c	Aerospace Structures (DCC)	4
3	OE-II	4
4	Proficiency-I	2
	TOTAL	**21**

SEMESTER-V		
S. No.		**Credits**
1	DEC-I	4
2a	Gas Turbine Propulsion (DCC)	4
2b	Aerospace Systems (DCC)	4
2c	Aircraft Design (DCC)	4
3	DEC-II	4
4	Minor Project	3
	TOTAL	**23**

SEMESTER-VI		
S. No.		**Credits**
1	**Internship Training (Optional)**	12
	Students opting for course work will do Deptt. Elective (4 credits), Open Elective (4 credits) and Project Work (4 credits)	
	TOTAL	**12**

SEMESTER-VII		
S. No.		**Credits**
1	HS-III	3
2	DEC-III	4
3	DEC-IV	4
4	OE-III	4
5	OE-IV	4
6	Major Project-I	2
	TOTAL	**21**

SEMESTER-VIII		
S. No.		**Credits**
1	HS-IV	3
2	DEC-V	4
3	OE-V	4
4	OE-VI	4
5	Discipline	2
6	Proficiency-II	2
7	Major Project-II	4
	TOTAL	**23**

ABBREVIATIONS		
	Basic Science Course	BSC
	Engineering Science Course	ES
	General Science Course	GS

ABBREVIATIONS		
	Department Core Course	DCC
	Department Elective Course	DEC
	Open Elective Course	OE

Total Credits = 160 without Honours

Total Credits = 160 + 16 with Honours

Note: Minor Specialization will be given to a student who earns 16 credits from the basket of Open Elective courses offered by any one department (outside the parent department). Major Specialization will be given to a student who earns 16 credits in any one domain of Department Elective courses offered by parent department. To get Honours, the student will have to complete additional 16 credits of discipline

Electives.

ES-I	Introduction to Computing
ES-II	Engineering Drawing with CAD Software
ES-III	Introduction to Mechatronics
ES-	Introduction to Electronics &

IV	electrical Engineering
ES-V	Introduction to Manufacturing
ES-IV	Strength of Materials
ES-VII	Artificial Intelligence

ES-VII and HS-II (in 3rd and 4th semesters) are common to all branches.

Orientation Course (OR1101) of 2 credits includes Introduction to Discipline Engineering of 1 credit – 14 hours

Course Name	**:**	**Introduction to Aerospace Engineering**
Course Code	**:**	**AE1101**
Credits	**:**	**1**
Lectures	**:**	**14 hrs**

Course Objectives:

1	To introduce various aspects of aerospace engineering
2	To make the students aware about challenges and opportunities in the field of aerospace engineering.

Total No. of Lectures – 14

Lecture wise breakup		**No. of Lectures**
1	**Aerospace: History and future** History of aviation and space technology, Scope of Aerospace Engineering , Aerospace Industry, Current status and future of Aerospace Industry.	(2)
2	**Aspects of Aerospace Engineering** Anatomy of Aircraft and spacecraft, Classification of aircrafts and space crafts, Brief introduction to: Aircrafts instruments and systems, Aircraft structural components, Wind Tunnel: Utility	(4)
3	**Basic understanding of flight** Airfoils, lift, drag, Thrust, weight and moments, force diagram. Different phases of flight, VTOL and STOL.	(2)
4	**Aerospace Propulsion** Introduction to different aerospace propulsion systems: Piston engine, Turboprop, Turbojet, Turbofan, Ramjet, Scramjet, Pulsejet and Pulse detonation engine and Rocket propulsion.	(2)
5	**Satellites** Different Launch Vehicles, Accomplishment of ISRO	(2)
6	**Aircraft Regulating Bodies** Role of DGCA, AAI and MoCA, Introduction to airports.	(2)

Course Outcomes:

1	The students will be able to realize interesting aspects of aerospace engineering
2	The students will be able to describe important basic concepts of aerospace engineering

Text Books:

S.No.	**Name of Books**	**Year of Publication**
1	Introduction to Flight by John D. Anderson Jr.,7th Edition, Mc Graw Hill Pvt. Ltd.	2011
2	Aircraft Basic Science by Ralph D. Bent & James L. Mackinley.	1993

Reference Books:

S.No.	**Name of Books**	**Year of Publication**
1	Flight without formulae by A.C. Kermode, 5th Edition, Pearson publication,	1989

Course Name	**:**	**Calculus and Ordinary Differential Equations**
Course Code	**:**	**MA1101 (Common to all branches)**
Credits	**:**	**4**
L T P	**:**	**3-1-0**
Total No. of Lectures	**:**	**42**

Course Objectives:

1	Understand the behavior of infinite series and their use.
2	learn the concepts related to differential calculus of functions of several variables and their applications.
3	learn the concept and methods of evaluating multiple integrals and their applications to various problems.
4	learn the methods to solve ordinary differential equations of various types.

	Lecture wise breakup	**No. of Lectures**
1	**INFINITE SERIES** Infinite series and convergence, alternating series, power series and convergence. Taylor's and Maclaurin's Series. (Scope as in Chapter 8, Sections 8.1, 8.3 – 8.9 of Text Book1).	8
2	**DIFFERENTIAL CALCULUS** Limit, Continuity and Partial Derivatives; Euler's Theoem for Homogeneous functions; Differentiability, Linearization and Differentials; Chain rule; Extreme values and Saddle Points; Lagrange multipliers; Taylor's Formula**. (**Scope as in Chapter 12, Sections 12.1 – 12.6, 12.8 – 12.10 of Text Book 1).	12
3	**INTEGRAL CALCULUS** Cylinders and Quadric surfaces, Double integrals in Rectangular and Polar form, Triple integrals in Rectangular, Cylindrical and Spherical Coordinates, Substitutions in Multiple integrals. Applications to practical problems. (Scope as in Chapter10, Sections10.6 and 10.7 and Chapter 13, Sections 13.1, 13.3, 13.4,13.6 and 13.7 of Text Book 1).	10

4	**ORDINARY DIFFERENTIAL EQUATIONS** First order exact differential equations, Integrating factor, Orthogonal trajectories, Second and Higher order Linear Differential Equations with constant coefficients, Differential Operators, Methods of Variation of Parameters and Undetermined Coefficients, Euler Cauchy Equation, Wronskian. (Scope as in Chapter 1, Section 1.5, 1.8 Chapter 2, 2.1-2.4, 2.6, 2.9-2.10, 2.13- 2.15 of Text Book 2).	12

Course Outcomes: At the end of this course, the students will be able to

1	test the behavior of infinite series.
2	Apply the concepts of differential calculus of functions of several variables.
3	evaluate multiple integrals and apply them to practical problems.
4	solve ordinary differential equations of various types

Text Books:

1	Calculus and Analytic Geometry, Thomas and Finney, 9th edition, Pearson Education Asia.	2006
2	Advanced Engineering Mathematics, Kreyszig, 8th edition, John Wiley and Sons.	2005

Reference Books:

1	Differential Equations, Frank Ayers, SI edition, Mc Graw Hill.	1972
2	Advanced Engineering Mathematics, Wylie and Barrett, 6th edition, Mc Graw Hill.	2003

Course Name	**:**	**Linear Algebra, Vector Calculus and Partial Differential Equations**
Course Code	**:**	**MA1201 (For Aero, ECE, Mech and student-specific for Civil)**
Credits	**:**	**4**
L T P	**:**	**3-1-0**
Total No. of Lectures	**:**	**42**

Course Objectives:

1	learn the various concepts associated with real vector spaces and theory of matrices
2	learn the various concepts of vector calculus and their applications to problems.
3	formulate and solve linear and nonlinear partial differential equations and apply to engineering problems.

S.No	**Lecture wise breakup**	**No. of Lectures**
1	**ALGEBRA** Vector spaces over reals, Linear dependence, Basis, Dimension, Co-ordinates with respect to a basis, Change of basis, Subspace, Linear transformation $R^n \rightarrow R^m$, Range space and Rank, Null space and Nullity, Rank and Nullity relation, Matrix representation of a linear transformation, Similar matrices, Invertible linear transformation, Eigenvalues and eigenvectors, Cayley Hamilton theorem, Diagonalization of a matrix.	16
2	**VECTOR CALCULUS** Gradient, Divergence and Curl – their physical interpretation, Line, Surface and Volume integrals, Green's theorem in the plane, Stoke's theorem, Divergence theorem, Applications to Science and Engineering.	14
3	**PARTIAL DIFFERENTIAL EQUATIONS** Formation and solution of first order partial differential equations, Linear equations of higher order with constant coefficients, Applications to Engineering problems**.**	12

Course Outcomes: At the end of the semester, the students are able to

1	solve the various problems related to real vector spaces and theory of matrices
2	apply various concepts of vector calculus to problems.
3	formulate and solve linear and nonlinear partial differential equations and apply to engineering problems.

Text Books:

1	Introductory Linear Algebra with Applications, Kolman, B. and Hill,D.R.,7th editiom, Pearson Education	2001
2	E. Kreyszig, Advanced Engineering Mathematics, Eighth Edition, John Wiley.	2005

Reference Books:

1	Elements of Partial differential equations, Sneddon, Mc Graw Hill.	1957
2	Advanced Engineering Mathematics, Wylie and Barrett, 6th edition, Mc Graw Hill.	2003

Course Name	**:**	**Mechanics and Optics**
Course Code	**:**	**PY1101 (For Mechanical, Production, Civil and Aero)**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:

1. To inculcate the application of mechanics concepts in engineering.
2. To familiarize students with statics, kinematics and kinetics of rigid body.
3. To familiarize the students with lasers, optical fibers, ultrasonics and their applications.
4. To make the students able to understand the basic concepts of nanotechnology and its applications.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**STATICS:** Free body diagrams, analysis of system of forces, Equation of equilibrium in space and its applications, Center of gravity, Centroid, mass, area and Polar moment of inertia of simple and compound bodies	6
2	**DYNAMICS:** Kinematics of a Particle, Introduction, Motion of a projectile. Kinetics of a particle: Force and acceleration, Work and energy, Impulse and momentum.	4
3	**PLANAR KINEMATICS OF A RIGID BODY:** Rigid-Body motion, Translation, Rotation about a fixed axis, Absolute general Plane Motion analysis. Relative-Motion Analysis: Velocity, Instantaneous center of zero velocity, Acceleration, Relative-Motion analysis using Rotating axes.	4
4	**PLANAR KINETICS OF A RIGID BODY:** Momentof Inertia. Planar Kinetic equations of motion. Equations of motion: Translation, Rotation about a fixed axis and General Plane motion. Kinetic Energy, Work of a Force, Work of a Couple, Principle of Work and Energy, Conservation of Energy, Linear and Angular Momentum, Principle of Impulse and Momentum, Conservation of Momentum, Eccentric Impact.	12
5	**LASERS, OPTICAL FIBRES ANDULTRASONICS:** Basics of Interference, Diffraction and Polarization, Laser and its characteristics, He-Ne laser, ruby laser, semiconductor lasers, Applications of Lasers, Optical fibres; Numerical aperture, Classification of optical fibres, fibre Losses, fibre manufacturing, Applications of optical fibres. Production of ultrasonics, detection	12

	and uses of ultrasonic, reverberation.	
6	**NANOTECHNOLOGY:** Introduction, Length Scale, Size dependence, Synthesis of Nanoparticles: Mechanical Method,Sol-gel Technique, Physical Vapour Deposition, Chemical Vapour Deposition, Applications of Nanotechnology	4

List of Experiments		**No.of Turns**
1	Familiarization of students with basic instruments Vernier Calipers, Screw Gauge and Spectrometer.	1
2	To find the wavelength of sodium light using Fresnel's biprism.	1
3	(i) To determine the wavelength of He-Ne laser using transmissiongrating. (ii) To determine the slit width using the diffraction pattern.	1
4	To determine the wave length of sodium light by Newton's rings method.	1
5	To determine the wave length of sodium light using a diffraction grating.	1
6	To find the specific rotation of sugar solution using a Bi-quartz Polarimeter.	
7	(i)To determine the angle of acceptance and numerical aperture of given fibre optical cable. (ii) To determine the losses in optical fibre in dB due to micro bending of fibre.	1
8	To determine the Moment of Inertia of a Flywheel.	1
9	To determine the range of projectile as a function of angle of inclination and initial velocity.	1
10	To determine the velocity of ultrasonic waves in a given liquid.	1
11	To determine the restoring force per unit extension of a spiral spring by a statistical and dynamic method and also to determine the mass of the spring.	1
12	To measure the centripetal force, F_c, and compare to $F_c = mv^2/r = m\omega^2 r$.	1
13	To study conservation of energy and momentum in collision.	1

Course Outcomes: By the end of the course students will be able to

1	Students will be able to understand and applythe concepts of mechanics, types of motions and characteristics of a rigid body.
2	Students will develop capability to tackle the numerical problems in general and in the various areas covered in the course.
3	Students will learn about lasers and fibre optics, which have important applications for societal needs.

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher/Edition
1	Engineering Mechanics, Statics and Dynamics, R.C. Hibbeler, Pearson (12th Edition).
2	Dynamics, Merriam and Kraige, Wiley and Sons (5th Edition).
3	Dynamics F.P. Beer et al., McGraw Hill (8th Edition).
4	Optics, AjoyGhatak, McGraw-Hill (3rd Edition).

Course Name	**:**	**Applied Chemistry II**
Course Code	**:**	**CH1201 (For Mech., Prod., Metta, Aero. And Civil)**
Credits	**:**	**4**
L T P	**:**	**3 -0-2**

Objective:

To teach the fundamentals and application of chemical sciences essential for the development of engineering materials and processing technologies. Students will be learning various analytical techniques for the characterizations of composites and hybrid materials.

Total No. of Lecture-42

Lecture wise breakup		**No. of Lectures**
1	**Fundamentals for Applied Chemistry** Molecular orbital theory, Jahn-Teller Effect in Crystal Field Theory, Solid state chemistry: Crystal defects and line imperfections , Reaction mechanism in organic chemistry: Principles and methods of determination, Chemical Kinetics: Langmuir –Hinselwood Mechanism, Acid -base equilibria in non aqueous media	**(8)**
2	**Polymer Chemistry** Mechanism and methods of polymerization, Structure-Activity relationship, High performance polymers and applications, Natural and synthetic fibres, biodegradable polymers	**(5)**
3	**Fuels and Catalysis** Petroleum processing**,** Solid and liquid Fuels for Propellents, Chemistry of combustion and equations, Catalytic convertors	**(5)**
4	**Electrochemistry and Corrosion:** Introduction to Electrochemistry, Fuel cells, Batteries (Lithium-ion Batteries and EV Batteries), Corrosion control and protective coatings	**(7)**
5	**Spectroscopic Methods for strucutral analysis:** Principle and Applications (UV, IR, NMR, AAS/ICP-AES, SEM, TEM, XRD)	**(10)**
6	**Chemistry of Metal based and Composite Materials** Ceramic and Cement Materials, Metals and Alloys ,Phase change materials, Bio-inspired materials, Composite materials, Smart materials	**(7)**

Practicals	
Sr. No.	**Name of Experiment**
1.	Synthesis of metal-complex and determination of melting point

2.	Implementation of IR technique for the analysis of metal-complex synthesized
3.	Preparation of Metal-oxide by sol gel and hydrothermal method
4.	Characterization of metal–oxide using SEM technique by structural determination
5	Synthesis of an organic compound and chemicals analysis.
6	Structural analysis of organic compound by NMR technique.
7	Synthesis of polymer material and its analysis.
8	Application of UV spectroscopy for polymer functional group analysis
9	Investigation of redox chemistry of an inorganic material by Cyclic Voltammeter.
10	Application of open source software for chemical analysis and drug design.

Course Outcomes: At the end of the course, the students will be able to:

1	To be able to apply the fundamentals of chemistry towards emerging materials to benefit the societal needs.
2	To attain the essential analytical skills and designing of materials for various applications.
3	To be able to identify the chemical compositions required for designing of high performance materials.

Books:

1	Concise Inorganic Chemistry, by J. D. Lee, 5th Edition, 2003 (Chapman & Hall).
2	Organic Chemistry by S. M. Mukherji, and S. P. Singh, 2017 (Newagepublishers).
3	Principles of Physical Chemistry by Puri, Sharma and Pathania, 2008 (W.H. Freeman & Co).
4	Atkin's Physical Chemistry by Peter Atkins, Julio de Paula, 7th Edition (Oxford University Press).
5	Principle of Polymerization by G. Odian, 4th Edition, (John Wiley & Sons, Inc.).
6	D. S. Pavia, G.M. Lasmpman and G.S. Kriz: Introduction to Spectroscopy, 4th Edition, (Thomson learning, Indian Edition).
7	NPTEL web lectures: Chemistry of Materials, Engineering Chemistry I & III.

Course Name	**:**	**Introduction to Environmental Sciences-I**
Course Code	**:**	**GS 1101 (Common to all branches)**
Credits	**:**	**2**
L T P	**:**	**2 0 0**

Course Objectives:

1. This course aims to acquaint students with the basics of Environmental Sciences.
2. To make them understand the importance of Environmental Sciences.

Total No. of Lectures – 28

S. No.	**Lecture wise breakup**	**No. of Lectures**
1	Introduction to environmental studies: Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development.	4
2	Ecosystems: What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :a)Forest ecosystem b) Grassland ecosystem c)Desert ecosystem d)Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	8
3	Natural Resources: Renewable and Non-Renewable Resources: Land resources and Landuse change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over--exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter--state).Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.	8
4	Environmental Pollution: Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution. Nuclear hazards and human health risks. Solid waste management: Control measures of urban and industrial waste. Pollution case studies.	8

Course Outcomes:

1. Students will be able to relate the importance of Environmental Sciences for sustainable development of society
2. Students will be able to understand the problems and remedies of Environmental Sciences

Text Books:

1	Environmental Science Ceonage Learning Publications, Miller G.T. and Spool Mar
2	Environmental Studies, Tata Mcgraw Hill Pub., Banny Joseph
3	Text book of Environmental Studies for U.G. Courses - University Press – ErachBharucna
4	Environmental Studies – from criteria to cure, Oxford Univ. Press, R. Raogopalan

Reference books:

S. No.	**Name of Book/Authors/Publishers**	**Year of Publications/Reprints**
1.	"Building Construction Punmia B.C, Punmia Arun Jain & Ashok Jain, Laxmi Publication (P) Ltd.	2012
2.	"Estimation and costing in Civil Engineering", B.N Dutta, UBS publisher distributors.	2014
3.	"Engineering Materials", S.C. Rangwala, Charotar Publishing House.	2016
4.	"Building Construction", P.C. Varghese, PHI learning Pvt Ltd.	2014
5.	"Building Construction", Mckay W. Barry, Pearson Publication.	2013

Course Name	**:**	**Introduction to Environmental Science-II (GSC-II)**
Course Code	**:**	**GS1201 (Common to all branches)**
Credits	**:**	**2**
L T P	**:**	**1 0 2**

Course Objectives:

This course aims to attract the attention of students towards understanding the chemistry of pollutants, their analysis and disposal along with introduction to green chemistry for Environment friendly processes and products.

Total No. of Lectures: 14

	Contents	Lectures
1.	**Air Pollution:** Introduction, Air pollutants, Photochemical reactions in the atmosphere, Photochemical smog, Health effects and the usual ways to control air pollution	3
2.	**Water Pollution:** Types of Pollution, Contaminants and their sources, measurements and its control	3
3.	**Soil Pollution:** Inorganic and organic contaminants, Pesticides and herbicides, health effects and remedial measures, metal toxicology	3
4.	**Green chemistry for clean Technology:** Goals, Principles and applications	2
5.	**E-waste Management:** Introduction, Environmental impact/ health effects of e-waste exposure, Methods to dispose e-waste	3

Course Outcomes: At the end of this course, students will be able to

1. Students will be able to identify the source of contaminants in Water, Soil and Air and develop the strategies to minimize the levels of pollution
2. Students will understand the applications of green chemistry in mitigating the environmental pollution
3. Hands on training through lab experiments for chemical analysis of various pollutants.

