B.E. AERO

R-2019 (Revised)

CURRICULUM

(CHOICE BASED CREDIT SYSTEM)

RAJALAKSHMI ENGINEERING COLLEGE
(An Autonomous Institution Affiliated to Anna University Chennai)

DEPARTMENT OF AERONAUTICAL ENGINEERING
CBCS CURRICULUM AND SYLLABUS R – 2019 (Revised)
B.E., AERONAUTICAL ENGINEERING

VISION

To provide excellent graduate education in Aeronautical Engineering and continuously support the community of aerospace professionals that will spearhead and strengthen the design and development of Aerospace related industries and institutions in India.

MISSION

- To impart quality exposure in theory and practical with proficiency, skill and humane values with the best of teaching and industrial expertise.
- To continuously strengthen the laboratory learning of students in tune with the best industry processes and practices.
- To ensure the updated knowledge and skill sets of students in emerging technologies.
- To provide the students the right ambience and opportunities to develop into creative, talented and globally competent Aero professionals.
- To promote research and development activities in the sphere of aeronautics for the benefit of the society.

Program Educational Objectives (PEOs)

1. Our graduates have the ability to apply knowledge across the disciplines and in emerging areas of Aerospace Engineering for higher studies, research, employability and product development.
2. Our graduates have the communication skills, sense of responsibility to protect the environment and ethical conduct towards their profession and commitment to serve the society.
3. Our graduates possess academic excellence, managerial skills, leadership qualities and understand the need for lifelong learning for a successful professional career.

Programme Outcomes (POs)

Engineering Graduates will be able to,

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcome (PSOs)

A graduate of the Aeronautical Engineering program will

1. Develop deep working knowledge to solve complex problems in aerodynamics, propulsion, structures and flight mechanics
2. Demonstrate the problem-solving ability and hands-on skills to enter careers in the design, manufacturing, testing, or maintenance of aeronautical systems.
3. Be equipped to use CAE packages and simulation language skills to solve practical, design and analysis problems.

CBCS CURRICULUM AND SYLLABUS
B.E. AERONAUTICAL ENGINEERING
REGULATION 2019 (Revised)

CURRICULUM

SEMESTER I

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	HS19151	TECHNICAL ENGLISH	HS	3	2	1	0	3
2	MA19151	ALGEBRA AND CALCULUS	BS	4	3	1	0	4
3	PH19141	PHYSICS OF MATERIALS	BS	5	3	0	2	4
4	GE19101	ENGINEERING GRAPHICS	ES	4	2	2	0	4
5	GE19121	ENGINEERING PRACTICES - CIVIL AND MECHANICAL	ES	2	0	0	2	1
6	MC19101	ENVIRONMENTAL SCIENCE AND ENGINEERING (Non-Credit Course)	MC	3	3	0	0	0
TOTAL				**21**	**13**	**4**	**4**	**16**

SEMESTER II

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	MA19251	DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS	BS	4	3	1	0	4
2	CY19241	ENGINEERING CHEMISTRY	BS	5	3	0	2	4
3	EE19242	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	ES	5	3	0	2	4
4	GE19201	ENGINEERING MECHANICS	ES	3	2	1	0	3
5	GE19122	ENGINEERING PRACTICES - ELECTRICAL AND ELECTRONICS	ES	2	0	0	2	1
6	GE19211	PROBLEM SOLVING AND PROGRAMMING IN PYTHON	ES	5	1	0	4	3
7	MC19102	INDIAN CONSTITUTION AND FREEDOM MOVEMENT (Non-Credit Course)	MC	3	3	0	0	0
TOTAL				**27**	**15**	**2**	**10**	**19**

SEMESTER III

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	MA19351	TRANSFORMS AND STATISTICS	BS	4	3	1	0	4
2	AE19301	FUNDAMENTALS OF AEROSPACE ENGINEERING	PC	3	3	0	0	3
3	AE19302	MECHANICS OF MACHINES	PC	3	2	1	0	3
4	AE19341	FLUID MECHANICS AND FLUID MACHINERY	PC	5	2	1	2	4
5	AE19342	SOLID MECHANICS	PC	5	2	1	2	4
6	CS 19411	PYTHON PROGRAMMING FOR MACHINE LEARNING	ES	5	1	0	4	3
7	MC19301	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE (Non-Credit Course)	MC	3	3	0	0	0
8	AE19311	COMPUTER AIDED MODELING LABORATORY	PC	4	0	0	4	2
TOTAL				**32**	**16**	**4**	**12**	**23**