Books:

1. Chemistry for Environmental Engineering and Science, Fifth Edition by Sawyer, McCarty and Parkin (Publisher: McGraw-Hill Education, 2003)

2. Environmental Chemistry, Seventh Edition by A.K. De (Publisher: New Age International (P) Limited, 2017)

3. Environmental Chemistry: Pollution and Remedial Perspectives by A.V. Salker (Publisher: Alpha Science International Limited, 2017)

Practicals	
Sr. No.	**Name of Experiment**
1.	Determination of total dissolved solid (TDS) by conductivity measurement
2.	Measurement of acid-base equilibria by pH meter in water/soil sample.
3.	Measurement of dissolved oxygen in given waste water sample
4.	Determination of organic pollutants (pesticides) in water/soil sample by extraction and IR analysis
5	Measurement of alkalinity and hardness in a given sample of water
6	Measurement of biological oxygen demand (BOD) in given sample of water
7	Measurement of chemical oxygen demand (COD) in given sample of water
8	Measurement of oil and greases in waste water by gravimetric analysis
9	Detection of heavy metal by complexation and UV-Visible spectrophotometer
10	Removal of toxic metals by chemical adsorption method

Course Name	**:**	**Introduction to Computing**
Course Code	**:**	**ES1101 (Common to all branches)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objective:

To develop logical skills so that students should be able to solve basic programming problems.
To use programming knowledge to develop small projects including basic GUI design

Total No. of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1	**INTRODUCTION TO PROGRAMMING** Evolution of languages: Machine languages, Assembly languages, High-level languages. Software requirements for programming: System softwares like operating system, compiler, linker, loader; Application softwares like editor. Flowcharts. Algorithm, specification of algorithm. Industrial uses of programming in various domains	**3**
2	**DATA TYPES and OPERATORS AND EXPRESSION** Storing integers, numbers with decimals, characters and strings, typecasting. User input and output, use of command line arguments Operators:arithmetic operators, relational operators, logical operators, bitwise operators, miscellaneous operators. Expressions and their evaluation. Precedence and associativity rules.	**7**
3	**ITERABLE CONTAINERS and STATEMENTS** List, set, tuple and dictionaries; range function; difference between various iterable containers Decision making statements: if, if-else, nested if and if-else. Control statements: for & while loops, nested loops; Role of statements like break, continue	**7**
4	**FUNCTIONS and CLASSES** Advantage of modularizing program into functions, function definition and functioninvocation. Function arguments: default, keyword and positional arguments. Scope and lifetime of a variable. Recurrence relations and Recursion Advantage of using classes, defining class data members & functions and accessing using objects. Constructors and destructors in a class, parameterized constructors	**8**

5	**GUI design** Introduction to tkinter library, use of TK &mainloop methods, use of widgets like Button, Canvas, Checkbutton, Entry, Frame, MenuButton, Listbox, Menu, Scrollbar, Text, Message, Pack, Grid, place etc. for GUI design	**5**
6	**SORTING AND SEARCHING** Searching: Linear search, binary search and hash search. Sorting: Insertion sort, selection sort, bubble sort, quick sort, merge sort, heap sort, and Bucket sort. Time and space complexity of algorithms, comparing algorithms	**9**
7	**Problem Solving** Real-world programming problems	**3**

Total no. of turns: 14

List of Experiments:	
1	Implement programs to input/output various data types
2	Implement programs to use command line arguments
3	Implement programs making use of various operators
4	Implement programs making use of conditional statements and loops
5	Implement programs making use of iterable containers
6	Implement programs making use of functions and recursion
7	Implement programs performing file operations
8	Implement various searching and sorting algorithms
9	Project work including GUI design using tkinter

Course Outcomes: At the end of the course, students will be able to:

1	Develop understanding ofthe fundamental concepts essential for programming.
2	Make efficient use of iterables, function and classes to programming problems
3	Develop simple GUI applications
4	**Learn to compare algorithms and improve efficiency of algorithms**

Reference Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Think Python, How to Think Like a Computer Scientist, Version 2.0.17 Allen Downey Green Tea Press Needham, Massachusetts	2012
2	Python Programming: An Introduction to Computer Science by John M. Zelle, Franklin, Beedle& Associates Inc	2015
3	Core python programming, Dr. R. Nageswara Rao, 2nd edition, Dreamtech press	2018

Course	**Engineering Drawing with CAD Software**
Course Code	**ES1201 (Common to all branches)**
Credits	**3**
L TP	**2-0-2**
Total No. Lectures	**28**

Course Objectives:

At the end of this course, the student should be able to understand the basic concepts of Engineering Drawing. The student should be able to visualize and draw the two- and three-dimensional objects. The student should also be able to understand the features associated with operations of the computer-aided design (CAD) software.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	Introduction to Engineering Graphics, Concept of points and lines, System of Projections, Orthographic projections, Dimensioning.	4
2	Introduction to different types of CAD Softwares e.g. SolidWorks/AutoCAD/ CATIA etc., 2D-Sketching, Sketching Entities & Relation, 3D-Sketching, Editing and its Features, Dimensions, Sketch Tools, File handling	7
3	Projections of planes / lamina on reference planes, classification of primary and secondary planes, use of auxiliary planes, Exercises using CAD software	5
4	Classification of solids, Projections of solids on the basis of positions of the axis of various solids on reference planes and Sectioning of solids, Exercises using CAD software	6
5	Introduction to Perspective projection, isometric views, Isometric lines & Axes, conversion of orthographic views to isometric views and vice-versa, Exercises using CAD software	6

List of Experiments:		**Number of Turns**
Exercises to be done using CAD software		
1	2D & 3D Sketching using various sketching tools.	2
2	Projection of planes.	2

3	Developments of 3D-parts.	2
4	Projection of solids.	2
5	Projection of Sectioning of solids.	2
6	Isometric and orthographic views.	2
7	Generating drawings of 3D-parts.	2

Course Outcomes: At the end of this course, the students will be able to:

1	Understand the basic concepts of Engineering Graphics.
2	Visualize the actual objects and convert them in to readable drawings.
3	Understand the drawing standards, conventions and symbols that are in common usage.
4	Draw the common Engineering drawings using available Drafting softwares.
5	Come up with innovative conceptual ideas by using Drafting softwares.

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/
1	Engineering Drawing, P. S. Gill, S.K. Kataria& Sons.	2012
2	Engineering Drawing, D.A. Jolhe, Tata McGraw Hill	2010
3	Engineering Graphics with SOLIDWORKS, David C. Planchard, SDC Publications	2020

Course Name	**:**	**Introduction to Mechatronics**
Course Code	**:**	**ES1301 (Common to all branches)**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives:

The objective of the course content is to:
CO1:Impart knowledge and information about product design.
CO2:Development and control of intelligent systems for all aspects of life.

Lecture wise breakup		**No. of Lectures**
1	**Understanding Mechatronics** Mechatronics System, Evolution, Definitions of Mechatronics, Key Elements of Mechatronics, Mechatronics for all Civil, Metallurgical, Aerospace, Chemical, Architecture, Medical, Robotics, Defense, Agriculture, etc., Role of Mechanical, Electrical, Electronics, Computer Engineers in Intelligent Product and Process Design, Development and Control, Bio-mechatronics.	02
2	**Systems and Machines :** System, Classification of System, Mechanistic System Classification Based on Input Energy, Mathematical Model and Function, Machine, Parts of Machine, Concepts of Machine, Classification of Machines based on Function and Size.	02
	System Intelligence: Properties of Intelligent System, System Intelligence Levels, Human Intelligence System, Future Generation System Intelligence Level, Expressing System Intelligence.	02
3	**Sensor and Transducer :** Sensors in Mechatronics System, Difference between Sensors and Transducers, Classification of Sensors, Based on Sensor Output Signal, Sensor Input Physical Parameters, Sensor Accuracy (Smart/Intelligent Sensor), Performance Terminology, Static Characteristics, Dynamic Characteristics.	03
4	**Signal Conditioning Devices :** Signal Conditioning Processes,Application of Signal Conditioning Devices in Mechatronics based on Their Characteristics such as Diode, Transistor, SCR, DIAC, TRIAC, Op-Amps, Signal Filtering, Circuit Protection, Signal Conversion, ADC and DAC, Logic Gates, Flip-Flops, Register, Counters.	05
5	**Actuators:** Actuators, Types of Actuators, Mechanical Actuation System (i.e. Linear-rotary, Rotary-linear Mechanism, Gear, Bearing,	05

	Pulleyetc.). Electrical Actuation System (DC, AC, Stepper Motors), Pneumatic and Hydraulic Actuation System.	
6	**Controllers :** Microprocessor, Microcontroller, PLC Controller& Their Architectures, Principles and Working Software Programs (Assembly/High Level),Interfacing Aspects, Application Examples.	05
7	**Robotics and Automation:** Evolution of Robots, Definitions, Types of Motions, Function, Governing Laws, Classification, Features and Components of Robots, System Automation .	04
	Total No. of Lectures	28

LIST OF EXPERIMENTS		
Number of Turns		
1	**Experiment on Sensors & Transducers (Mechatronics Lab)**	
(i)	To study the characteristics of LVDT using linear displacement trainer Kit & compare with ideal characteristics.	01
(ii)	To measure the strain of the metal strip using strain gauge trainer kit & compare with ideal characteristics.	01
(iii)	To measure the angular displacement of resistive & capacitive transducer using angular displacement trainer kit & compare with ideal characteristics.	01
(iv)	To obtain the characteristics of RTD, Thermistor, thermocouple with hot and cold junction thermal trainer kit & compare with ideal characteristics.	01
2.	**Experiments on Signal Conditioning**.	
(a)	Experiments on Analog Devices	
(i)	PN Junction Diode	01
(ii)	Zener Diode	01
(iii)	Half wave rectifier	01
(iv)	Full wave rectifier	01
(b)	**Experiments on Digital devices**	
(i)	Logic Gates (AND, OR, NAND, NOR etc)	01
(ii)	Flip Flop (RS Flip Flop), D Flip Flop.	01
3	**Experiments on Controller**	01
(i)	Study of microprocessors, microcontroller, programmable logic controller (PLC)	
(ii)	PLC interfacing of I/O and I/O addressing.	01
(iii)	To perform any basic sequence programming using PLC.	01
4.	**Experiments on Actuators**	01
(i)	Study of mechanical, electrical, hydraulic/pneumatic actuators.	

Course Outcomes: At the end of this course, students will be able to

	By the end of this course, the student will be able: CO1: To understand components of mechatronic system, CO2: To design product and systems theoretically as well as practically with intelligence.

Reference Books:

Sr.	Name of Book/ Authors/ Publisher	Year of

No.		Publication/ Reprint
1	Mechatronics First edition by Tilak Thakur, published by Oxford University Press	2016
2	Mechatronics, Fourth edition, by W Bolton. ISBN 978-81-317-3253-3	2013
3	Dan Necsulescu Mechatronics published by Pearson Education (Singapore) Pvt. Ltd., Indian Branch, 482 FIE, Patparganj, Delhi India.	2001
4	Book by H M T Limited, Mechatronics Tata McGraw Hill Publishing Company Limited, New Delhi.	1988
5	Mechatronics Principles, Concepts & Applications by Nitaigour P Mahalik published by TMH	2003

Course	**Engineering Drawing with CAD Software**
Course Code	**ES1201 (Common to all branches)**
Credits	**3**
L TP	**2-0-2**
Total No. Lectures	**28**

Course Objectives:

At the end of this course, the student should be able to understand the basic concepts of Engineering Drawing. The student should be able to visualize and draw the two- and three-dimensional objects. The student should also be able to understand the features associated with operations of the computer-aided design

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	Introduction to Engineering Graphics, Concept of points and lines, System of Projections, Orthographic projections, Dimensioning.	4
2	Introduction to different types of CAD Softwares e.g. SolidWorks/AutoCAD/ CATIA etc., 2D-Sketching, Sketching Entities & Relation, 3D-Sketching, Editing and its Features, Dimensions, Sketch Tools, File handling	7
3	Projections of planes / lamina on reference planes, classification of primary and secondary planes, use of auxiliary planes, Exercises using CAD software	5
4	Classification of solids, Projections of solids on the basis of positions of the axis of various solids on reference planes and Sectioning of solids, Exercises using CAD software	6
5	Introduction to Perspective projection, isometric views, Isometric lines & Axes, conversion of orthographic views to isometric views and vice-versa, Exercises using CAD software	6

List of Experiments:		**Number of Turns**
Exercises to be done using CAD software		
1	2D & 3D Sketching using various sketching tools.	2
2	Projection of planes.	2
3	Developments of 3D-parts.	2

4	Projection of solids.	2
5	Projection of Sectioning of solids.	2
6	Isometric and orthographic views.	2
7	Generating drawings of 3D-parts.	2

Course Outcomes: At the end of this course, the students will be able to:

1	Understand the basic concepts of Engineering Graphics.
2	Visualize the actual objects and convert them in to readable drawings.
3	Understand the drawing standards, conventions and symbols that are in common usage.
4	Draw the common Engineering drawings using available Drafting softwares.
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3	Engineering Graphics with SOLIDWORKS, David C. Planchard, SDC Publications	2020

Course Name	**:**	**Introduction to Mechatronics**
Course Code	**:**	**ES 1301 (Common to all branches)**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives:

The objective of the course content is to:
CO1:Impart knowledge and information about product design.
CO2:Development and control of intelligent systems for all aspects of life.

Lecture wise breakup		**No. of Lectures**
1	**Understanding Mechatronics** Mechatronics System, Evolution, Definitions of Mechatronics, Key Elements of Mechatronics, Mechatronics for all Civil, Metallurgical, Aerospace, Chemical, Architecture, Medical, Robotics, Defense, Agriculture, etc., Role of Mechanical, Electrical, Electronics, Computer Engineers in Intelligent Product and Process Design, Development and Control, Bio-mechatronics.	02
2	**Systems and Machines :** System, Classification of System, Mechanistic System Classification Based on Input Energy, Mathematical Model and Function, Machine, Parts of Machine, Concepts of Machine, Classification of Machines based on Function and Size.	02
	System Intelligence: Properties of Intelligent System, System Intelligence Levels, Human Intelligence System, Future Generation System Intelligence Level, Expressing System Intelligence.	02
3	**Sensor and Transducer :** Sensors in Mechatronics System, Difference between Sensors and Transducers, Classification of Sensors, Based on Sensor Output Signal, Sensor Input Physical Parameters, Sensor Accuracy (Smart/Intelligent Sensor), Performance Terminology, Static Characteristics, Dynamic Characteristics.	03
4	**Signal Conditioning Devices :** Signal Conditioning Processes,Application of Signal Conditioning Devices in Mechatronics based on Their Characteristics such as Diode, Transistor, SCR, DIAC, TRIAC, Op-Amps, Signal Filtering, Circuit Protection, Signal Conversion, ADC and DAC, Logic Gates, Flip-Flops, Register, Counters.	05
5	**Actuators:** Actuators, Types of Actuators, Mechanical Actuation System (i.e. Linear-rotary, Rotary-linear Mechanism, Gear, Bearing,	05

	Pulleyetc.). Electrical Actuation System (DC, AC, Stepper Motors), Pneumatic and Hydraulic Actuation System.	
6	**Controllers :** Microprocessor, Microcontroller, PLC Controller& Their Architectures, Principles and Working Software Programs (Assembly/High Level),Interfacing Aspects, Application Examples.	05
7	**Robotics and Automation:** Evolution of Robots, Definitions, Types of Motions, Function, Governing Laws, Classification, Features and Components of Robots, System Automation .	04
	Total No. of Lectures	28

LIST OF EXPERIMENTS		
Number of Turns		
1	**Experiment on Sensors & Transducers (Mechatronics Lab)**	
(i)	To study the characteristics of LVDT using linear displacement trainer Kit & compare with ideal characteristics.	01
(ii)	To measure the strain of the metal strip using strain gauge trainer kit & compare with ideal characteristics.	01
(iii)	To measure the angular displacement of resistive & capacitive transducer using angular displacement trainer kit & compare with ideal characteristics.	01
(iv)	To obtain the characteristics of RTD, Thermistor, thermocouple with hot and cold junction thermal trainer kit & compare with ideal characteristics.	01
2.	**Experiments on Signal Conditioning**.	
(a)	Experiments on Analog Devices	
(i)	PN Junction Diode	01
(ii)	Zener Diode	01
(iii)	Half wave rectifier	01
(iv)	Full wave rectifier	01
(b)	**Experiments on Digital devices**	
(i)	Logic Gates (AND, OR, NAND, NOR etc)	01
(ii)	Flip Flop (RS Flip Flop), D Flip Flop.	01
3	**Experiments on Controller**	01
(i)	Study of microprocessors, microcontroller, programmable logic controller (PLC)	
(ii)	PLC interfacing of I/O and I/O addressing.	01
(iii)	To perform any basic sequence programming using PLC.	01
4.	**Experiments on Actuators**	01
(i)	Study of mechanical, electrical, hydraulic/pneumatic actuators.	

Course Outcomes:

	By the end of this course, the student will be able: CO1: To understand components of mechatronic system, CO2: To design product and systems theoretically as well as practically with intelligence.

Reference Books:

Sr.	Name of Book/ Authors/ Publisher	Year of

No.		Publication/ Reprint
1	Mechatronics First edition by Tilak Thakur, published by Oxford University Press	2016
2	Mechatronics, Fourth edition, by W Bolton. ISBN 978-81-317-3253-3	2013
3	Dan Necsulescu Mechatronics published by Pearson Education (Singapore) Pvt. Ltd., Indian Branch, 482 FIE, Patparganj, Delhi India.	2001
4	Book by H M T Limited, Mechatronics Tata McGraw Hill Publishing Company Limited, New Delhi.	1988
5	Mechatronics Principles, Concepts & Applications by Nitaigour P Mahalik published by TMH	2003

S. No.	Title, author and Publisher	Publication year / Reprint
(1)	Manufacturing Engineering & Technology, Kalpakjian and Shmid (Pearson Publications)	2013
(2)	Advanced Manufacturing Processes, VK Jain, Allied Publishers	2014
(3)	Introduction to Basic Manufacturing, CS Jawalkar, Narosa Publishers	2016

Course Name	**:**	**Introduction To Electronics & Electrical Engineering**
Course Code	**:**	**ES1401 (Common to all branches)**
Credits	**:**	**2**
LTP	**:**	**2-0-0**

Course Objective:

To introduce to the students, the fundamental concepts of electronic devices, circuits and electrical systems for engineering applications.

Total Number of Lectures: 28

Lecture wise breakup		**Number of Lecture**
1	**Semiconductor Device sand applications**: Familiarizations with active and passive components Physics of p-n junction diode, BJT, JFET and MOSFET, diode as Rectifier, clippers and clampers, Transistor as an amplifier, Introduction to Audio amplifiers, Functional operation of OpAmp, concept of Oscillators, filters and their types	7
2	**Digital Electronics**: Introduction to logic gates, combinational circuits: adder, subtractor, multiplexer, demultiplexer, sequential circuit: flipflops, counters, registers, Analog to digital conversion, Digital to analog conversion and applications	5
3	**Communication Systems:** Various frequency bands used for communication, Block diagram of Analog and Digital communication, need of modulation, Analog modulation techniques (Amplitude and frequency), Digital modulation techniques (ASK, FSK, PSK,)	3
4	**Fundamentals of Electrical Engineering:** Introduction to circuit laws, Network theorems, Amplitude, Phase, Phase difference, RMS value and Average value of a AC signal, Active and Reactive Power, single phase and 3 phase systems,star delta connection, construction, working principle and speed control of AC and DC machines, Transformer: construction, working principle and applications	8
5	**Measurements:** Principle of measurement, voltage, current, power and energy measurement, analog and digital measurement system	5

Course Outcomes: By the end of this course, the students will be able to

1. Express the understanding of semiconductor devices (p-n Diode, BJT, MOSFET etc), and their applications.

2. Describe the functional operation of various analog and digital electronic circuits.
3. Solve basic electronic circuits using circuit laws and network theorems.
4. Describe the basic principle and working of fundamental electrical systems, ac dc motors and transformer etc.
5. Explain the basic principle of measuring electrical quantity such as voltage, current, power and energy.

ReferenceBooks:

Sr. No	**Name of Book/Authors/Publisher**	**Year of Publication/ Reprint**
1	Electronics Devices & Circuit Theory, RLBoylestead & LNashelsky(PHI)	2009
2	CircuitsandNetworks:AnalysisandSynthesis,SudhakarandShyamMohan,TMH	2009
3	ElectronicCommunicationSystemsbyG.Kennedy,McGrawHill,4thEdition	2008
4.	Digital Principles And Applications, Seventh Edition, A. Malvino and D. Leach	2011
5.	Alexander, Charles K., and Sadiku, Matthew N. O., Fundamentals of Electric Circuits, 5th Ed, McGraw Hill	2013
6.	A K.Sawhney-A course in Electrical and Electronic Measurements and Instrumentation	Latest Edition

Course Name	**:**	**Introduction to Manufacturing**
Course Code	**:**	**ES1501 (For Aero, CSE, ECE and Electrical)**
Credits	**:**	**2**
LTP	**:**	**2-0-0**

Course Objectives:

To equip the students with basic understanding and learning of its concepts for conventional and advanced manufacturing processes along-with their applications.

Total no. of lectures: 28

	Syllabus	**Hrs**
(1)	Concept of Manufacturability, Classification of Manufacturing processes -Introduction to Primary Manufacturing processes: Types and applications -Introduction to Secondaryand Tertiary Manufacturing processes: Types and applications.	6
(2)	Concept of Smart, Digital and Sustainable manufacturing processes with applications. Concepts of Industry 4.0 its relevance and Industrial Internet of Things (IIOT).	6
(3)	Introduction to Advanced Manufacturing practices: Classification, Principles and Applications of Electric Discharge Machining (EDM), Laser Beam Machining (LBM), Abrasive Flow Machining (AFM), Chemical and Electro Chemical Machining (ECM), Ultrasonic Machining and Welding etc.	6
(4)	Computer Integrated Manufacturing: Concept of CAD/ CAM. a) Concept of Additive and Subtractive manufacturing processes: Rapid Prototyping & Rapid Manufacturing, Principles, Major technologies used and its applications. b) CNC machines, concepts, uses and applications. c) Industrial Robots, types and applications.	6
(5)	Case studies and practical examples on: a) Manufacturing of small precision parts. b) Manufacturing of ICs & PCB. c) Manufacturing of keyboards and hardware.	4

Course Outcomes:

1	Students would be able to classify and choose manufacturing processes for typical applications.
2	Understand the process, steps and applications of Rapid Prototyping

3	Understand the principles and applications of CNC and Robots in manufacturing.

Course Name	**:**	**Communication Skills & Ethics**
Course Code	**:**	**HS1101 (Common to all branches)**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives :

1. Thecourseaimstoenhancecommunicationskillsandcriticalthinkingskillsofthe studentsto further develop their personality so as to be more effective in personal and professional life.
2. The course further aims to provide basic knowledge in ethics, values, norms and standards
   to establish their importance in life and to enable students to self-assess and enhance their personality.

Total No. of Lectures – 28

Lecture-wise Breakup		**No. of Lectures**
1	**Introduction to Communication Process** Scope, Significance, Types, Levels and Tools of Effective Communication. Verbal, Vocal and Non-Verbal Skills	**(1)**
2	**Critical Thinking Skills** Developing Thinking Skills-Descriptive, Referential, Inferential, Discursive, Analytical, Evaluative, Creative and Lateral Using Texts and Various Media Forms:(Books, Newspaper Articles, Films, Social Visuals)	**(4)**
3	**Speaking Skills** Developing Speaking Skills PACESS-Governed (PACESS-Purpose, Audience, Content, Expression, Structure, Style) for Communication at Various Levels: Interpersonal, Group, Organization and Society	**(3)**
4	**Advanced Technical Writing** Job Application, E-mail, PACESS-Governed Short Essay, Memo, Notice, Agenda, Minutes, IMRD-BasedReport.	**(4)**
5	**Job Preparation** Sensitization to Building Portfolio, Resume, Interview Skills	**(2)**
6	**Introduction to Ethics** Concept, Nature, Scope, Functions and Factors influencing Ethics, Psycho-Social Theories of Moral Development – Kohlberg and Carol Gilligan, Broader Ethical Issues in Society (Research Based)	**(5)**
7	**Ethics and Business** Concept and Objectives of Business Ethics, Factors influencing Business Ethics, 3 C's of Business Ethics, Ethical Dilemmas in	**(3)**

	Business (Role- Play)	
8	**Self-Awareness & Self-Development** Concept of Self Awareness, Self- Esteem, Self-Assessment – SWOT Analysis, Concept of Self-Development, Social Intelligence, Emotional Intelligence, Time and Stress Management, Positive Human Qualities (Empathy, Gratitude, Compassion, Forgiveness and Motivation), Personality Development Models – Johari Window, Myers Briggs Type Indicator Leadership Development	**(6)**

Total No. of Practical Sessions: 14

Practical Session Wise Breakup		No.of Practical Sessions
1	**Organizational Communication** Verbal, Vocal and Non-Verbal Communication at Various Levels, Self- Introduction, Speech, JAM	**(2)**
2	**Applying Critical Thinking Skills** Reading Comprehension, Book Review, Film Review, Social Visuals Interpretation and Critical Analysis .	**(4)**
3	**Speaking Techniques at Different Forums** Group Discussions, Making and Presenting Power Point Presentations	**(4)**
4	**Practice on Technical Writing** Job Application, Email, Memo, Notice, Agenda, Minutes, Report, Short Essay	**(3)**
5	**Towards Job Preparation** Sensitization to Building Portfolio, Resume, Interview	**(1)**

Course Outcomes:

1	The students will gain greater proficiency in English language and its technical aspects for its effective use in personal and professional life.
2	Thestudentswillachievegreaterrefinementofpersonalitythroughawarenessandacquisition of forms and techniques of communication skills.
3	The students will be able to distinguish between right and wrong in both personal and professional life.

Reference Books& E-Material

S.No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	TechnicalCommunication: Principles and Practices, III Edition,Meenakshi Raman and Sangeeta Sharma, OUP, NewDelhi (with E-Material)	2017
2	English for Writing Research Papers, Adrian Wallwork, Springer, London, New York	2011
3	Business Ethics – Text and Cases", Murthy C.S.V., 1st Edition, Pubs: Himalaya Publishing House.	2014
4	"Issues and Ethics in the Helping Professions", Corey G., Corey M.S. and CallananP., 8th Edition, Pubs: Brooks/Cole, Cengage Learning.	2010

Reference Books and E-Materials

1	Business Communication III Edition, RK Madhukar, Vikas Publication House Pvt. Ltd, Noida	2018
2	Body Language, Allan Pease, Sudha Publications Pvt Ltd., New Delhi	2004
3	Techniques of Writing Business Letter, Memos & Reports, Courtland L Bovee, Jaico Publishing House, Mumbai	2005
4	Bridging the Soft Skills Gap, Bruce Tulgan, Wiley, New Delhi	2005
5	A Guide to Gracious Living Etiquette & Life Skills, Jyoti Singh, Mohindra Publishing House	2017
6	TED Talks Videos on Ted.com (Not their Regional versions)	
7	"The Curse of Self: Self-awareness, Egotism and the Quality of Human Life", Leary M.R., 1st Edition, Pubs: Oxford University Press.	2007
8	Business Ethics", Hartman L.P. and Chatterjee A., 3rd Edition, Pubs: Tata McGraw Hill.	2006
9	Positive Human Qualities (web)	https://positivepsychology.com/
10	Theory of Moral Development (web)	https://www.verywellmind.com/kohlbergs-theory-of-moral-development-2795071

Aerospace Engineering UG Course Scheme 2021

List of Department Core course (DCC)

1. Fluid Mechanics
2. Aerodynamics
3. Aerospace Propulsion
4. Gas Turbine Propulsion
5. Aircraft Performance, Stability and Control
6. Solid Mechanics
7. Aerospace Structure
8. Aerospace Systems
9. Aircraft Design

3rd Semester Course Scheme

Sr. No.	Course	Course code	Credits
1	ES-VII/HS-II		3
2	Fluid Mechanics (DCC)	AE1301	4
3	Aerospace Propulsion (DCC)	AE1302	4
4	Solid Mechanics (DCC)	AE1303	4
5	OE-1	---	4
6	Industrial Tour		2

4th Semester Course Scheme

Sr. No.	Course	Course Code	Credits
1	HS-II/ES-VII		3
2	Aircraft Performance, Stability and Control (DCC)	AE1401	4
3	Aerodynamics (DCC)	AE1402	4
4	Aerospace Structures (DCC)	AE1403	4
5	OE-II	----	4
6	Proficiency – I		2

5th Semester Course Scheme

Sr. No.	Course	Course Code	Credits
1	DEC-I		4

2	Gas Turbine Propulsion (DCC)	AE1501	4
3	Aerospace Systems (DCC)	AE1502	4
4	Aircraft Design (DCC)	AE1503	4
5	DEC-II		4
6	Minor Project		3

6th Semester Course Scheme

Sr. No.	**Internship Training (Optional)**
1	Students opting for course work will do Deptt. Elective (4 credits), Open Elective (4 credits) and Project Work (4 credits)

7th Semester Course Scheme

Sr. No.	Course	Course Code	Credits
1	HS-III		3
2	DEC-III		4
3	DEC-IV		4
4	OE-III		4
5	OE-IV		4
6	Major Project-I		2

8th Semester Course Scheme

Sr. No.	Course	Course Code	Credits
1	HS-IV		3
2	DEC-V		4
3	OE-V	---	4
4	OE-VI	----	4
5	Discipline		2
6	Proficiency-II		2
7	Major Project-II		4

List of Department Elective Courses

The detail of domains is as follows:

Domain	Courses	Course code
Aerodynamics	1. Computational Fluid Dynamics 2. Experimental Methods 3. Helicopter Dynamics 4. Viscous flow Theory 5. Advanced aerodynamics 6. Wind Turbines	AE2001 AE2002 AE2003 AE2004 AE2005 AE2006
Aerospace Propulsion	1. Advanced Aerospace Propulsion systems 2. Rocket Propulsion 3. Missile Technology 4. Experimental Methods 5. Computational Fluid Dynamics	AE2007 AE2008 AE2009 AE2002 AE2001
Aerospace Structure	1. Vibrations and Aeroelasticity 2. Dynamics of Aerospace Structures 3. Composite materials 4. Computational methods for structural analysis	AE2010 AE2011 AE2012 AE2013
Miscellaneous (These will not lead to major specialization)	1. Space Dynamics 2. Aircraft Maintenance 3. Avionics 4. Air Transportation and Operations 5. Control Theory in Aerospace 6. Aircraft System Identification	AE2014 AE2015 AE2016 AE2017 AE2018 AE2019

List of Open elective Courses (OEC)
List of open elective courses:

S. No.	Course Name	Course Code	Semester
1	Introduction to Aerospace Engineering	AE6001	Odd
2	Aerodynamics	AE6002	Even
3	Flight Mechanics	AE6003	Even
4	Aircraft Materials And Processes	AE6004	Odd
5	Aircraft Propulsion	AE6005	Odd
6	Introduction to Aerospace Structures	AE6006	Odd

Syllabus: Department Core Courses

Fluid Mechanics

Course Name	Fluid Mechanics
Course Code	AE1301
Credits	4
L T P	3-0-2

Course Objectives:

To enable the students to understand the basic concepts of fluid statics and dynamics, classify different type of flows, carry out dimensional analysis and comprehend various non-dimensional parameters and their physical significance.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Introduction and background:** Fluid Statics, Flow classification: Continuum and free molecular flows, inviscid and viscous flows, incompressible and compressible flows, Newtonian and Non-Newtonian flows, Dimensional analysis, Buckingham Pi Theorem, Flow similarity	5
2	**Fundamental concepts** Gradient of a scalar field, Divergence and Curl of a vector field, Line, Surface and Volume integrals, Control volume and fluid element approach, Total derivation, Streamlines, Pathlines, Streaklines, Timelines, Stream function, Velocity potential, Angular velocity, Vorticity and strain Laplace's equations. Vorticity and circulation, Kutta-Joukowski theorem. Biot-Savart's law and Helmholtz's theorem.	9
3	**Inviscid and Incompressible flow** Integral and differential forms of the equations of conservation of mass, momentum and energy. Derivation of Bernaulli's equation, Euler equation and Navier-Stokes Equation. Incompressible flow in a duct, Condition on velocity for flow incompressibility. Elementary flows: Uniform flows, source flow and Vortex flow. Flow over circular cylinder, Robins-Magnus effect.	10

4	**Compressible Flow** Compressibility, Governing equations for Inviscid and Compressible flow, Compressible flow properties: Total Enthalpy, Total Temperature, Temperature and Pressure ratios as a function of Mach No., Mass Flow Parameter (MFP), Flow regimes, Mach number, Critical Mach number, Drag Divergence Mach number, Shock waves: Normal shock, Oblique shock, Expansion waves.	10
5	**Viscous Flow** Boundary layer definitions and properties, Prandtl's boundary layer equations, Blasius solution, Karman's Integral equation. Laminar flow, Turbulent flow, Laminar and Turbulent boundary layer, skin friction drag, boundary layer control.	8

List of Experiments:

S.No.	Experiments	No. of Turns
1	Measurement of fluid viscosity.	1
2	Measurement of drag on a circular cylinder in high Reynolds number flow.	1
3	To determine boundary layer thickness over a flat plate at various locations.	1
4	Pressure distribution around a circular cylinder in high Reynolds number flow.	1

Course Outcomes**:** At the end of this course, students will be able to:

1	Understand the fundamental concepts of fluid dynamics, flow similarity; define non-dimensional parameters and their significance.
2	Comprehend inviscid and incompressible flow and develop the associated governing equations.
3	Comprehend the compressible flow, its properties and develop the corresponding governing equations.
4	Comprehend viscous flows: the associated definitions and physical flow properties.

Text Books**:**

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Fluid Mechanics", Frank M. White, 7th Ed. McGraw Hill	2011
2	"Fluid Mechanics", P. K. Kundu, I. M. Cohen and David R. Dowling, 6th Ed., Academic Press.	2015

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Fluid Mechanics and Fluid Machines", S.K Som, G. Biswas & S. Chakraborty, 3rd Ed., McGraw Hill Education	2017
2	"Fluid Mechanics: Fundamentals and Applications", Yunus A. Cengel & John M. Cimbala, 3rd Ed., McGraw Hill Education	2017

Aerospace Propulsion

Course Name	Aerospace Propulsion
Course Code	AE1302
Credits	4
L T P	3-1-0

Course Objectives:

This subject introduces the students to the fundamental concepts related to thermodynamics, heat transfer, air-breathing, and non-air breathing engines. It will make students understand the working principle of an aircraft gas turbine engine and rocket propulsion systems.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Introduction to Propulsion** Laws of Physics applied to propulsion, Types of propulsion used in Aircrafts and Spacecraft's. Thermodynamic Review - Processes, Gas laws and Properties: Enthalpy, pressure temperature, entropy. Introduction to heat transfer.	6
2	**Aircraft Piston Engines** Types: S.I and C.I engines,4-stroke and 2-stroke engines, Air standard cycles, valve timing diagrams, Power in a cycle, I.H.P, B.H.P. and S.H.P., Performance - Effect of altitude, Power required and Power available, supercharging., Multi-cylinder configuration, power output from various types of cylinder arrangements in aircraft engines.	6
3	**Propellers** Ideal momentum theory, blade element theory, activity factor, airscrew coefficients, Performance of propellers, selection of propellers, fixed, variable and constant speed propellers.	8
4	**Aircraft Gas Turbine Engines** Simple Turbo-jet Engine, Components of a Gas-turbine engine – Intake, Exhaust, Combustion chambers: simplex and duplex burners, Types of Compressors and turbine, their working, and efficiencies. Equation of Thrust installed and uninstalled thrust, thrust augmentation, Types of Gas turbine engines: Turboprop,	8

	turboshaft, turbofan, and multi shaft gas turbine engines.	
5	**Introduction to Rocket Propulsion** Brief History: Development of German V-2 rocket propulsion, propulsion system of space shuttle, PSLV and GSLV launch vehicles. Propulsion system of Ariane and Saturn launch vehicles. Rocket classification based on Propellants, Thrust, specific impulse, exhaust velocity, energy and efficiency, Tsiolkovsky's rocket equation, multistage rocket, optimizing a multistage rocket, engines, strap-on boosters, thrust reversing & vectoring, Internal ballistics, Thrust control methods, Thermal Management – Rocket motor insulation, Nozzle cooling, throat cooling,	8
6	**Other Propulsion Systems** Introduction to other propulsion systems such as Ram jet, Scramjet, Rocket propulsion, Pulse detonation engine, electric and hybrid propulsion.	4

Course Outcomes**:** On successful completion of this course, students will be able to:

1	Comprehend and describe the fundamental thermodynamic laws
2	Interpret performance of various engines under various parametric conditions
3	Perform the preliminary design of propellers using momentum theory and blade element theory
4	Analyze and explain the fundamentals of the various gas turbine engines
5	Analyze and distinguish the propulsion system in addition to the advanced propulsion system and classify the types of rockets based on the propellant
6	Differentiate between various propulsion systems and their utilization

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint

1	“Elements of Propulsion: Gas Turbines and Rockets”, J. D. Mattingly and K. M. Boyer, AIAA.	2006
2	“Gas Turbine Theory”, Cohen, Rogers and Sarvanmattoo, Pearson.	2017

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	“Thermodynamics: An Engineering Approach”, Y. A. Cengel, Michael A. Boles, McGraw-Hill	2019
2	“Rocket Propulsion Elements”, Sutton, G.P., John Wiley & Sons Inc., New York.	2016.
3	“Aerodynamics for Engineering Students” E. L. Houghton, P.W. Carpenter., Butterworth-Heinemann	2016

Solid Mechanics

Course Name	Solid Mechanics
Course Code	AE1303
Credits	4
L T P	3-0-2

Course Objectives:

To enable the student to understand about the basics of aircraft structural mechanics, structure's behavior and failure under various loads, and its prediction and design based on it. The student should also be able to explain the basic principles of elasticity, theory of failure and instability.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Statically Determinate And Indeterminate Structures** Statically determinate and indeterminate trusses. Truss analysis by method of joints, Truss analysis with single and double redundancy, other structures with single redundancy	8
2	**Elasticity** Concept of displacement, Strain, Stress, Equations of equilibrium. Plane stress, stresses on inclined planes, principal stresses, Mohr's circle. Strain, compatibility equations, plane strain, principal strains. Linear stress-strain relations, strains induced by normal and shear stress. 3-D stress-strain relations - Anisotropic, Orthotropic, isotropic material. Numerical problems, 2- D problems, stress functions.	10
3	**Symmetric And Unsymmetrical Bending Of Beams** Center of gravity and moment of inertia. Shear force and Bending moment. Symmetrical bending, direct stress due to bending, deflection due to bending, approximation for thin walled section, bending stresses in beams of unsymmetrical sections – Bending of symmetric sections with skew load. Torsion of beams: Torsion of Solid and Hollow shaft, Stepped and Composite shaft, Indeterminate Shaft, Shear of open section beams, shear centre, shear of closed section beams, Bredt – Batho	10

	formula,	
4	**Buckling Of Columns And Plates** Buckling load of Euler columns with different end conditions, beam columns, effect of initial imperfections, pure bending of thin plates, plates subjected to distributed transverse loads.	8
5	**Strain Energy And Theory Of Failure** Strain Energy due to axial bending and Torsional loads, Castigliano's theorem, Maximum Stress theory, Maximum Strain Theory, Maximum Shear Stress Theory, Distortion Theory, Maximum Strain energy theory, Application to aircraft Structural problems.	8

List of Experiments:

S. No.	**Experiment**
1	To conduct tensile test on a mild steel specimen and determine - Ultimate strength • Young's Modules. • Ultimate stress • Breaking stress • Percentage reduction in area. • Percentage elongation.
2	To find the Modulus of Rigidity of the given test specimen.
3	To find direct strain in a simply supported beam carrying a point load at a distance 'a' from left support by strain gauge
4	To find direct strain in a cantilever carrying a concentrated load at mid span by strain gauge
5	Determination of flexural stress and strain of a simply supported beam
6	To prove Maxwell Reciprocal theorem for a cantilever beam
7	To prove Maxwell Reciprocal theorem for a simply supported beam

Course Outcomes**:** At the end of this course, students will be able to:

1	Do the stress analysis of statically determinate and indeterminate structures.

2	Understand the concept of tensor and the basic principles of elasticity.
3	Analyze various geometric properties of sections; know the concept of the shear force (SF) and bending moment (BM) for different types of beams with various load conditions. Use the appropriate method to determine the slope and displacement of beam deflection for different beam sections.
4	Describe and calculate elastic buckling characteristics of columns and plates. Design of supporting structures like struts, column and plates is also an outcome of the course.
5	Analyze the maximum stresses produced in the body and apply various failure theories to predict the failure loads.