SEMESTER IV

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	MA19451	NUMERICAL METHODS	BS	4	3	1	0	4
2	AE19401	AERODYNAMICS - I	PC	3	2	1	0	3
3	AE19403	ADVANCED STRENGTH OF MATERIALS	PC	3	2	1	0	3
4	AE19441	AERO ENGINEERING THERMODYNAMICS	PC	5	2	1	2	4
5	AE19442	AIRCRAFT MATERIALS AND PROCESSES	PC	5	3	0	2	4
6	AE19411	AERODYNAMICS LAB	PC	4	0	0	4	2
7	AE19412	AIRCRAFT COMPONENT DRAWING	PC	4	0	0	4	2
8	GE19421	SOFT SKILLS - I	EEC	2	0	0	2	1
TOTAL				**30**	**12**	**4**	**14**	**23**

SEMESTER V

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	AE19501	AERODYNAMICS - II	PC	3	2	1	0	3
2	AE19502	PROPULSION - I	PC	3	2	1	0	3
3	AE19504	AIRCRAFT STRUCTURES	PC	3	2	1	0	3
4	AE19505	FLIGHT DYNAMICS	PC	3	2	1	0	3
5	AE19541	AIRCRAFT SYSTEMS AND INSTRUMENTS	PC	4	2	0	2	3
6	AE19511	AIRCRAFT STRUCTURES LAB	PC	4	0	0	4	2
7	AE19512	AIRFRAME REPAIR AND AERO ENGINE LABORATORY	PC	4	0	0	4	2
8	GE19521	SOFT SKILLS - II	EEC	2	0	0	2	1
9		OPEN ELECTIVE - I	OE	3	3	0	0	3
TOTAL				**29**	**13**	**4**	**12**	**23**

SEMESTER VI

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	AE19601	FINITE ELEMENT METHOD	PC	3	2	1	0	3
2	AE19602	PROPULSION - II	PC	3	2	1	0	3
3	AE19603	CONTROL ENGINEERING	PC	3	3	0	0	3
4	AE19641	FLIGHT VEHICLE DESIGN	PC	5	3	0	2	4
5	GE19304	FUNDAMENTALS OF MANAGEMENT FOR ENGINEERS	HS	3	3	0	0	3
6	AE19611	JET PROPULSION LABORATORY	PC	4	0	0	4	2
7	AE19612	INNOVATION AND DESIGN THINKING FOR ENGINEERS	EEC	4	0	0	4	2
8	GE19621	PROBLEM SOLVING TECHNIQUES	EEC	2	0	0	2	1
9		OPEN ELECTIVE - II	OE	3	3	0	0	3
8	AE19721	SUMMER INTERNSHIP	EEC	-	-	-	-	1
TOTAL				**30**	**16**	**2**	**12**	**25**

SEMESTER VII

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	AE19701	COMPUTATIONAL FLUID DYNAMICS	PC	3	3	0	0	3
2	AE19741	AVIONICS	PC	5	3	0	2	4
3		PROFESSIONAL ELECTIVE - I	PE	3	3	0	0	3
4		PROFESSIONAL ELECTIVE – II	PE	3	3	0	0	3
5		PROFESSIONAL ELECTIVE - III	PE	3	3	0	0	3
6	AE19711	PROJECT WORK (PHASE – I)	EEC	4	0	0	4	2
7	AE19712	STRUCTURAL AND FLOW SIMULATION LABORATORY	PC	4	0	0	4	2
8	AE19713	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR AERONAUTICAL ENGINEERING	EEC	4	0	0	4	2
TOTAL				**29**	**15**	**0**	**14**	**22**