Text Books:

S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	"Aircraft Structures for Engineering Students", T.H.G.Megson ,4th Ed., Elsevier Ltd.	2012
2	"Structural stability of Columns and Plates", N G R Iyengar, John Wiley & sons	1988

Reference Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Mechanics of aircraft structures: C.T.Sun, 3rd Ed , John Wiley publishers	1998
2	Strength of Materials by Dr. Sadhu Singh, Khanna Publishers 11th edition.	2015
3	R. K. Bansal, *A textbook of strength of materials :(in SI units)*. Laxmi Publications.	2010
4	Aircraft Structures: lalit Gupta & Dr. O.P. Sharma. , Himalayan Books	2005

Aircraft Performance, Stability and Control

Course Name	Aircraft Performance, Stability and Control
Course Code	AE1401
Credits	4
L T P	3-1-0

Course Objectives:

To enable the student to understand, describe and apply the concepts related to aircraft performance (steady & accelerated) and aircraft stability & control (longitudinal, lateral & directional) and estimate the performance, stability & control characteristics of various types of aircrafts.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Aircraft Performance In Steady Flight** Equations of motion for straight & level flight, Minimum drag conditions, Minimum power conditions, Gliding flight, Shallow & steep angles of glide, Sinking speed, Minimum sinking speed, Time of descent, Climbing flight at shallow angles, Correction for steep angles, Time to flight, Maximum rate of climb, Energy climb, Range and endurance, Numerical problems.	7
2	**Aircraft Performance In Accelerated Flight** Level turns, Pull-up & pull-down maneuvers, Flight envelope, Take-off performance, Calculation of take-off ground run and take off distances, Landing performance, Calculation of landing ground run and landing distances.	5
3	**Static Longitudinal Stability (Stick Fixed & Stick Free)** Introduction to stability, Criterion for static stability of an aircraft, Contribution of different parts to static longitudinal stability of aircraft, Power effects, Neutral point (stick fixed), In flight measurement of stick fixed neutral point, Control surface hinge moments characteristics, Effect of free elevator on airplane stability, Elevator control power, Stick force gradients, Neutral point (stick free), In flight measurement of stick free neutral point, Static margin, Center of gravity range limits.	10

4	**Maneuvering Stability** Effect of acceleration on airplane stability, Elevator angle per g, Stick force per g, Maneuver point (stick fixed & free). In flight measurement of maneuver points (stick fixed & stick free), Maneuver margins.	5
5	**Lateral And Directional Stability & Controls** Asymmetric flight, Weather cock stability, Contribution of different parts of Aircraft, Adverse yaw, Frise Aileron, Spoiler Controls. Rudder Fixed and Rudder free static directional stability, Rudder control power, Rudder lock. Dihedral Effect. Contribution of different parts of aircraft, Aileron control power.	8
6	**Dynamic Stability** Introduction to dynamics, Spring-mass system. Equations of motion, Stability & control derivatives, Longitudinal dynamic stability, Lateral and Directional dynamic stability, Cross coupling of lateral and directional effects, Analysis of different stability modes.	7

Course Outcomes**:** At the end of this course, students will be able to:

1	Estimate and analyze aircraft performance during steady and level flight.
2	Estimate and analyze aircraft performance during accelerated flight.
3	Analyze static longitudinal stability of an aircraft.
4	Comprehend maneuvering stability of an aircraft
5	Understand lateral and directional stability and controls of an aircraft.
6	Estimate and analyze dynamic stability (longitudinal and lateral-direction) of an aircraft.

Text Books:

S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	"Aircraft Performance and Design", J. D. Anderson Jr., McGraw – Hill Education	2010
2	"Flight Stability and Automatic Control", R. C. Nelson, 2nd edition, McGraw – Hill	2017
3	Airplane Performance Stability and Control", C. D. Perkins & R. E. Hage, John Wiley	1949

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication / Reprint
1	"Introduction to Flight", J. D. Anderson Jr., 8th edition, McGraw – Hill Education	2015
2	"Dynamics of Flight", Bernard Etkin, John Wiley & Sons, 3rd edition	1995

Aerodynamics

Course Name	Aerodynamics
Course Code	AE1402
Credits	4
L T P	3-0-2

Course Objectives:

To help the students understand the basic concepts of flow over airfoils, finite wings and flow across shocks and through nozzles and instruments to measure forces and moments.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Flow over Airfoils** Airfoils: Center of pressure, Airfoil Characteristics, center of pressure, aerodynamic center, Aerodynamic forces, moments and coefficients, coefficient of pressure, Classical thin airfoil theory	4
2	**Flow over finite wings** Vortex system, Downwash & induced drag, Prandtl's classical lifting line theory. Elliptic and general lift distribution over finite unswept wings, effect of aspect ratio, Lifting Surface theory, Formation Flying, Ground effect. Drag reduction by variable twist, variable camber wings, Laminar flow control, and winglets. Delta wing: Polhamus theory, leading edge suction analogy, calculations of lift coefficient, flow field, aspect ratio effect, leading edge extension	10
3	**Shock Waves and Expansion Waves** Point source in a compressible flow, Mach waves and shock waves. Normal Shock wave equation of motion, relations for a perfect gas, stagnation conditions, Rankine–Hugoniot relations. Oblique shock relations, M-θ-β relations, supersonic flow over wedge and cone, weak oblique shock, supersonic compression, Supersonic expansion by turning, Prandtl-Meyer flow. Method of characteristics, Shock wave–Boundary Layer interaction, Shock–Expansion theory, flow field in supersonic flows, analytical determination of lift and drag coefficients on: flat plate, bi-convex, diamond shaped sections, supersonic leading and trailing edges.	12

4	**Compressible Flow Through Nozzles** Governing equations, Nozzle flows, Diffuser flow, Shock wave – Boundary Layer interaction inside nozzles. Isentropic Area ratio (A/A*), Velocity-Area variations, Rayleigh Pitot tube formula, Effect of friction and heat transfer on flow in constant area duct.	8
5	**Introduction to Experimental Methods** Types of experimental facilities, Types of wind tunnels: Subsonic, Transonic, supersonic wind tunnels, shock tube. Flow measurement instruments: Wind tunnel balances, measurement of forces and moments, measurement of profile drag by pitot traverse of wake, shadowgraph system, Schlieren system, interferometer, Hot wire Anemometer	8

List of Experiments:

S. No.	Experiment	No. of Turns
1	Flow visualization on symmetrical airfoil at various angles of attack	1
2	Flow visualization on flapped airfoil at various angles of attack	1
3	Flow visualization on cambered airfoil at various angles of attack	1
4	Flow visualization on delta wing at various angles of attack.	1
5	To find airspeed in the low speed wind tunnel	1
6	To find pressure coefficient distribution on symmetrical airfoil	1
7	To find pressure coefficient distribution on cambered airfoil	1
8	To determine pressure distribution over a flat plate	1

Course Outcomes: At the end of this course, students will be able to

1	The students will be able to calculate aerodynamics coefficients, moment and forces for flow over airfoils.
2	The students will be able to solve flow over finite wings, estimate the lift generated and design efficient wings for aircrafts.
3	The students will be able to estimate flow properties across shocks and expansion waves and calculate lift in supersonic flows.
4	The students will be able to design efficient nozzles for aircrafts.
5	The students will have knowledge of various experimental instruments and will be able to use them to calculate forces and moments.

Text Books:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication / Reprint
1	"Fundamentals of Aerodynamics", John D.Anderson (Jr.) 5th Ed., McGraw Hill Education (I) Pvt. Ltd.	2013
2	"Aerodynamics for Engineering Students",	1996

	E.L.Houghton and P.W.Carpenter, 4th Ed., CBS Publishers , India	

Reference Books:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication / Reprint
1	"Aerodynamics for Engineers", J. J. Bertin, and R. M. Cummings, 6th Ed., Pearson Education.	2014
2	"Aerodynamics", L. J. Clancy, 1st Ed., Shroff Pubs & Dists Pvt. Ltd.	2006
3	"Theoretical and Computational Aerodynamics". T. K. Sengupta, 1st Ed., Wiley	2014

Aerospace Structures

Course Name	Aerospace Structures
Course Code	AE1403
Credits	4
L T P	3-0-2

Course Objectives:

To equip the student with the knowledge about the mechanics of different aircraft structural members, and their design and analysis. The student should also be able to know the basic concepts of the advanced material utilized in the aerospace structures.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Introduction To Aircraft Structure And Materials** Aerospace Materials, Composite materials: Classifications and characteristics of composite materials, Types of Fibres, Matrix materials, Sandwich and Laminate Composite. Basic structural elements in aircraft structures, wing and fuselage, aircraft materials. Airworthiness, Factor of safety, Flight envelope. Airframe loads: Inertial loads, Maneuver loads, Gust loads, Fatigue: Fail safe and safe life	10
2	**Thin-walled Beams** Bending of open and closed thin walled beams, Shear of beams, Torsion of beams, Combined open and closed section of beams, Structural idealization. Single and multi – cell structures, Approximate methods, Shear flow in single & multi-cell structures under torsion.	10
3	**Design and analysis of Aircraft Wings** Wing spars and box beams, tapered wing spars, open and closed section beams, wings with variable stringer area, Three boom shell, Bending torsion, shear center, tapered wings, Deflections, Cut-outs	10

4	**Design and analysis of Fuselage** Bending, shear, torsion, cut-outs in fuselage, Principles of stiffener web construction, Fuselage frames, wing ribs, Fuselage detail design, Wing fuselage interaction, Landing gears, Engine mounts	6
5	**Introduction to Aeroelasticity** Static and dynamic aero elastic phenomenon, Critical speeds, Divergence of 2-D wing section and an idealized cantilever wing, Loss and reversal of aileron control, flutter and buffeting.	6

List of Experiments

S. No.	Experiment
1	To find shear centre of channel section
2	To find shear centre of Z section
3	Stress analysis of a truss by using software
4	Stress analysis of a beam by using software
5	Stress analysis of a bar by using software
6	Stress analysis of a tapered wing by using software

Course Outcomes**:** At the end of this course, students will be able to:

1	Have an understanding of aerospace materials along with the skills to analyze the basic elements of aircraft structures, and to calculate loads acting on the aircraft.
2	Apply the concept of structural idealization for stress analysis of open and closed section beams, and understand the concept of shear flow in cell-structures.
3	Do stress analysis of aircraft wing including the tapered wing and wings with variable stringer area.
4	Evaluate stresses in various aircraft components like fuselage, wing ribs, etc., and understand the wing-fuselage interaction and fuselage detailed design.

5	Understand the basic concept of static and dynamic aeroelasticity including the flutter and buffeting.

Text Books

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Mechanics of aircraft structures: C.T.Sun, 3rd Ed , John Wiley publishers	1998
2	"Aircraft Structures for Engineering Students": T.H.G.Megson ,4th Ed. Elsevier Ltd.	2012

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Aircraft structures" : D.J.Peery, McGraw Hill	1950
2	Aeroelasticity:R.L.Bisplinghoff Holt Ashley R.L.Halfman, Addison Wesley Publishing Co. Reading, Mass.	1965

Gas Turbine Propulsion

Course Name	Gas Turbine Propulsion
Course Code	AE1501
Credits	4
L T P	3-0-2

Course Objectives:

This subject will help the student understand the working principle of various components of a gas turbine engine. It will help students become familiar with the basic concepts used in gas turbine engine designing. It also emphasizes on the analysis of different thermodynamic processes using the Brayton cycle. In addition to this, the student would learn how various conditions and design limitations affect the gas turbine engine performance.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**GT Cycle Analysis** Air standard Brayton cycle, Actual gas turbine engine cycle – component efficiencies, Cycle analysis – single spool, Multi-spool, With Afterburner, with free-turbine.	6
2	**Inlets and Nozzles** Subsonic Inlets and nozzle operation under design & Off-design conditions, efficiency & its variation, Review of Supersonic flows, Supersonic Inlets and Nozzle operation, nozzle coefficients, nozzle performance.	6
3	**Compressors** Turbomachinery - Principal of operation, Euler's turbomachinery equation, Total temperature ratio, Total Pressure ratio. Centrifugal Compressor: Velocity Diagram, Work done, Pressure rise, Diffuser and compressor characteristics, numerical problems. Design characteristics. Axial Flow Compressor: Velocity diagrams, Work done, degree of reaction, axial flow compressor coefficients – Flow Coefficient, Loading Coefficient, stage pressure ratio, repeating stage-repeating row-mean line design, performance and design.	12

4	**Axial Flow Turbine** Principal of operation, velocity diagrams, mean radius stage calculations, stage parameters, loading and flow coefficients, degree of reaction, axial flow turbine stage analysis, performance and design. Prediction of Performance of Gas Turbines: Component characteristics, turbine - compressor matching, off-design operation of single shaft gas turbine, free turbine and jet engine. Method of displacing equilibrium running line.	12
5	**Combustion Systems** Operational requirements, types of combustion systems, Input from externals required, design aspects of combustion chamber, combustion process, combustion chamber performance, Practical problems.	6

List of Experiments

Sr. No.	Experiment	No. of turns
1	Study of the basic gas turbine working	2
2	Study the working of Axial flow compressor	1
3	Study the working of centrifugal compressor	1
4	Find the energy balance equation with CCU.	3
5	Analyze the solid rocket propellant properties with actual firing.	2
6	Study the combustion chamber process and working of combustion tubes	2
7	Study the different types of engines used in the aerospace field.	2

Course Outcomes: After the course completion, the students will be able to

1	Analyze and explain the basic fundamentals of the various gas turbine cycles
2	Discuss the efficiency of various types of inlets and nozzles under design and off-design conditions
3	Comprehend the types of compressors and evaluate their performance and design characteristics

4	Determine the off-design behavior of turbine and relate it to changes in the velocity diagrams
5	The ability to analyze the combustion stability in practical combustion devices

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Elements of Propulsion: Gas Turbines and Rockets", J. D. Mattingly and K. M. Boyer, AIAA.	2006
2	"Gas Turbine Theory", Cohen, Rogers and Sarvanmattoo, Pearson.	2017

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Mechanics and Thermodynamics of Propulsion" Philip G. Hill, Carl R Peterson, Pearson.	1999
2	"Aircraft Engine Design" Jack D. Mattingly, AIAA.	2003
3	"Modern Compressible Flow" John D. Anderson, McGraw-Hill	2003

Aerospace Systems

Course Name	Aerospace Systems
Course Code	AE1502
Credits	4
L T P	3-1-0

Course Objectives:

The course allows the student to comprehend the role of different aerospace systems such as engine control systems, hydraulic systems, and flight control systems. This course helps students learn the construction and functioning of gyroscopic and navigational instruments used in an aircraft.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Aircraft Systems** Power-plant, undercarriage, hydraulic system, fuel system, environment systems, pressurization system, air-conditioning system, Oxygen system, Fire protection system, Ice protection system, Rain-removal system, Auxiliary power unit	10
2	**Flight Control Systems** Mechanical and hydraulic flight control systems. Fly by wire system, Flight control system of Helicopter. Automatic flight control system: Longitudinal, Lateral & Direction Autopilot, Flight Computers	8
3	**Display Systems** Comparison of earlier flight deck (Electromechanical type instruments) to modern flight deck (glass fight deck), Cathode Ray Tube (CRT), Active Matrix Liquid Crystal Display (AMLCD), Head Down Display (HDD), Head Up Display (HUD),Helmet Mounted Display (HMD), Integrated Standby Instrument System (ISIS)	10
4	**Communication systems** HF, U/VHF, Satellite Communication , Air Traffic Control (ATC) Transponder, Traffic Collision & Avoidance System (TCAS), Identification Of Friend & Foe (IFF)	6
5	**Navigation Systems** Automatic Direction Finding, Very High Frequency Omni-Range (VOR), Distance Measuring Equipment (DME), Tactical Air Navigation (TACAN), VORTAC (VOR+TACAN), Satellite Navigation System-Global Positioning System (GPS), Differential GPS, Instrument Landing System (ILS), Transponder Landing System (TLS), Microwave Landing System (MLS),	8

	Astronavigation.	

Course Outcomes**:** At the end of this course, students will be able to:

1	Identify and explain the functioning of various aircraft systems and sub systems
2	Understand and describe the functioning of Fly by wire system and various autopilot systems to facilitate comfortable and hands-off flight.
3	Explain the working principle of display systems and list out the types of display systems.
4	Describe the functioning of various communication systems.
5	Comprehend various navigation systems and describe their functioning to facilitate the navigation between the pilot, aircraft, and ATC.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Aircraft Instrumentation and Systems", S. Nagabhushana , L. K. Sudha, Ist edition IK Books.	2010
2	"Introduction to Avionics Systems", R. P. G. Collison., Springer Netherlands.	2011

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Aircraft Electricity and Electronics", Thomas K. Eismin, McGraw Hill.	2013
2	"Aircraft Instruments and Integrated Systems", E.H.J. Pallett, Longman	1992

Aircraft Design

Course Name	Aircraft Design
Course Code	AE1503
Credits	4
L T P	3-1-0

Course Objectives:

The course enables the student to understand the aircraft design methodology. It also enhances the basic concepts related to airplane design, such as aircraft weight calculation, mission fuel weight, propulsion system selection, wind design considerations, etc.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Design Concepts** Aircraft design: three phases of design, Requirements and specifications, Classifications of aircraft, Special purpose airplanes, Types of civil & military aircrafts, UAVs, Control configured vehicles, Unique aircraft concepts.	8
2	**Gross Weight Estimation** Estimation of weight of an aircraft based on type, mission, wing loading, aerodynamic efficiency, propulsion system and material, Iterative approach, Trends in wing loading and thrust loading, take-off & landing distance.	9
3	**Airframe, Wing And Fuselage Design Considerations** Airfoil & wing geometry selection, Estimation of fixed & control surface geometry, Estimation of fuselage geometry, Structural layout of straight, tapered & swept (forward & aft) wings, Cockpit & passenger cabin layout, Wing-fuselage joining methods, Configuration layout and Lofting, Preparation of 3-views.	9
4	**Undercarriage And Power Plant Integration** Undercarriage: types, retraction mechanisms, Requirement of undercarriage, Different arrangements, Absorption of landing loads, Calculations of loads, Types of propulsion system, Rubber engine & fixed engine sizing, Various geometric locations of power plants, Types & location for inlets, Variable geometry inlets.	8
5	**Operational And Environmental Issues** Classical methods of estimating symmetrical maneuvering loads on a wing in flight, Basic flight loading conditions, Span wise air loads variation, V-n diagram, Gust envelope, Payload-range	8

	diagram, Noise & emission levels, Airworthiness, Crashworthiness.	

Course Outcomes**:** At the end of this course, students will be able to:

1	Analyze and assess different types of aircraft. Also, comprehend the total design cycle of an aircraft including conceptual, preliminary and detail design.
2	Estimate the total weight and weight fractures of an aircraft and optimize the design parameters to get the optimum weight using an iterative approach.
3	Understand the layout design of the aircraft, followed by selecting the wing and fuselage geometry.
4	Describe the concepts related to undercarriage mechanisms and their load calculations.
5	Appreciate environmental issues associated with the area of Aeronautics, such as energy conservation, pollution etc.

Text Books

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	“Aircraft Design: A Conceptual Approach”, D. P. Raymer, AIAA.	2018
2	“Aircraft Performance and Design”, J. D. Anderson Jr., TATA McGRAW-HILL	2010

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	“Airplane Design Airplane Design Part V: Component Weight Estimation” Jon Roskam., DAR Corporation	2013
2	“The Design of the Airplane”, D. Stinton, Bsp Professional Books	1989

Syllabus: Department Elective Courses

Aerodynamics Domain DEC

1. Computational Fluid Dynamics
2. Experimental Aerodynamics
3. Helicopter Dynamics
4. Viscous flow Theory
5. Advanced aerodynamics
6. Wind Turbines

Computational Fluid Dynamics

Course Name	:	Computational Fluid Dynamics
Course Code	:	AE2001
Credits	:	4
L T P	:	3-0-2

Course Objectives:

To help the students understand the concepts, to be able to solve and apply various types of equations for the analysis of the flow, generate various types of grid and use panel method for solving flow problems.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Types Of Equations And Finite Difference Techniques** Classification of partial differential equations, Linear/Nonlinear partial differential equations, Elliptic, parabolic, hyperbolic partial differential equations, System of first order partial differential equations, Initial and Boundary Conditions. Finite difference approximations, Discretization using Taylor series, Discretization using Orthogonal Polynomials, Truncation error estimates, finite volume method	10
2	**Methods For Parabolic Equations** Parabolic partial differential equation, Finite difference formulation, Explicit and Implicit methods, Von Neumann stability analysis, Consistence analysis, Solution of tridiagonal systems	8

3	**Hyperbolic Equations And Panel Method** Solution of hyperbolic equations- Burgers equation, Two and three-dimensional panels, Panel singularities, Panel method for Two dimensional non-lifting bodies, Two and three-dimensional source panels, Two-dimensional vortex lattice and Vorticity panel methods, Panel method for compressible subsonic and supersonic flows, Time-split methods,	8
4	**Methods For Elliptic Equations** Elliptic partial differential equation, Finite difference Discretization, Iterative schemes (Point Jacobi, Gauss Seidel, SOR, SLOR) Applications to literalized subsonic potential flow	8
5	**Grid Generation Techniques** Structured and Unstructured grids, Boundary fitted grids, Elliptic grid, generation, Algebraic grid generation, Working problem based on two methods	8

List of Experiments:

S. No	Experiments	No. of turns
1	Point relaxation method for Laplace equation for the flow over airfoil	2
2	Successive Line Relaxation for the Laplace equation over airfoil	2
3	Structural grid generation over NACA 0012	2
4	Relaxation method for subsonic full potential equation for flow over airfoil with zero angle of attack	2
5	Lifting subsonic incompressible potential flow over airfoil	2
6	Two dimensional Panel method for subsonic incompressible flow over NACA 0012	2
7	Zoukowski transformation for subsonic incompressible flows	1

Course Outcomes: By the end of this course, the student will be able to:

1	Classify different types of partial differential equations (PDEs), boundary conditions, finite difference approximations, discretization methods, estimate errors and basic understanding of finite volume method.
2	Solve parabolic differential equations by implicit and explicit methods and carry out stability analysis of PDEs.
3	Solve hyperbolic equations and various two dimensional and three dimensional flow problems using panel methods.
4	Solve elliptic equations by various iterative methods using finite difference approximations.

5	Generate various type of grids based on the problem.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"High Accuracy Computing Methods, Fluid Flows and Wave Phenomena" Tapan K. Sengupta, 1st Ed., Cambridge University Press	2013
2	"Computational Fluid Dynamics The Basics with Applications", John D. Anderson Jr., 1st Ed., McGraw Hill Education India	2017

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Fundamentals of Computational Fluid Dynamics", Tapan K. Sengupta, 1st Ed., Universities Press	2004
2	"Computational Aerodynamics and Aeroacoustics", T. K. Sengupta and Y. G. Bhumkar, 1st Ed., Springer	2020
3	"Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics", C. Hirch, Volume-2, 2nd Ed., Butterworth-Heinemann	2007

Experimental Methods

Course Name	:	Experimental Methods
Course Code	:	AE2002
Credits	:	4
L T P	:	3-1-0

Course Objectives:

This subject enables the students to understand the numerous experimental techniques corresponding to various flow fields. This course helps students learn about the sensors and their measurement methodology. This will provide an understanding of getting a digital output using Data Acquisition and wind tunnel modeling.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Introduction** Introduction to aerodynamic test facilities in various Mach number regimes: low speed, transonic, supersonic, hypersonic, and high enthalpy, wind tunnel calibration, Measurements techniques in wind tunnels: forces and moments, pressure, velocity, temperature, aero-acoustic measurements.	8
2	**Flow Visualization Techniques** Low speed flow visualization techniques, Schlieren, shadowgraph, interferometry, introduction to laser diagnostic techniques.	8
3	**Measurements** Measurement of temperature using thermocouples, resistance thermometers, temperature sensitive paints and liquid crystals, Steady and unsteady pressure measurements and various types of pressure probes and transducers, errors in pressure measurements, thermocouples, thermography, velocity measurement using hot wire anemometry , Laser Doppler Velocimetry and Particle Image Velocimetry	10

4	**Data Acquisition** Data acquisition and digital signal processing techniques, wind tunnel data acquisition, measurement of steady and unsteady pressure, velocity, temperature, turbulence intensity, calibration of force, pressure and acoustic sensors. Virtual instrumentation, Calibration of single and two wire probes.	10
5	**Wind Tunnel Modeling** Skin friction, forces and moments – Model design and fabrication force measurement techniques. Introduction to dynamic testing	6

Course Outcomes: By the end of this course, the student will be able to:

1	Understand the test facilities corresponding to various flow fields ranging from subsonic to supersonic Mach numbers.
2	Demonstrate and analyze the various visualization techniques from subsonic to supersonic flow-field.
3	Acquire knowledge of various probes and transducers, their uses and measurement.
4	Analyze and interpret the experimental data using various softwares.
5	Able to design experiments required for any particular problem in aerodynamics.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Wind Tunnels: Aerodynamics, Models & Experiments", Justin D. Pereira., Nova science Pub. Inc.	2010
2	"Instrumentation, Measurements, and Experiments in Fluids", E. Rathakrishnan, CRC Press.	2007

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Low Speed Wind Tunnel Testing", W. E. Rae and A. Pope., John Wiley	1999
2	"High Speed Wind Tunnel Testing", K. L. Goin, and A. Pope., KrieZKR.	1978

Helicopter Dynamics (DEC)

Course Name	Helicopter Dynamics
Course Code	AE2003
Credits	4
L T P	3-1-0

Course Objectives:

To help the students understand the concepts and estimate the performance and stability aspects of helicopters, analyze the vibrations of blade and helicopters under various dynamic conditions.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Introduction and Basic Concepts** Historical development of helicopter and overview, Classification based on main rotor configuration and tail rotor configuration. Comparative analysis, Major components of conventional helicopter, Composite structure. Rigid, semi-rigid and articulated rotors, Feathering, flapping and lead-lag motion, Rigid, Semi-rigid and articulated helicopter control system, Collective and cyclic pitch control, Yaw control, Throttle control, Anti-torque control, Solidity, Tip-speed ratio, In-flow ratio, Figure of merit.	14
2	**Aerodynamics Of Main Rotor** Coning of rotor, Dissymmetry of lift, Precession, Coriolis effect, Compressibility effects, Retreating blade stall, Reverse flow region, Flapping, feathering and lead-lag motion, Autorotation, Schrenk's diagram, Various types of autorotative landings.	7
3	**Performance During Hovering And Vertical** The actuator-disc theory, Working states of rotor, Optimum rotor, Efficiency of rotor, Ground effect on lifting rotor, The effect of finite number of blades, Induced velocity and induced power, Total power.	7

4	**Performance During Forward Flight** Blade forces and motion in forward flight, Force, torque and flapping coefficient, Induced velocity and induced power in forward flight – Mangler and Squire method, Flight and wind tunnel test, The vortex wake, Aerofoil characteristics in forward flight, Helicopter trim analysis, Performance in forward flight.	7
5	**Dynamic Stability And Vibrations** Longitudinal and lateral stability, Equations of motion, Stability characteristics, Auto stabilization, Control response. Sources of vibration, Active and passive methods for vibration control, Fuselage response, Measurement of vibration in flight.	7

Course Outcomes: By the end of this course, the student will be able to:

1	Understand the basic concepts and phenomena involved in helicopter engineering and dynamics.
2	Estimate the power requirement for various flight conditions such as hovering, climbing, forward flights etc. and understand the aerodynamics of the main rotor.
3	Estimate various performance parameters during hovering and vertical flight.
4	Estimate different performance parameters during forward flight.
5	Analyze stability and vibration levels in blades and helicopters under various conditions.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Helicopter Dynamics", A.R.S. Bramwell, G. Done and D. Balmford, 2nd Ed., Butterworth Heinemann.	2001
2	"Principles of Helicopter Engineering", Jacob Shapiro, 1st Ed., McGraw Hill.	1955
3	"Fundamentals of Helicopter Dynamics", C. Venkatesan, 1st Ed., CRC Press.	2017

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Helicopter Aerodynamics", E. Rathakrishnan, 1st Ed., PHI Learning	2018
2	"Helicopter Flight Dynamics", Gareth D Padfield, 3rd Ed., Wiley India Pvt. Ltd.	2018

Viscous Flow Theory

Course Name	Viscous Flow
Course Code	AE2004
Credits	4
L T P	3-1-0

Course Objectives:

To enable the students to understand the characteristics of viscous flows, the Navier-Stokes equations and its properties and determine laminar and turbulent boundary layer thickness over flat plate and in pipes.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Viscous Flow Properties** Viscous fluid flow with historical outlines of viscous flow, Boundary conditions for viscous flow problems, Development of boundary layer- Prandtl's hypothesis, Estimation of boundary layer thickness- Displacement thickness, momentum and energy thickness for two-dimensional flows. Viscosity and thermal conductivity, thermodynamic properties	8
2	**Slow Viscous Flow** Introduction, Stokes Flows, Two – Dimensional Flows, Three – dimensional Stokes Flows, analysis of Stokes's Solution, The Oseen Equations, Three- Dimensional Oseen Flows, Hele Shaw flow, Problems	8
3	**Navier-stokes Equations And Solution** General stress system in a deformable body, the rate at which the fluid element is strained in a flow, Relation between stress and rate of deformation, Stoke's hypothesis, bulk viscosity and thermodynamic properties, The Navier – Stokes Equation (N-S) , General properties of Navier – Stokes Equation. Two dimensional flow through a straight channel. Hagen-Poiseuille flow, Suddenly accelerated plane wall, Stagnation in plane flow (Hiemenz problem), Flow near a rotating disk, Very slow motion, Parallel flow past a sphere.	10

4	**Laminar Boundary Layer** Analysis of Boundary layer temperature profiles for constant wall temperature, Falkner-Skan Wedge flows, Free shear flows- plane laminar jet, plane laminar wake. Integral equation of Boundary layer, Karman-Pohlhausen method. Thermal boundary layer calculations- One parameter (U_o) and two parameters (U_0 and ΔT) integral methods. Stability of laminar flows	8
5	**Turbulent Boundary Layer** Two dimensional turbulent boundary layer equations, Integral relations, Eddy-Viscosity theories, Velocity profiles; The law of the wall, The law of the wake. Turbulent flow in pipes and channels. Turbulent boundary layer on a flat pate, Boundary layers with pressure gradient	8

Course Outcomes: By the end of this course, the student will be able to:

1	Calculate the boundary layer thickness, displacement thickness, momentum and energy thickness for two dimensional flows.
2	Solve and analyze various two and three dimensional flow problems.
3	Analyze the Navier-Stokes Equation and its properties for various two dimensional flow problems.
4	To understand the concept of laminar boundary layer and analyze the stability of laminar flows.
5	To understand the concept of turbulent boundary layer and determine the turbulent boundary layer thickness in pipes and flat plate.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Boundary Layer Analysis", Joseph A. Schetz, 2nd Ed., Prentice Hall.	1993
2	"Boundary Layer theory", H. Schlichting, 6th Ed., McGraw Hill.	1968

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Aerodynamics for Engineers", John Bertin, 4th Ed., Pearson.	2004
2	"Viscous Fluid Flow", Frank M White, 3rd Ed., McGraw Hill.	2006
3	Turbulent Flow in Engineering, A. J. Reynolds, 1st Ed., Wiley–Blackwell.	1974

Advanced Aerodynamics

Course Name	Advanced Aerodynamics
Course Code	AE2005
Credits	4
L T P	3-1-0

Course Objectives:

Aims at enabling the student to analyze supersonic flows using different techniques, calculate boundary layer thickness in compressible flows and analyze supersonic and hypersonic configurations.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Non Linear Supersonic Flows** Numerical techniques, method of characteristics, supersonic nozzle design, finite difference method, time dependent technique for supersonic blunt bodies, numerical problems.	6
2	**Laminar And Turbulent Boundary Layer:** Laminar :Compressible flow over a flat plate, reference temperature method, stagnation point aerodynamic heating, boundary layer over arbitrary bodies using finite difference method, Turbulent: reference temperature method for flat plate, Meador-Smart reference temperature method, prediction of airfoil drag ,turbulence modeling, numerical problems	8
3	**Flow With Small Perturbations** One dimensional wave equation, D' Alembert's solution,2-D Subsonic and supersonic flow past a wavy wall, method of characteristics to unsteady 1-D homentropic flow, uniform flow regions, simple wave regions and non-simple wave regions, simple compression and expansion waves.	8
4	**Bodies Of Revolution** Introduction, cylindrical coordinates, axially symmetric flow, subsonic flow, supersonic flow, solution for cone, and slender cone, yawed body of revolution in supersonic flow, cross flow solutions for slender body of revolution, lift of slender body of revolution, Rayleigh formula	8

5	**Supersonic Airplane Configurations And Hypersonic Flow** Governing equations and boundary conditions, consequences of linearity, conical flow method for rectangular, swept, delta and arrow wings, singularity distribution method, design consideration for supersonic aircraft, aerodynamic interaction, supersonic analysis for complete configurations. Qualitative aspects, Newtonian theory, lift and drag of wings at hypersonic speeds, hypersonic shock wave relations, Mach no. independence, hypersonic and CFD, high L/D hypersonic configurations, Aerodynamic heating, ground test data and flight test data	12

Course Outcomes: By the end of this course, the student will be able to:

1	Implement advanced techniques for analysis of supersonic flow over aerodynamic bodies.
2	Analyze laminar and turbulent compressible flow over arbitrary bodies and predict drag.
3	Solve one dimensional wave equation, 2D subsonic and supersonic flow past wavy wall and analyze simple compression and expansion waves.
4	Analyze and calculate lift over bodies of revolution.
5	Design and analyze supersonic and hypersonic aircraft configurations

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Fundamentals of Aerodynamics", John D.Anderson, 5th Ed., McGraw Hill	2013
2	"Elements of Gas dynamics", H. W. Liepmann, and A. Roshko, 1st Ed., Dover Publications Inc.	2002
3	"Modern Compressible Flow with Historical Perspective, J. D. Anderson", 3rd Ed., McGraw-Hill	2004

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
2	"Aerodynamics for Engineers", John J. Bertin, 4th Ed, Pearson.	2011
5	"Gas Dynamics", Vol I , M. J. Zucrow and J. D. Hoffman, 1st Ed., Wiley	1976

Wind Turbines

Course Name	Wind Turbines
Course Code	AE2006
Credits	4
L T P	3-1-0

Course Objectives:

To acquaint students with working principles, analysis, design and applications of wind turbines and its parts.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Introduction And Classification Of Wind Turbines** History of wind power technology, wind resources, economic viability, experience in Europe and America, The Indian experience, factors in favor of wind energy, environmental effects. Types of wind energy collectors: horizontal axis rotors; Head on, fixed pitch and variable pitch blade rotors, cross wind. Vertical axis rotors; Savonius type and its variants, Darrieus type .lift based devices and drag devices.	10
2	**Design Features** Description of various types of wind energy conversion systems (WECS) in use through their design features from 1kW range onwards. Considerations of complexities getting into the design and operation with increase in size and power output.	8
3	**Applications And Characteristics Of Wind Turbines** Standalone system; water pumping, direct heating and electric generation applications. Wind energy farms; Grid connected mode, hybrid mode. Wind histories, wind characteristics, power in wind stream, recording wind streams, wind rose, and choice of site.	8

4	**Performance Of Wind Turbines** Power extraction from the wind stream, Ideal power coefficient, typical performance curves for various types, maximum power coefficients, speed-torque curves, power density of a wind stream, ducted system, vortex generator.	8
5	**Complete System Design** Objectives, power requirements, wind availability, type and size of WECS required, cost of energy delivered, WECS viability, system characteristics, system requirements, system evaluation, design optimization, wind system design synthesis. Independent design project.	8

Course Outcomes: By the end of this course, the student will be able to:

1	Understand different wind turbine concepts and its configuration.
2	Select wind turbine and its parts according to given operating conditions using scientific methods and procedures.
3	Understand various applications and characteristics of wind turbines.
4	Analyze and estimate parameters related to performance of wind turbines.
5	Integrate the fundamental knowledge to design wind turbine with optimum performance.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Wind Machines", Frank R. Eldridge, 2nd Ed., Van Nostrand Reinhold.	1982
2	"Wind Turbines: Fundamentals, Technologies, Application, Economics", Hau, Erich, 3rd Ed., Springer	2013

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Wind Machines", Frank R. Eldridge, 2nd Ed., Van Nostrand Reinhold.	1982

2	"Wind Power", Paul Gipe, 1st Ed., Chelsea Green	2004

Aerospace Propulsion Domain DEC

1. Advanced Aerospace Propulsion systems
2. Rocket Propulsion
3. Missile Technology
4. Experimental Aerodynamics
5. Computational Fluid Dynamics

Advanced Aerospace Propulsion systems

Course Name	ADVANCED AEROSPACE PROPULSION SYSTEMS
Course Code	AE2007
Credits	4
L T P	3 1 0

Course Objectives:

The objective of the course is to make the student understand the various problems associated with a gas turbine and rocket engine. This involves the analysis of the performance parameters such as velocity, range, and payload. This also includes the performance parameters of solid and liquid propellant rocket motors.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	AIRCRAFT GAS TURBINES Impulse and reaction blading of gas turbines – Velocity triangles and power output – Elementary theory – Vortex theory – Choice of blade profile, pitch and chord – Estimation of stage performance – Limiting factors in gas turbine design- Overall turbine performance –Methods of blade cooling – Matching of turbine and compressor – Numerical problems.	8
2	RAMJET PROPULSION Operating principle – Sub critical, critical and supercritical operation – Combustion in ramjet engine – Ramjet performance – Sample ramjet design calculations – Introduction to scramjet – Preliminary concepts in supersonic combustion – Integral ram- rocket- Numerical problems.	8

3	FUNDAMENTALS OF ROCKET PROPULSION Operating principle – Specific impulse of a rocket – internal ballistics- Rocket nozzle classification – Rocket performance considerations – Numerical Problems.	8
4	CHEMICAL ROCKETS Solid propellant rockets – Selection criteria of solid propellants – Important hardware components of solid rockets – Propellant grain design considerations – Liquid propellant rockets – Selection of liquid propellants – Thrust control in liquid rockets – Cooling in liquid rockets – Limitations of hybrid rockets – Relative advantages of liquid rockets over solid rockets- Numerical Problems.	8
5	ADVANCED PROPULSION TECHNIQUES Electric rocket propulsion – Ion propulsion techniques – Nuclear rocket – Types – Solar sail- Preliminary Concepts in nozzle-less propulsion, Pulse detonation propulsion.	10