SEMESTER VIII

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1		PROFESSIONAL ELECTIVE – IV	PE	3	3	0	0	3
2		PROFESSIONAL ELECTIVE – V	PE	3	3	0	0	3
3	AE19811	PROJECT WORK (PHASE – II)	EEC	16	-	-	16	8
TOTAL				**22**	**6**	**0**	**16**	**14**

ELECTIVES FOR B.E. AERONAUTICAL ENGINEERING

Verticals / Professional Electives

Semester	VERTICAL 1	VERTICAL 2	VERTICAL 3	DIVERSIFIED COURSES
	Aerodynamics	**Propulsion**	**Structures And Materials**	
VII	AE19A11 - Experimental Aerodynamics	AE19B11 - Heat Transfer	AE19C11 - Fatigue and Fracture	AE19D11 - Introduction to UAV Systems
	AE19A12 - Applied Aerodynamics	AE19B12 - Design of Gas Turbine Engine components	AE19C12 - Theory of Elasticity	AE19D12 - Space Mechanics
	AE19A13 - Hypersonic Aerodynamics	AE19B13 - Advanced Propulsion Systems	AE19C13 – Non-destructive Evaluation	AE19D13 - Civil Aviation Requirements
	AE19A14 - Launch Vehicle Aerodynamics	AE19B14 - Combustion and Flames	AE19C14 - Introduction to Vibrations	AE19D14 - Aero Engine Maintenance and Repair
	AE19A15 - Missile Aerodynamics	AE19B15 – Spray Theory	AE19C15 - Aeroelasticity	AE19D15 - Aircraft General Engineering and Maintenance Practices
VIII	AE19A16 - Helicopter Theory	AE19B16 - Turbo Machines	AE19C16 - Composite Materials and Structures	AE19D16 - Drone Safety Rules & Regulations
	AE19A17 - Boundary Layer Theory	AE19B17 - Numerical Heat transfer	AE19C17 - Experimental Stress Analysis	AE19D17 - Entrepreneurship Development for Engineers
	AE19A18 - Turbulence modeling in Fluid Flows	AE19B18 - High-temperature Gas Dynamics	AE19C18 - Theory of Plates and Shells	AE19D18 - Air Traffic Control and Planning
	AE19A19 - Introduction to Aeroacoustics	AE19B19 - Refrigeration and Cryogenics	AE19C19 - Material Testing and Characterization	AE19D19 – Total Quality Management for Engineers

OPEN ELECTIVES OFFERED BY DEPT. OF AERO

SL.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	OAE1901	Introduction to Aeronautical Engineering	OE	3	0	0	3
2	OAE1902	Fundamentals of Jet Propulsion	OE	3	0	0	3
3	OAE1903	Introduction to space flight	OE	3	0	0	3
4	OAE1904	Industrial Aerodynamics	OE	3	0	0	3

STRUCTURE OF UNDERGRADUATE ENGINEERING PROGRAM

Sl. No	Category	No. of Credits (AICTE)	No. of Credits (revised R2019)	% Distribution (revised R2019)
1	Humanities and Social Sciences including Management courses (HS)	12	6	3.6
2	Basic Science courses (BS)	25	24	14.5
3	Engineering Science courses (ES)	24	19	11.5
4	Professional core courses (PC)	48	77	46.7
5	Professional Elective courses (PE)	18	15	9.1
6	Open Elective Course (OE)	18	6	3.6
7	Project work, seminar and internship in industry or elsewhere (EEC)	15	18	10.9
8	Mandatory Courses (MC) [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge]	0	0	0

CREDIT DISTRIBUTION – SEMESTER WISE

SEMESTER	NO. OF CREDITS
I	**16**
II	**19**
III	**23**
IV	**23**
V	**23**
VI	**25**
VII	**22**
VIII	**14**
TOTAL	**165**

SEMESTER – I

Subject Code	Subject Name	Category	L	T	P	C
HS19151	TECHNICAL ENGLISH	HS	2	1	0	3

Common to all branches of B.E./ B.Tech programmes – I semester

Objectives:

- To enable learners to acquire basic proficiency in English reading and listening.
- To write in English precisely and effectively.
- To speak flawlessly in all kinds of communicative contexts.