Course Outcomes: At the end of the course, the students will be able to

1	Understand the different types of propulsion systems and their applications.
2	Demonstrate a working knowledge and critical awareness of gas turbine performance, analysis techniques and component design and associated technologies.
3	Explain and differentiate critically the concepts and theories for a wide range of areas of gas turbine engineering and associated applications.
4	Analyze and describe the appropriate technique in the assessment of specific aspects of rocket fundamentals.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Rocket Propulsion Elements", Sutton, G.P., John Wiley & Sons Inc., New York.	2016.
2	"Elements of Propulsion: Gas Turbines and Rockets", J. D. Mattingly and K. M. Boyer, AIAA.	2006

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Gas Turbine Theory", Cohen, Rogers and Sarvanmattoo, Pearson.	2017
2	"Mechanics and Thermodynamics of Propulsion" Philip G. Hill, Carl R Peterson, Pearson.	1999

Rocket Propulsion

Course Name	ROCKET PROPULSION
Course Code	AE2008
Credits	4
L T P	3-1-0

Course Objectives:

This course enables the students to understand various types of rocket engines such as solid, liquid, and hybrid. Comprehend the working principle of a nozzle particularly with their applications in a rocket propulsion system. Finally, the student would learn the basic requirements of the rocket test facility

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	HISTORY AND INTRODUCTION Development of German V-2 rocket propulsion, propulsion system of space shuttle, PSLV and GSLV launch vehicles. Propulsion system of Ariane and Saturn launch vehicles	7
2	SOLID PROPELLANT ROCKET MOTORS Basic configuration, the properties and the design of solid motors, Propellant composition, Additives, Toxic exhaust, thrust stability, thrust profile and grain shape, Integrity of the combustion chamber, Thermal protection, inter-section joints, Nozzle thermal protection.	7
3	LIQUID PROPELLANT ROCKET ENGINES The basic configuration of the liquid propellant engine, the combustion chamber and nozzle, injection, ignition, liquid propellant distribution systems, cavitation , pogo, cooling of liquid fuelled rocket engines, example of rocket engine propellant flow, the space shuttle main engine.	7
4	HYBRID PROPELLANT ROCKETS Applications and propellants, hybrid motor ballistics, performance analysis and grain configuration, design example, combustion instability.	6

5	NUCLEAR ROCKETS Introduction, reactor dimensions, neutron leakage, thermal stability, nuclear thermal propulsion, fuel elements, exhaust velocity, increasing operating temperature, nuclear thermal rocket engine, radiation and its management, propellant flow and cooling, nozzle and thrust generation.	8
6	THRUST VECTOR CONTRO AND ROCKET TESTING TVC mechanism with single nozzle, TVC with multiple thrust chambers and nozzles, testing and integration with vehicles, numerical problems, rocket testing, types of tests, test facilities and safeguards, instrumentation and data management, flight testing, post-accident procedures.	7

Course Outcomes: After the course completion, the students will be able to

1	Analyze and distinguish the propulsion system in addition to the advanced propulsion system.
2	Identify design requirements of a solid motor used in a rocket engine.
3	Comprehend various parameters used in a liquid rocket engine.
4	Analyze and describe various parameters used in a hybrid rocket engine.
5	Describe the requirement of various parameters related to the rocket testing.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Rocket Propulsion Elements", Sutton, G.P., John Wiley & Sons Inc., New York.	2016.
2	"Rocket and spacecraft propulsion", Martin J.L. Turner., Springer publishers.	2008

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Introduction to flight", John D Anderson, Tata Mc Graw Hill.	2016

2	"Rocket propulsion and space flight dynamics", J.W.Cornelisse, H F R Schoyer, K F Wakker, Pitman Publishers.	2004

Missile Technology

Course Name	:	MISSILE TECHNOLOGY
Course Code	:	AE2009
Credits	:	4
L T P	:	3-1-0

Course Objectives:

The course will provide the fundamental aerodynamics of the missiles. It focuses on the different types of control systems employed and the stability analysis for various missiles. This course will also provide a basic understanding of missile navigation and control.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	INTRODUCTION History of development of missiles, missiles versus airplanes aerodynamics, classification of missiles, axes, angle of bank, included angle, angle of attack and side slip, Indian missiles and their configurations and mission applications.	6
2	SLENDER BODY THEORY Slender body at supersonic speeds, body of revolution at zero angle of attack, sources and doublets, slender body theory at angle of attack, slender body of general cross section at supersonic speeds, pressure coefficient, lift, side force, pitching moment and yawing moment, drag force, drag due to lift.	8
3	AERODYNAMIC CONTROLS Types of controls, conventions, all moveable controls for planar configurations and cruciform configuration, coupling effects, trailing edge controls, non-linear effect in aerodynamic controls, estimation of hinge moments.	8

4	MISSILE DRAG Components of drag, pressure force drag of slender body of given shape, drag due to lift, pressure force drag of non-slender missile noses at zero angle of attack, shapes of bodies of revolution for least pressure force drag at zero angle of attack, pressure drag of wing alone, pressure force drag of wing-body combination at zero angle of attack, base drag, skin friction drag.	8
5	STABILITY ANALYSIS References axes, notation, general nature of aerodynamic forces, stability derivatives and its properties resulting from missile symmetries, Maple Synge analysis for cruciform, triform and other missiles. Bryson method, stability derivatives of slender flat triangular wing.	6
6	MISSILE NAVIGATION AND CONTROL Fully gimbaled gyroscope, rate gyroscope, integrating gyroscope, laser gyroscope, single axis stable platform, the stable platform, inertial navigation, stability of inertial navigation	6

Course Outcomes: After the course completion, the students will be able to

1	Understand the fundamental concepts of missile and distinguish the various types of missiles.
2	Describe the forces and moments acting on an slender body vehicle.
3	Analyze and describe the types of controls for various configurations.
4	Evaluate the types of drag acting on a slender and non-slender missile nose.
5.	Analyze the static stability on an aerospace vehicle.
6.	Understand and describe the navigation and its stability aspects.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	“Spaceflight Dynamics”, William E. Wiesel., Mcgraw Hill.	2010
2	“Missile Aerodynamics”, J. N. Nielsen., McGraw Hill publishers	2001

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Rocket and spacecraft propulsion", Martin J.L. Turner., Springer publishers.	2008
2	"Flight Dynamics and Control of Aero and Space Vehicles", Rama K. Yedavalli., John Wiley & Sons.	2020

Experimental Methods

Course Name	:	Experimental Methods
Course Code	:	AE2002
Credits	:	4
L T P	:	3-1-0

Course Objectives:

This subject enables the students to understand the numerous experimental techniques corresponding to various flow fields. This course helps students learn about the sensors and their measurement methodology. This will provide an understanding of getting a digital output using Data Acquisition and wind tunnel modeling.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Introduction** Introduction to aerodynamic test facilities in various Mach number regimes: low speed, transonic, supersonic, hypersonic, and high enthalpy, wind tunnel calibration, Measurements techniques in wind tunnels: forces and moments, pressure, velocity, temperature, aero-acoustic measurements.	8
2	**Flow Visualization Techniques** Low speed flow visualization techniques, Schlieren, shadowgraph, interferometry, introduction to laser diagnostic techniques.	8
3	**Measurements** Measurement of temperature using thermocouples, resistance thermometers, temperature sensitive paints and liquid crystals, Steady and unsteady pressure measurements and various types of pressure probes and transducers, errors in pressure measurements, thermocouples, thermography, velocity measurement using hot wire anemometry , Laser Doppler Velocimetry and Particle Image Velocimetry	10

4	**Data Acquisition** Data acquisition and digital signal processing techniques, wind tunnel data acquisition, measurement of steady and unsteady pressure, velocity, temperature, turbulence intensity, calibration of force, pressure and acoustic sensors. Virtual instrumentation, Calibration of single and two wire probes.	10
5	**Wind Tunnel Modeling** Skin friction, forces and moments – Model design and fabrication force measurement techniques. Introduction to dynamic testing	6

Course Outcomes: By the end of this course, the student will be able to:

1	Understand the test facilities corresponding to various flow fields ranging from subsonic to supersonic Mach numbers.
2	Demonstrate and analyze the various visualization techniques from subsonic to supersonic flow-field.
3	Acquire knowledge of various probes and transducers, their uses and measurement.
4	Analyze and interpret the experimental data using various softwares.
5	Able to design experiments required for any particular problem in aerodynamics.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Wind Tunnels: Aerodynamics, Models & Experiments", Justin D. Pereira., Nova science Pub. Inc.	2010
2	"Instrumentation, Measurements, and Experiments in Fluids", E. Rathakrishnan., CRC Press.	2007

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Low Speed Wind Tunnel Testing", W. E. Rae and A. Pope., John Wiley	1999

2	“High Speed Wind Tunnel Testing”, K. L. Goin, and A. Pope., Kriezkr.	1978

Computational Fluid Dynamics

Course Name	:	Computational Fluid Dynamics
Course Code	:	AE2001
Credits	:	4
L T P	:	3-0-2

Course Objectives:

To help the students understand the concepts, to be able to solve and apply various types of equations for the analysis of the flow, generate various types of grid and use panel method for solving flow problems.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Types Of Equations And Finite Difference Techniques** Classification of partial differential equations, Linear/Nonlinear partial differential equations, Elliptic, parabolic, hyperbolic partial differential equations, System of first order partial differential equations, Initial and Boundary Conditions. Finite difference approximations, Discretization using Taylor series, Discretization using Orthogonal Polynomials, Truncation error estimates, finite volume method	10
2	**Methods For Parabolic Equations** Parabolic partial differential equation, Finite difference formulation, Explicit and Implicit methods, Von Neumann stability analysis, Consistence analysis, Solution of tridiagonal systems	8
3	**Hyperbolic Equations And Panel Method** Solution of hyperbolic equations- Burgers equation, Two and three-dimensional panels, Panel singularities, Panel method for Two dimensional non-lifting bodies, Two and three-dimensional source panels, Two-dimensional vortex lattice and Vorticity panel methods, Panel method for compressible subsonic and supersonic flows, Time-split methods,	8

4	**Methods For Elliptic Equations** Elliptic partial differential equation, Finite difference Discretization, Iterative schemes (Point Jacobi, Gauss Seidel, SOR, SLOR) Applications to literalized subsonic potential flow	8
5	**Grid Generation Techniques** Structured and Unstructured grids, Boundary fitted grids, Elliptic grid, generation, Algebraic grid generation, Working problem based on two methods	8

List of Experiments:

S. No.	Experiments	No. of turns
1	Point relaxation method for Laplace equation for the flow over airfoil	2
2	Successive Line Relaxation for the Laplace equation over airfoil	2
3	Structural grid generation over NACA 0012	2
4	Relaxation method for subsonic full potential equation for flow over airfoil with zero angle of attack	2
5	Lifting subsonic incompressible potential flow over airfoil	2
6	Two dimensional Panel method for subsonic incompressible flow over NACA 0012	2
7	Zoukowski transformation for subsonic incompressible flows	1

Course Outcomes: By the end of this course, the student will be able to:

1	Classify different types of partial differential equations (PDEs), boundary conditions, finite difference approximations, discretization methods, estimate errors and basic understanding of finite volume method.
2	Solve parabolic differential equations by implicit and explicit methods and carry out stability analysis of PDEs.
3	Solve hyperbolic equations and various two dimensional and three dimensional flow problems using panel methods.
4	Solve elliptic equations by various iterative methods using finite difference approximations.
5	Generate various type of grids based on the problem.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"High Accuracy Computing Methods, Fluid Flows and Wave Phenomena" Tapan K. Sengupta, 1st Ed., Cambridge University Press	2013
2	"Computational Fluid Dynamics The Basics with Applications", John D. Anderson Jr., 1st Ed., McGraw Hill Education India	2017

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Fundamentals of Computational Fluid Dynamics", Tapan K. Sengupta, 1st Ed., Universities Press	2004
2	"Computational Aerodynamics and Aeroacoustics", T. K. Sengupta and Y. G. Bhumkar, 1st Ed., Springer	2020
3	"Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics", C. Hirch, Volume-2, 2nd Ed., Butterworth-Heinemann	2007

Aerospace Structures Domain DEC

1. Vibrations and Aeroelasticity
2. Dynamics of Aerospace Structures
3. Composite materials
4. Computational methods for structural analysis

Vibrations and Aeroelasticity

Course Name	:	VIBRATIONS AND AEROELASTICITY
Course Code	:	AE2010
Credits	:	4
L T P	:	3 1 0

Course Objectives:

To enable the student to understand fundamentals of free and forced vibrations analysis; and to provide the skills to analyze dynamic aero elastic instability due to interactions among aerodynamics, structure and inertia effect such as flutter.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	INTRODUCTION AND UNDAMPED FREE AND TRANSIENT VIBRATIONS Definitions and terminology, simple harmonic motion ,combinations of two simple harmonic motions, solution of second order differential equations, complex numbers, classical solution, energy solution, summery of procedures for determining natural frequency, transient, response, equivalent systems.	8
2	DAMPED FREE AND TRANSIENT VIBRATIONS-SINGLE DEGREE OF FREEDOM Introduction, viscous damping, critical damping, over damping, under damping,equivalent dampers, coulomb damping.	6

3	STEADY STATE FORCED VIBRATIONS –SINGLE DEGREE OF FREEDOM Introduction, sources of excitation, impressed harmonic force, impressed force due to unbalance excitation, transverse critical speed of a single disk, motion excitation, transmissibility and isolation, summary of simple harmonic excitation, commercial isolator materials.	8
4	INTRODUCTION TO AEROELASTICITY Definition and historical background, static and dynamic aero elastic phenomenon, integration of aerodynamic, elastic and inertia forces, influence of aero elastic phenomenon on aircraft design, comparison of critical speeds.	06
5	DIVERGENCE OF LIFTING SURFACES The phenomenon of divergence, divergence of 2-D wing section, divergence of an idealized cantilever wing, solution based on semi-rigid assumptions, solution to generalized coordinates method of successive approximation ,use of numerical methods.	07
6	STEADY STATE AEROELASTIC PROBLEMS IN GENERAL Loss and reversal of aileron control, 2-D and general case, lift distribution on a rigid and elastic wing, effect on static longitudinal stability of airplane, flutter and buffeting.	07

Course Outcomes: At the end of the course, the students will be able to

1	Understand fundamentals of vibration such as natural frequencies and modes, resonance, and effect of mass, stiffness and damping on vibration characteristics
2	Develop mathematical models and derive equations to solve damped free and forced vibration for single-degree of freedom systems.
3	Develop mathematical models and derive equations to solve the steady-state forced vibration.
4	Understand dynamic aero elastic instability due to interactions among aerodynamics, structure and inertia effects such as flutter.
5	Understand the effects of aeroelasticity like divergence phenomena.
6	Apply the fundamentals of vibration and aeroelasticity on different engineering and airplane components.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Mechanical Vibration. Author: G. K. Grover. Publisher: Nem Chand And Bross, Roorkee . Edition: 8.	2009
2	Aeroelasticity: R.L.Bisplinghoff Holt Ashley R.L.Halfman, Addison Wesley Publishing Co. Reading, Mass.	1965

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Mechanical vibrations: Austin H. Church, John Wiley & sons	1963
2	Vibration problems in engineering: S. Timoshenko Van Nostrand Co.,.John Wiley Publishers	1974
3	Mechanical Vibrations: V.P.Singh, Dhanpat Rai and Co. Pvt. Ltd., Delhi.	2012
4	An introduction to the Theory of Aeroelasticity: Y.C.Fung, Dover Publications.	1969

Dynamics of Aerospace Structures

Course Name	:	DYNAMICS OF AEROSPACE STRUCTURES
Course Code	:	AE2011
Credits	:	4
L T P	:	3-1-0

Course Objectives:

At the end of this course, the student should be able to analyze landing gear, beams and beam columns along with fatigue failure of aircraft structures by applying various analytical methods and be able to evaluate buckling strength of plates.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	EQUILIBRIUM OF FORCES: Two force members, analysis of typical space structures, stress analysis of landing gear, stress analysis of wing structure, numerical problems.	7
2	INERTIA FORCES AND LOAD FACTORS: Numerical problems on pure translation motion, inertia forces on rotating bodies, load factors for translational acceleration, load factor for angular acceleration, numerical problems.	7
3	SPECIAL METHODS OF ANALYSIS: Area moments, conjugate beam method, beam columns, superposition of beam column loadings, moment distribution method, numerical problems.	7
4	FAILURE CRITERIA OF ISOTROPIC STRUCTURES: Fracture mechanics, stress concentration, fracture criterion, stress intensity factor, symmetrical and unsymmetrical loading, relation between K and G, mixed mode fracture, fatigue failure, constant stress amplitude, S-N curves, variable amplitude loading, fatigue crack growth	7

5	STRUCTURAL VIBRATIONS: Oscillation of mass spring systems, numerical problems, oscillation of beams, numerical problems, approximate methods for determining natural frequencies.	7
6	ELASTIC BUCKLING OF THIN PLATES: Equilibrium approach, boundary conditions, numerical problems with different boundary conditions and loadings, Energy approach, Rayleigh Ritz method, Galerkin's method, numerical problems with different loadings.	7

Course Outcomes: By the end of this course, the student will be able to

1	Do stress analysis of landing gear, space structures, beams and beam columns by applying various techniques.
2	Determine inertia forces and load factors acting on the aircraft.
3	Understand the special method of analysis like area moments, conjugate beam method, etc.
4	Understand the basics of fracture mechanics and fatigue crack growth.
5	Solve the single and multi-degree of freedom spring-mass system problems for natural frequency and mode shapes.
6	Evaluate elastic buckling characteristics of columns and plates, and apply energy and equilibrium approach to determine buckling stress in the plates with different boundary conditions.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Mechanical Vibration. Author: G. K. Grover. Publisher: Nem Chand And Bross, Roorkee . Edition: 8.	2009
2	Aircraft structures : D.J.Peery, McGraw Hill	1950
3	Mechanics of aircraft structures: C.T.Sun, 3rd Ed , John Wiley publishers	1998
4	Structural stability of Columns and Plates : N G R Iyengar, John Wiley & sons	1988

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Aircraft Structures for Engineering Students : T.H.G.Megson , 4th Ed., Elsevier Ltd.	2012
2	Mechanical Vibrations: V.P.Singh, Dhanpat Rai and Co. Pvt. Ltd., Delhi.	2012

Composite materials

Course Name	:	COMPOSITE MATERIALS
Course Code	:	AE2012
Credits	:	4
L T P	:	3-1-0

Course Objectives:

At the end of this course, the student should be able to describe the concepts related to composite materials and matrix materials, and apply the knowledge during fabrication of composites in aircraft and allied industry.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	Introduction Definition, Characteristics, Classification, comparison with metallic materials, Particulate Composites, Fiber-reinforced composites, Applications of composites in Aerospace Industry.	(6)
2	Fibers Glass fibers, Carbon & Graphite fibers, Aramid fibers, Boron fibers and other fibers. Properties and applications of various types of fibers. Fiber finishing, Weave pattern of fibers,	(5)
3	Matrix Materials Definition, Functions of a matrix, Thermosetting, thermoplastic, Carbon, Metal and Ceramic matrix materials. Curing of resins. Prepregs, characteristics, handing and storing of prepregs.	(6)
4	Sandwich and Laminate Composites Sandwich construction, Face and Core material, Honeycomb structures and their properties, Honeycomb manufacturing, Fabrication of sandwich structures, Laminate lay-up, importance of ply orientation, lay-up code, Joining of laminate structures, Tooling required.	(6)

5	Manufacturing Processes Open mold processes, Closed mold processes, Continuous processes. Their merits and demerits. Fabrication of thermosetting resin matrix composites – Hand lay-up techniques, Bag molding processes, Resin transfer molding, Filament winding, Pultrusion, preformed molding compounds. Fabrication of thermoplastic resin matrix composites short fiber composites), Fabrication of metal matrix composites, Fabrication of ceramic matrix composites	(8)
6	Repair of Composites Defects in composites, Non-destructive inspection techniques, Damage assessment, evaluation and classification, Repair of composites.	(5)
7	Advanced Composites Introduction to Carbon Nanotube (CNT) and Graphene, Graphenated Carbon Nanotubes (g-CNT), Categories of CNT based on structures, Properties, characterization, fabrication and applications of these materials.	(6)

Course Outcomes: By the end of this course, the student will be able to:

1	Gain the knowledge of various types of composites materials in Aerospace Industry.
2	Have an understanding on various types of fibers, its advantage and its application in aerospace industry.
3	Have the knowledge of various types of matrix along its properties and usage.
4	Have an understanding of sandwich and laminated composite materials and its mechanics and applications.
5	Learn the knowledge of manufacturing processes of composite materials and be able to fabricate composite based on their own requirements.
6	Know how to analyze the defects in composite material and how to repair composites in Aerospace Industry.
7	Know about the properties, characterization fabrication, and application of advanced composite material.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Autar K Kaw, Mechanics of Composite Materials, CRC Press	2005
2	"Mechanics of Composite Materials", R.M. Jones, Taylor & Francis	1999

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Advanced Composite Materials", Lalit Gupta, Himalayan Books Publication	1998
2	"Analysis and Performance of Fiber Composites", B. D. Aggarwal, L. J. Broutman and K. Chandrashekhara, John Wiley & Sons	2006

Computational methods for structural analysis

Course Name	**:**	**COMPUTATIONAL METHODS FOR STRUCTURAL ANALYSIS**
Course Code	**:**	**AE2013**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:

At the end of this course, the student should be able to understand various computational approaches for structural analysis. The student should be able to apply finite element method for the structural analysis of bars, beams and plates. Also the student should be able to understand advanced finite element approaches using NURBS-based approach.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
1	**Introduction to Computational Method** Basic Equations in elasticity. Types of Solution – Analytical, 3-D Elasticity Solution, Navier Solution/closed-form Solution, Numerical Solution using Weighted residual approach and Variational approach. Numerical Integration techniques used in FEA. FEM Vs Classical method, FEM Vs FDM, Matrix displacement formulation, FEA for stress analysis.	**7**
2	**Introduction to Finite Element Method** Finite element modeling, Element Shapes, Nodes, Nodal Unknown and Coordinate systems, Shape Functions, Discretization of a structure, Isoparametric formulation, Strain displacement matrix, assembly of Global Stiffness matrix and load vector, properties of K, quadratic shape function. Stress calculation, Boundary Condition.	**7**
3	**Finite Element Analysis of 1-D Structures** Beam Theory. Structural analysis of Truss, Bar, Beams.	**7**
4	**Finite Element Analysis of 2-D Structures** Plate Theories. Structural analysis of Plates. Thermal bending problem.	**7**
5	**Isogeometric Analysis** Limitations of FEM, CAD Model Vs FEA Model, Integration of CAD and FEA: Isogeometric Analysis. Curve and surface representation, Knot vectors, Bezier Curve, B-spline Curves, Rational B-spline curves (NURBS), Refinement, Boundary Conditions, Isogeometric mathematical formulation.	**7**

Course Outcomes: By the end of this course, the student will be able to

1	Understand various computational approaches
2	Understanding the various fundamentals of Finite Element methods
3	Analyze truss, bars and beams using FEA.
4	Analyze plates for various structural problem with/without thermal environment
5	Understand an advanced computational approach for the integration of CAD and FEA

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"An Introduction to finite elements method", J.N. Reddy,Mc-Graw Hill .3rd Ed.	2006
2	Cottrell, J. Austin, Thomas JR Hughes, and Yuri Bazilevs. Isogeometric analysis: toward integration of CAD and FEA. John Wiley & Sons.	2009

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Bhavikatti, S. S. Finite element analysis. New Age International	2005
2	"Aircraft Structures for Engineering Students", T.H.G.Megson ,4th Ed., Elsevier Ltd.	2012
3	"Introduction to finite elements in engineering", T.R.Chandrupatla and A.D.Belegundu, 4th Ed. , Prentice- Hall of India	2012

Other Department Elective Courses

List of courses in DEC category which doesn't fall under any particular domain:

1. Space Dynamics
2. Aircraft Maintenance
3. Avionics
4. Air Transportation and Operations
5. Control Theory in Aerospace
6. Aircraft System Identification

Space Dynamics

Course Name	:	SPACE DYNAMICS
Course Code	:	AE2014
Credits	:	4
L T P	:	3-1-0

Course Objectives:

At the end of this course, the student should be able to describe basic terminology of space flight as well as understand the satellite attitude control methods for spinning and non-spinning spacecrafts; and be able to solve trajectory parameters of atmospheric and exo- atmospheric space flight.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	PRINCIPLE OF ROCKET PROPULSION Thrust, specific impulse, exhaust velocity, energy and efficiency, Tsiolkovsky's rocket equation, orbits, optimizing a multistage rocket, optimising the rocket engines, strap-on boosters, Solar system, the planets, reference frames and coordinate systems, celestial sphere, the ecliptic, geocentric reference frames, velocity vector.	7

2	LAUNCH VEHICLE DYNAMICS Range in the absence of gravity, Vertical motion the Earth's gravitational field, Vehicle velocity, Range, Inclined motion in a gravitational field, Constant pitch angle, The flight path at constant pitch angle, Motion in the atmosphere, Aerodynamics forces, Dynamic pressure, The gravity turn, Basic launch dynamics, Airless bodies, Typical Earth- launch trajectories, The vertical segment of the trajectory, The gravity turn or transition trajectory, constant pitch or the vacuum trajectory, Orbital injection, Actual launch vehicle trajectories,	8
3	SPACE FLIGHT Introduction, differential equations, Lagrange's equation, orbit equation, space vehicle trajectory, Kepler's laws, introduction to earth and planetary trajectory, general equations of motion for atmospheric entry, application to ballistic entry. Entry heating, lifting entry with application to Space Shuttle.	8
4	THE EARTH SATELLITE OPERATIONS The Hohmann transfer, inclination-change maneuver, launch to rendezvous, decay life time, earth oblateness effect, low thrust orbit transfer.	6
5	SATELLITE ATTITUDE DYNAMICS Torque –Free-axisymmetric rigid body, The general torque free rigid body, semi-rigid spacecraft, attitude control, Spinning and Non spinning spacecraft. The Yo-Yo mechanism, gravity gradient satellite, the dual spin spacecraft.	6
6	INTERPLANETARY MISSIONS Basic concepts, 2-D interplanetary trajectories, Hohmann trajectories, launch opportunities, fast interplanetary trajectories, 3-D interplanetary trajectories, launch of interplanetary spacecraft, trajectory about target planet	7

Course Outcomes: By the end of this course, the student will be able to

1	Understand the basic principal of rocket propulsion.
2	Calculate trajectory parameters of a launch vehicle and orbital parameters of a satellite, and compute trajectory of a multistage rocket.
3	Know about the space vehicle trajectory, planetary trajectory, Kepler's low, etc.
4	Understand the operations of earth's satellite.

5	Describe and compare various methods for satellite attitude control.
6	Calculate 2-D and 3D interplanetary trajectories.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Space Flight Dynamics", William E. Wiesel, 1st Ed. Mcgraw Hill	1989
2	"Introduction to flight", John D Anderson Jr., 6th Ed., Tata Mc Graw Hill	2011

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Rocket and spacecraft propulsion", Martin J.L. Turner, 2nd Ed., Springer publishers	2005
2	"Rocket Propulsion and Spacecraft Dynamics", J.W. Cornelisse, H.F.R.Schoyer, 4th Ed. Pitman publishers	2004

Aircraft Maintenance

Course Name	:	AIRCRAFT MAINTENANCE
Course Code	:	AE2015
Credits	:	4
L T P	:	3 1 0

Course Objectives:

Understand aircraft certification and maintenance issues, the procedures for maintenance of structures, and management of aircraft assembly & rigging; and be able to apply the required maintenance schedule wherever applicable.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	AIRWORTHINESS REGULATIONS Airworthiness, Airworthiness standards, Airworthiness Authorities such as DGCA, FAA, CAA, JAR etc. and their functions. Salient features of their airworthiness regulations, Operations certification, Certificate of Airworthiness, Airworthiness Directives.	6
2	WEIGHT AND BALANCE Fundamental principles, terminologies used, Loading conditions, Determination of CG locations for light, medium and large aircrafts.	4
3	MAINTENANCE SCHEDULES AND TECHNICAL PUBLICATIONS Maintenance of aircraft, its components, systems and sub-systems. Types of maintenance schedules, Mandatory schedules, Inspection of aircraft and components: Types of Inspections, Various Aircraft Manuals, Service Letters, Service Bulletin, Advisory Circulars, Repair, Modifications, Alteration, Reconditioning, History Record Sheet, Walk around inspection, Pre-flight checks	7

4	MAINTENANCE OF STRUCTURE AND VARIOUS SYSTEMS Maintenance of aircraft structure, propeller, power-plant, undercarriage, hydraulic system, fuel system, pressurization system, air-conditioning system, Oxygen system, Fire protection system, Ice protection system, Rain-removal system, Auxiliary power unit., Ground run of piston engines and turbine engines.	8
5	COMPONENT IDENTIFICATION & STANDARD HARDWARE Aircraft station numbers, Zoning, Nomenclature & definitions, Part numbering, Aircraft drawings, Standards, Specifications, Threaded & non-threaded fasteners, cable fittings, turnbuckles, safety belts.	5
6	Aircraft Assembly and Rigging Aircraft Assembly, Rigging, Alignment of fixed surfaces and control surfaces, Mechanical and hydraulic flight control systems. Fly by wire system, Balancing, Inspection and Maintenance. Flight control system of Helicopter.	6
7	GROUND HANDLING AND SAFETY Towing, Taxiing and Starting aircraft, Mooring, Jacking and hoisting of aircraft, Ground support equipment, Fuelling of aircraft, General Safety precautions, Compressed-gas safety, Fire safety, Flight-line safety.	6

Course Outcomes: At the end of the course, the students will be able to:

1	Understand the various Airworthiness standards and regulations along with having the knowledge about the Airworthiness authorities and their functions.
2	Understand about the fundamental principles of weight and balance for the medium and large aircraft.
3	Explain the principles of reliability as applied in maintenance and inspections, and get the understanding about the various aircraft manuals.
4	Critically appraise the different philosophies for the maintenance of aircraft structures and various systems.
5	Know the nomenclature and identification of standard hardware for an aircraft.
6	Know about the aircraft assembly, control surfaces, and mechanical and hydraulic flight control systems.
7	Have basic idea of ground handling of aircraft.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Aviation Maintenance Technician Handbook, general, AC 65-9A, Shroff Publishers and Distributors	2008
2	Aircraft Basic Science, M. J. Kroes et al., 8th Edition, McGraw Hill.	2013

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Aviation Maintenance Technician Handbook, Airframe, AC 65-15A, Shroff Publishers and Distributors.	2008
2	Aircraft Maintenance and Repair, M. J. Kroes et al., 7th Edition, McGraw Hill.	2013

Avionics

Course Name	:	AVIONICS
Course Code	:	AE2016
Credits	:	4
L T P	:	3-1-0

Course Objectives:

The course enables the student to understand the role of avionic systems and their architecture. Introduction to the various avionic systems such as display systems, air-data sensors, communication, and navigation systems will be discussed thoroughly. It also focuses on the fundamental principles and their functioning in detail.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	AVIONICS TECHNOLOGY Processors, Memory Devices, Digital Data Buses –MIL-STD-1553B, ARINC 429, ARINC 629, Fiber Optic Buses, LRU architecture for avionics packaging, software, environmental effects, difference in avionics architecture of commercial and military aircraft.	(8)
2	SENSORS Air Data Sensing – Use of pitot static probe, static probe to derive air data indications; Role of Air Data Computer (ADC), Magnetic Sensing – Magnetic Heading Reference System (MHRS), Inertial Sensing – Position Gyros, Rate Gyros, Accelerometers Radar Sensing - Radar Altimeter (RADALT), Doppler Radar, Weather Radar.	(8)

3	DISPLAY Comparison of earlier flight deck (Electromechanical type instruments) to modern flight deck (glass fight deck), Cathode Ray Tube (CRT), Active Matrix Liquid Crystal Display (AMLCD), Head Down Display (HDD), Head Up Display (HUD),Helmet Mounted Display (HMD), Integrated Standby Instrument System (ISIS)	(8)
4	COMMUNICATION HF, U/VHF, Satellite Communication , Air Traffic Control (ATC) Transponder, Traffic Collision & Avoidance System (TCAS), Identification Of Friend & Foe (IFF)	(6)
5	NAVIGATION Automatic Direction Finding, Very High Frequency Omni-Range (VOR), Distance Measuring Equipment (DME), Tactical Air Navigation (TACAN), VORTAC (VOR+TACAN), Satellite Navigation System-Global Positioning System (GPS), Differential GPS, Instrument Landing System (ILS), Transponder Landing System (TLS), Microwave Landing System (MLS), Astronavigation.	(9)
6	AUTOMATIC FLIGHT CONTROL SYSTEM Longitudinal, Lateral & Direction Autopilot	(3)

Course Outcomes: After the successful completion of this course, the student will be able to:

1	Comprehend and explain the functioning of various avionic systems and sub systems.
2	Understand and describe the functioning of various air data sensors employed in an aircraft and comprehend their limitations for civil and military aircraft.
3	Explain working of various display systems and their functioning so as to visualize the required data during the operation of various avionics systems.
4	Describe working of various communication systems and their functioning so as to facilitate the communication between the pilot and ATC.
5	Explain working of various navigation systems and their functioning so as to facilitate the navigation between the pilot, aircraft and ATC.

6	Explain working of various autopilot systems and their functioning so as to facilitate comfortable and hands-off flight.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Civil Avionics Systems", Ian Moir, Allan Seabridge and Malcom Jukes, Wiley	2013
2	"Introduction to Avionics Systems", R. P. G. Collison., Springer Netherlands.	2011

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Civil Avionics Systems", Ian Moir, Allan Seabridge and Malcom Jukes, Wiley	2013
2	"Aircraft Instruments and Integrated Systems", E.H.J. Pallett, Longman	1992

Air Transportation and Operations

Course Name	:	AIR TRANSPORTATION AND OPERATIONS
Course Code	:	AE2017
Credits	:	4
L T P	:	3 1 0

Course Objectives:

This course enables the student to understand the techniques and operations management applications used in air transportation. These comprise aircraft routing, crew pairing, runway scheduling, planning of flight operations, etc. It also emphasizes the procedures for various segments of aircraft operations and issues involved during the airline operations.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	AIRLINES Introduction to airline industry and economics, determination of operating costs, Airline route selection and scheduling, Methods of describing peaking, planning of flight operations, special topics in airline operations, Emergence of LCC.	7
2	AIRPORTS Aircraft characteristics affecting airport design, Functions of airport, Components of an airport, Airport layouts and configurations, Geometric design of the airfield, Wind Rose Diagram, Geometric design of the airfield, Design alternatives, Airport operations manual.	7
3	CURRENT ISSUES AND TRENDS IN AIR TRANSPORTATION Modeling & Simulation of ATC systems, Factors affecting Capacity & Delay, Estimation of airway Capacity & Delay, Human Factors and Controller Workload, Performance Based Navigation, Free Flight, Conflict Detection and resolution, Environmental effects of Aviation, Modeling air transport systems.	7

4	AIRSPACE CLASSIFICATION & COMMUNICATION PROCEDURES Airspace classification, controlled versus uncontrolled airspace, IFR & VFR in controlled & uncontrolled airspace, Airspace classes, Radio communication, ATC communication procedures, clearance, aircraft identification, destination airport, departure instructions, route of flight, altitude assignment, required reports, holding instructions.	7
5	AIR TRAFFIC CONTROL Principles of Air Navigation and Air Traffic Control, Overview of CNS & ATM, Separation standards, Radar and Non-radar separation, wake turbulence longitudinal separation minima, Precision approaches for landing, Radar systems for ATC, General, Visual and Instrument Flight rules.	7
6	CONTROL TOWER PROCEDURES Control towers, Delegation of responsibility, En-route controller duties, ATC tower responsibilities, Flight data controller duties, Clearance delivery controller duties, Ground controller duties, Local controller duties.	7

Course Outcomes: At the end of the course, the students will be able to:

1	Analyze and explain the principles of reliability as applied in aircraft operations.
2	Critically appraise the different philosophies for airports and aircraft operations.
3	Explain the control of operational procedures and standards.
4	Comprehend and describe the functioning of Air traffic control.
5	Develop a process for design of airports and smooth airline operations.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Fundamentals of Air Traffic Control, 4th Edition, Michael S. Nolan, Thomson Brooks/Cole, USA.	2004.
2	Air Transportation: A Management Perspective, 6th Edition, John G. Wensveen, Ashgate Publishing Ltd.,	2007.

	UK.	

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Planning and Design of Airports, 4th Edition, Robert Horonjeff & Francis X. McKelvey, McGraw Hill Professional Publishing.	1993.
2	Airline Route Planning, John H. H. Grover, BSP Professional Books, Blackwell Scientific Publications, Oxford, UK.	1990
3	Airport Planning and Management, sixth edition, Seth B. Young & Alexander T. Wells, McGraw Hill Education.	2011.

Automatic Flight Control

Course Name	:	AUTOMATIC FLIGHT CONTROL
Course Code	:	AE2018
Credits	:	4
L T P	:	3-1-0

Course Objectives:

To acquaint the students with the concepts of stability derivatives, automatic flight control, design of autopilot systems, transfer functions and control design, to design longitudinal and lateral-directional controls for various types of aircrafts.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	INTRODUCTION Classical and modern control theory, Open loop and closed loop (feedback) control systems, Types of feedback control systems.	(4)
2	FEEDBACK CONTROL SYSTEM Transfer function of linear systems. Impulse response of linear systems, Block diagrams of feedback control systems, Multivariable systems, and Block diagram algebra.	(6)
3	SYSTEM STABILITY Routh-hurwitz criterion, the root locus Method, Governing rules for plotting root locus, Effect of addition of Zeroes and Poles, Gain and phase margin from root locus.	(6)
4	ANALYSIS OF FEEDBACK CONTROL SYSTEMS Typical test input signals, Frequency domain techniques, Time domain performance characteristics of feedback control systems. Effects of derivative and integral control. Steady state response of feedback control system, Steady state error, Frequency response.	(6)

5	CONTROL SYSTEM DESIGN Control system design, Compensation, Forward-path compensation, Feedback-path compensation, Proportional, proportional-integral and proportional-integral-derivative (P, PI and PID) controller.	(6)
6	LONGITUDINAL AUTO-PILOTS Short period and phugoid dynamics, Longitudinal auto pilots: Brief description through block diagrams and root locus, Displacement autopilot, pitch-displacement autopilot, Acceleration control system, Fly-By-Wire control system, Stability augmentation system, Instrument Landing System.	(8)
7	LATERAL AUTO-PILOTS Introduction, Roll dynamics, Dutch roll approximation, Damping of Dutch Roll, Roll attitude autopilot, Methods of obtaining coordination, Yaw orientation control system.	(6)

Course Outcomes: By the end of this course, the student will be able to:

1	To identify open and closed loop control systems.
2	Analyze linear feedback control systems and acquaint with block diagram algebra
3	Carry out the system stability analysis
4	Analyze feedback control systems including steady state and frequency response.
5	Carry out design of control systems.
6	Design various autopilots (longitudinal/ lateral) for various types of aircrafts.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Flight Stability and Automatic Control", R. C. Nelson, 2nd Ed., McGraw Hill Education.	2017
2	"Automatic Flight Control", E. H. J. Pallett, Shawn Coyle, 4th Ed., Wiley-Blackwell.	1993

3	"Automatic Flight Control Systems", Donald McLean, 1st Ed., Prentice Hall.	1969

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Airplane Performance Stability and Control", C. D. Perkins & R. E. Hage, Wiley India Pvt. Ltd.	2011
2	"Flight Vehicle System Identification: A Time Domain Methodology", 2nd Ed., R.V. Jategaonkar, AIAA Series	2015

Aircraft System Identification

Course Name	:	Aircraft System Identification
Course Code	:	AE2019
Credits	:	4
L T P	:	3-1-0

Course Objectives:

To help the students with the concepts of system identification, develop a mathematical model for an aircraft, data acquisition and analysis and parameter estimation methods for various types of aircrafts.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	ELEMENTS OF SYSTEM IDENTIFICATION System identification & parameter estimation, Aircraft system identification, Outline of system theory.	(6)
2	MATHEMATICAL MODEL OF AN AIRCRAFT Reference frames & sign convention, Rigid-body equations of motion, Rotational kinematic equations, Navigation equations, Force equations, Aerodynamic model equations, Simplified equations of motion.	(8)
3	EXPERIMENT DESIGN & DATA COMPATIBILITY Data acquisition, Data acquisition system, Instrumentation, Input design, Data compatibility, Kinematic equations, Data reconstruction, Aircraft instrumentation error, Model equations for data compatibility check, Instrumentation error estimation methods.	(8)
4	PARAMETER ESTIMATION METHODS Output-error methods, Filter error methods, Equation error methods, Artificial Neural network based methods.	(10)
5	PARAMETER ESTIMATION & DATA ANALYSIS Parameter estimation using various estimation methods, Model validation, Data analysis, filtering, smoothing, interpolation, Parameter estimation from simulated & real flight data using Matlab.	(10)

Course Outcomes: By the end of this course, the student will be able to:

1	Comprehend aircraft system identification.
2	Develop mathematical model of different types of aircraft.
3	Design experiments for flight data acquisition and check data compatibility.
4	Learn and apply various parameter estimation methods for aircraft system identification.
5	Estimate parameters of aircraft from real flight data in aviation industry.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Flight Vehicle System Identification: A Time Domain Methodology", 2nd Ed., R.V. Jategaonkar, AIAA Series	2015
2	"Aircraft System Identification – Theory and Practice", Eugene A. Morelli, Vladislav Klein, 1st Ed., AIAA Education Series	2006

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Flight Stability and Automatic Control", R. C. Nelson, 2nd Ed., McGraw Hill Education.	2017

Syllabus: Open Elective Courses

1. Introduction to Aerospace Engineering (Even Sem)
2. Aerodynamics (Even Sem)
3. Flight Mechanics (Even Sem)
4. Aircraft Materials And Processes (Odd Sem)
5. Aircraft Propulsion (Odd Sem)
6. Introduction to Aerospace Structures (Odd Sem)

Introduction to Aerospace Engineering

Course Name	:	INTRODUCTION TO AEROSPACE ENGINEERING
Course Code	:	AE6001
Credits	:	4
L T P	:	3-1-0

Course Objectives:

To enable the students understand the various aspects, challenges and opportunities in the field of aerospace engineering.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	INTRODUCTION Pre Wright Brothers era, Wright Flyer, Conventional airplane, progress in airplane design and applications, Current status. Other kinds of heavier than air vehicles, helicopter, VSTOL machines.	7
2	SPACE VEHICLES Missile and its types, space vehicles and its types, reusable space vehicles, space shuttle, satellites, types of satellites and their functions.	5
3	AERODYNAMICS Airfoil nomenclature, symmetric & cambered airfoils and their aerodynamic characteristics, angle of attack, 2-D and 3-D wing, wing as a lifting surface, types of wing planforms and their aerodynamic characteristics, centre of pressure and pressure coefficient, types of drag, lift to drag ratio as efficiency of a lifting surface, different types of flows; laminar	10

	and turbulent, effect of viscosity, concept of boundary layer, boundary layer control, high coefficient of lift devices, subsonic, transonic, supersonic and hypersonic Mach no., critical Mach no., drag divergence Mach no.	
4	AIRPLANE PROPULSION Requirement of power to fly, balance of forces, various means of producing power for forward flight., piston engines ,jet propulsion-thrust equation, turbojet, turbofan, ramjet engines. Locations of such engines, Propeller and its use. Rocket engines.	8
5	AIRPLANE STRUCTURES AND MATERIALS Structural arrangement of the Wright Flyer, Structural details of landing gear, wing, fuselage and tail planes, functions of ribs, skin, spars, stringers, longerons. Monocoque and semi-monocoque structures, materials for main components, composite materials.	8
6	CONTROL SYSTEMS AND LEVEL FLIGHT Various types of flaps function of rudder, elevator, ailerons, flaprons, elevons, types of tail planes, and condition for straight & level flight, flight path angle.	4

Course Outcomes: At the end of this course, students will be able to

1	Describe basic concepts in aerospace engineering.
2	Explain fundamental aspects of aerodynamics, propulsion, structures and control systems of aircrafts.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Mechanics of flight ", A.C. Kermode, Himalyan Books, N. Delhi	2004
2	"Fundamentals of Aerodynamics", John D. Anderson Jr.,5th Ed., Mc Graw Hill Pvt. Ltd.	2013

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Aircraft Basic Science", Ralph D. Bent & James L.Mackinley.	2006

Aerodynamics

Course Name	Aerodynamics
Course Code	AE6002
Credits	4
L T P	3-1-0

Course Objectives:

By the end of this course, the student will be able to understand the fundamentals of aerodynamics. Students will be able to distinguish between incompressible and compressible aerodynamics. Apply the concepts of shock wave. Understand various experimental aerodynamics techniques.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Fundamental Principles** History, Center of Pressure, Aerodynamic Center, Flow Similarity, Lagrangian approach, Eulerian approach, Continuity equation, Momentum equation, Energy equation for fluid, Pathline, streamline, streakline and timeline of flow, Circulation, stream function and velocity potential	10
2	**Inviscid and Incompressible Flow** Compressibility, Conditions for flow incompressibility, Irrotational and incompressible flow, Elementary flows, Kutta Joukowski Theorem, Airfoil nomenclature and characteristics, Kutta condition, Kelvin's Circulation theorem, Downwash and Induced drag, Vortex filament, Biot-Savart Law, Helmholt's Theorem	10
3	**Compressible Flow** Mach number regime, Governing equations, Stagnation conditions, Speed of sound, Normal shockwave and its properties, Oblique shock wave, expansion wave and their properties, Drag divergence Mach Number, Supercritical airfoils, De-Laval Nozzles, Area ratio, Hypersonic flow	10
4	**Viscous Flow** Wake of cylinder, Viscosity and thermal conduction, Navier-stokes equation, Couette flow, Poiseuille flow, Laminar and Turbulent Boundary layers	6

5	**Experimental Aerodynamics** Aerodynamics testing facilities, Wind tunnel and their types, Flow visualization techniques, Velocity and pressure measurements, Pitot tube measurement of airspeed	6

Course Outcomes: At the end of this course, students will be able to

1	Apply fundamental aerodynamics concepts in solving problems
2	Use various mathematical tools used in solving potential flow
3	Evaluate the flow properties across shock waves and expansion waves
4	Examine the impact viscosity in fluid structure interaction
5	Contrast between different experimental aerodynamics techniques

Text Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	"Fundamentals of Aerodynamics", John D.Anderson (Jr.) 5th Ed., McGraw Hill Education (I) Pvt. Ltd.	2013
2	"Aerodynamics for Engineering Students", E.L.Houghton and P.W.Carpenter, 4th Ed., CBS Publishers , India	1996

Reference Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	"Aerodynamics for Engineers", J. J. Bertin, and R. M. Cummings, 6th Ed., Pearson Education.	2014
2	"Aerodynamics", L. J. Clancy, 1st Ed., Shroff Pubs & Dists Pvt. Ltd.	2006
3	"Theoretical and Computational Aerodynamics". T. K. Sengupta, 1st Ed., Wiley	2014

Flight Mechanics

Course Name	Flight Mechanics
Course Code	AE6003
Credits	4
L T P	3-1-0

Course Objectives:

At the end of this course, the student should be able to describe the concepts related to atmosphere, aerodynamic characteristics, steady flight, accelerated flight & stability and estimate performance of an aircraft during steady and accelerated flight.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**THE STANDARD ATMOSPHERE** Standard atmosphere, Relation between geo-potential & geometric altitudes, Pressure, temperature and density altitudes. Relations for isothermal and gradient atmospheric regions, Stability of atmosphere.	6
2	**AERODYNAMIC CHARACTERISTICS** Airfoil nomenclature, Aerodynamic center, Center of pressure, Lift, drag & moment coefficients, Effect of Reynold's Number, Mach number, aspect ratio, plan form, sweep, taper and twist on aerodynamic characteristics, Drag, Causes of drag, Types of drag, Factors affecting drag. Drag polar, Delta wing aerodynamics, High lift devices,	10
3	**AIRCRAFT PERFORMANCE IN STEADY FLIGHT** Equations of motion for straight & level flight, Minimum drag conditions, Minimum power conditions, Gliding flight, Shallow & steep angles of glide, Sinking speed, Minimum sinking speed, Time of descent, Climbing flight at shallow angles, Correction for steep angles, Time to flight, Maximum rate of climb, Energy climb, Range and endurance, Numerical problems.	10

4	**AIRCRAFT PERFORMANCE IN ACCELERATED FLIGHT** Level turns, Pull-up & pull-down maneuvers, Flight envelope, Take-off performance, Calculation of take-off ground run and take off distances, Landing performance, Calculation of landing ground run and landing distances, Energy concepts,	8
5	**INTRODUCTION TO STABILITY & CONTROL** Trim, stability, Criterion for static longitudinal stability of an aircraft, Contribution of different parts to static longitudinal stability of aircraft, Neutral point, Lateral & Directional stability, Weather cock stability, Dihedral Effect, Control power, Introduction to Dynamic stability.	8

Course Outcomes**:** At the end of this course, students will be able to:

1	Analyze atmospheric properties at different altitudes.
2	Understand and analyze aerodynamic concepts related to an airfoil, wing & aircraft.
3	Estimate and analyze aircraft performance during steady & level flight.
4	Estimate and analyze aircraft performance during accelerated flight.
5	Understand basic concepts of stability and control.

Text Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	"Introduction to Flight", J. D. Anderson Jr., 8th edition, McGraw – Hill Education	2015
2	"Flight Stability and Automatic Control", R. C. Nelson, 2nd edition, McGraw – Hill	2017

Reference Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	"Aircraft Performance and Design", J. D. Anderson Jr., McGraw – Hill Education	2010
2	Airplane Performance Stability and Control", C. D. Perkins & R. E. Hage, John Wiley	1949
3	"Aerodynamics for Engineering Students", E.L. Houghton and P.W. Carpenter, et.al., Butterworth Heinemann	2016

Aircraft Materials And Processes

Course Name	:	Aircraft Materials And Processes
Course Code	:	AE6004
Credits	:	4
L T P	:	3-1-0

Course Objectives:

At the end of this course, the student should be able to describe the concepts related to aircraft materials and production processes. The student should be able to know the usage of various materials in different components of aircraft.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**INTRODUCTION** Properties of Flight Vehicle Materials, Importance of strength/weight ratio of materials for Aerospace Vehicles structures, Importance of temperature variations, Factors affecting choice of material for different parts of airplane.	6
2	**LIGHT METAL ALLOYS** Aluminum alloys, Heat treatment, High strength and high corrosion alloys. Magnesium alloys and their properties, Heat treatment, Application of these alloys to Aerospace Vehicles.	5
3	**AIRCRAFT STEELS** Classification of alloys steels, Effect of alloying elements, Carbon Steel V/S Alloys	3
4	**HIGH STRENGTH AND HEAT RESISTANT ALLOYS** Classification of heat resistant materials, Iron, Nickel and Cobalt base alloys, Refractory materials, Ceramics, Titanium and its alloys, Properties of Inconel, Monel & K-Monel, Nimonic and Super Alloys, Application to Aerospace Vehicles.	7
5	**COMPOSITE MATERIALS** Introduction, Fibers, Glass fibers, Carbon fibers, Aramid fibres, Baron fibres, Engineering ceramix. Matrix Materials – their functions, various types, curing of resins.	5

6	**METAL JOINING PROCESSES** Weldability, Standard welding practices e.g. gas welding, resistance welding. Welding of light alloys, Riveting, advanced joining methods.	5
7	**JIGS AND FIXTURES FOR AIRCRAFT** General design, Method of Location of cylindrical and flat surface. Design principles of Jig for Wing, Fuselage and other components of aircraft.	5
8	**AIRCRAFT MANUFACTURING PROCESSES** Profiling, Hydroforming, Marforming, Bending rolls, Sparmilling, Spark erosion and Powdered metallurgy. Integral machining, Contour etching. High energy rate forming. Manufacture of honeycomb structures, General methods for construction of aircraft and aero engine parts.	6

Course Outcomes: By the end of this course, the student will be able to

1	Understand how to choose various types of materials for different parts of airplane.
2	Understand Application of various alloys to Aerospace Vehicles
3	Know various grades of aicraft steel and where they are implemented.
4	Application of high strength and heat resistant alloys to Aerospace Vehicles
5	Know the basics of composite materials and why and where they are used in aircrafts.
6	Under various metal joining processes.
7	Use various types of jigs and fixtures used for aircraft production.
8	Use different methods for producing various types of materials and their suitability in making different aircraft components. Apply the properties of various materials and examine their suitability in making different aircraft components.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Aircraft Material and Processes", G. F.Titterton, Himalayan Books	1998

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Advanced Composite materials", Lalit Gupta, Himalayan Books	1998
2	Aircraft Production methods", G. B. Ashmead, Chilton Company	1956
3	Workshop technology, Vol. I,II,III ",W. A. J. Chapman, Butterworth Heinamann	2012
4	"https://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/amt_handbook/media/FAA-8083-30_Ch05.pdf	2008

Aircraft Propulsion

Course Name	Aircraft Propulsion
Course Code	AE6005
Credits	4
L T P	3-1-0

Course Objectives:

This course enables the student to understand the fundamental concepts of various propulsive systems of aircraft and rockets. This subject also focuses on the performance and working principle of each individual component involved in gas turbine engine and rocket engine

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Introduction to propulsion:** Thrust mechanism: Newton's law, Thrust equation. Classification of engines and their types: Air breathing and non-air breathing engine, Velocity of operation (Turbo fan, Turbo jet, Ram jet, Scram jet), Fuel source (nuclear, H-C, electric, Exothermic chemicals), Region of operation (Rocket propulsion, Pulse detonation engine, electric and hybrid propulsion)	7
2	**REVIEW OF BASIC THERMODYNAMICS:** Basic thermodynamics, Processes, Gas laws and Properties: Enthalpy, pressure temperature, entropy. Introduction to heat transfer, heat exchangers. Introduction to propulsion.	6
3	**AIRCRAFT PISTON ENGINES** The internal combustion engine process, S.I and C.I engines, 4-stroke and 2-stroke engines, air standard cycles, cycle efficiency, valve timing diagrams, Various types of arrangements for multi cylinder aircraft engines, - merits, & I.H.P, B.H.P. and S.H.P, Performance, effect of altitude, power required and power available, supercharging, turbocharging.	8
4	**AIRCRAFT GAS TURBUNE ENGINES** Types of Gas-turbine engines: Turbo-prop, Turbo-shaft and Turbo-fan engines, Multi-shaft gas turbine engines. Brayton cycle, Actual gas turbine cycle: Compressor and Turbine efficiency.	10

	Parts of a simple gas turbine engine, their types, operation, and merits: Intake – (Subsonic, Supersonic, Variable Area inlet), Compressor – centrifugal and axial, Combustion Chamber – Annular, Can, Cannular. Turbine – Radial, Axial. Nozzle – (Convergent, CD nozzle, Variable area nozzle), Afterburners.	
5	**PROPELLERS** Ideal momentum theory, blade element theory, activity factor, airscrew coefficients, performance of propellers, selection of propellers, fixed, variable and constant pitch propellers.	6
6	**Rocket Propulsion:** Classification based on fuel types: Liquid, solid & hybrid rocket propulsion systems, Parts of a rocket engine: Solid, Liquid, Cryogenic, Hypergolic. Nozzle cooling. Classification based on stages of operation: single & Multi-stage rockets.	5

Course Outcomes: After the course completion, the students will be able to

1	Comprehend and describe the fundamental concepts involved in different propulsion systems.
2	Understand the basic thermodynamic concepts and apply same to the aircraft engines.
3	Understand the working of different engines and analyse the cycle efficiency.
4	Understand the working of various components of the gas turbine engine. Analyze the performance parameters of gas turbine engines.
5	Comprehend and design the typical fixed and variable pitch propeller
6	Explain the various rocket propulsion systems based on the fuel types.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Elements of Propulsion: Gas Turbines and Rockets", J. D. Mattingly and K. M. Boyer, AIAA.	2006
2	"Gas Turbine Theory", Cohen, Rogers and Sarvanmattoo, Pearson.	2002

3	"Aerodynamics for Engineering Students" E. L. Houghton, P.W. Carpenter., Butterworth-Heinemann	2016

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Mechanics and Thermodynamics of Propulsion" Philip G. Hill, Carl R Peterson, Pearson.	1999
2	"Rocket Propulsion Elements", Sutton, G.P., John Wiley & Sons Inc., New York.	2016

Introduction to Aerospace Structures

Course Name	Introduction to Aerospace Structures
Course Code	AE6006
Credits	4
L T P	3-1-0

Course Objectives:

To equip the student with the knowledge about the mechanics of different aircraft structural members, and their design and analysis. The student should also be able to explain the basic principles of elasticity, and instability. The student should also be able to know the basic concepts of the advanced material utilized in the aerospace structures.

Total No. of Lectures – 42

Lecture wise breakup		No. of Lectures
1	**Introduction to Elasticity** Concept of displacement, Strain, Stress, Equations of equilibrium. Plane stress, stresses on inclined planes, principal stresses, Mohr's circle. Strain, compatibility equations, plane strain, principal strains. Linear stress-strain relations, strains induced by normal and shear stress. 3-D stress-strain relations - Anisotropic, Orthotropic, isotropic material. Numerical problems, 2- D problems, stress functions.	10
2	**Introduction To Aircraft Structure And Materials** Aerospace Materials, Composite materials: Classifications and characteristics of composite materials, Types of Fibres, Matrix materials, Sandwich and Laminate Composite. Basic structural elements in aircraft structures, wing and fuselage, aircraft materials. Statically determinate and indeterminate trusses	8
3	**AIRFRAME LOADS** Airworthiness, Factor of safety, Flight envelope. Aircraft inertia loads, symmetric maneuver loads, steady pull out, correctly banked turn, gust loads, gust envelope, numerical problems, fatigue, safe life and fail-safe structures, designing against fatigue, fatigue strength of components, prediction of aircraft fatigue life.	8

4	**BENDING AND SHEAR OF BEAMS** Bending of thin plates, Symmetrical bending, unsymmetric bending, direct stress due to bending, deflection due to bending, Flexural shear flow in open thin-walled section, shear centre in open sections, shear of closed section beams, problems.	10
5	**Introduction to Aeroelasticity** Static and dynamic aero elastic phenomenon, Critical speeds, Divergence of 2-D wing section and an idealized cantilever wing, Loss and reversal of aileron control, flutter and buffeting.	6

Course Outcomes**:** At the end of this course, students will be able to:

1	Do the stress analysis of statically determinate and indeterminate structures.
2	Understand the concept of tensor and the basic principles of elasticity.
3	Have an understanding of aerospace materials along with the skills to analyze the basic elements of aircraft structures.
4	Understand various types of loads acting on aircraft.
5	Analyze bending behavior of beam for various open and closed sections. Use the appropriate method to determine the slope and displacement of beam deflection for different beam sections.
6	Analyze flexural shear behavior of beam for various open and closed sections.
7	Describe and calculate elastic buckling characteristics of columns and plates. Design of supporting structures like struts, column and plates is also an outcome of the course.
8	Understand the basic concept of static and dynamic aeroelasticity including the flutter and buffeting.

Text Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Aircraft Structures for Engineering Students": T.H.G.Megson ,4th Ed. Elsevier Ltd.	2012
2	"Structural stability of Columns and Plates", N G R Iyengar, John Wiley & sons	1988

Reference Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Mechanics of aircraft structures: C.T.Sun, 3rd Ed , John Wiley publishers	1998
2	Strength of Materials by Dr. Sadhu Singh, Khanna Publishers 11th edition.	2015
3	R. K. Bansal, A textbook of strength of materials :(in SI units). Laxmi Publications	2010
4	Aircraft Structures: lalit Gupta & Dr. O.P. Sharma. , Himalayan Books	2015