UNIT-I VOCABULARY BUILDING 9

The concept of word formation - Root words from foreign languages and their use in English - Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives - Synonyms, antonyms, and standard abbreviations. Compound words – abbreviation – single word substitution – **Listening:** Listening comprehension, listening to motivational speeches, podcasts and poetry. **Speaking:** Short talks on incidents - place of visit – admiring personalities, etc.

UNIT-II BASIC WRITING SKILLS 9

Sentence structures - Use of phrases and clauses in sentences - punctuation - coherence - Organizing principles of paragraphs in documents - Techniques for writing precisely. **Reading & Writing** – Free writing – paragraphs - article reading and writing criticism - change of tense forms in short text or story – inferential reading – rewrite or interpret text - prepare questions based on the text. **Speaking:** Everyday situations – conversations and dialogues, speaking for and against.

UNIT-III GRAMMAR AND LANGUAGE DEVELOPMENT 9

Subject-verb agreement- Noun-pronoun agreement - Articles – Prepositions – Redundancies. **Reading & Writing:** Read from innovation and ideas that changed the world, newspaper column writing – **Speaking:** Demonstrative speaking practice using visual aids (charts, graphs, maps, pictures, etc,).

UNIT-IV WRITING FOR FORMAL PRESENTATION 9

Nature and Style of sensible Writing - Describing – Defining – Classifying - Providing examples or evidence - Writing introduction and conclusion. **Reading & Writing –** Read from Literary pieces – identify different parts text – difference between print and digital writing. Writing: Recommendations - Foreword - Review of book. **Speaking-** Formal Presentations – Debate on social issues/taboos and solutions.

UNIT-V EXTENDED WRITING AND SPEAKING 9

Writing: Précis writing – Essay writing – workplace communication: Resume – Business letters and emails – Proposals. **Speaking:** Panel discussion – reporting an event – mock interview – Master Ceremony.

Total Contact Hours : 45

Course Outcomes:

On completion of course students will be able to

- Discuss and respond to the listening content.
- Read and comprehend different texts and appreciate them
- Understand structures and techniques of precise writing
- Analyse different genres of communication and get familiarized with new words, phrases, and sentence structures.
- Write and speak appropriately in varied formal and informal contexts.

Text Books:

1 1. English for Technologists & Engineers, Orient BlackSwan Publications, Chennai 2012.

Reference Books / Web links:

1. Technical Communication, Meenakshi Raman & Sangeeta Sharma, Oxford University Press
2. Effective Communication Skills, Kulbushan Kumar, Khanna Publishing House, Delhi
3. Communication Skills, Pushplata, Sanjay Kumar, Oxford University Press
4. Practical English Usage. Michael Swan. OUP. 1995.
5. Remedial English Grammar. F.T. Wood. Macmillan.2007
6. On Writing Well. William Zinsser. Harper Resource Book. 2001
7. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
8. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HS19151.1	1	3	-	2	-	2	1	-	3	3	-	1	1	1	1
HS19151.2	-	-	2	2	1	2	3	3	3	1	-	3	2	-	2
HS19151.3	-	-	-	1	-	1	1	1	3	3	3	3	1	-	1
HS19151.4	-	-	1	-	-	2	2	2	2	2	1	1	2	-	1
HS19151.5	-	-	-	1	-	2	2	-	1	2	3	3	1	1	-
Average	1	3	1.5	1.5	1	1.8	1.8	2	2.4	2.2	3	2.4	1.4	2	1.25

Subject Code	Subject Name	Category	L	T	P	C
MA19151	ALGEBRA AND CALCULUS	BS	3	1	0	4

Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechatronics & Mechanical Engineering

Objectives:

- To gain knowledge in using matrix algebra techniques and the limitations of using infinite series approximations for those problems arising in mathematical modelling.
- To understand the techniques of calculus which are applied in the Engineering problems.

UNIT-I MATRICES **12**

Symmetric and skew – symmetric matrices, orthogonal matrices – Eigen values and Eigen vectors - Cayley – Hamilton theorem (without proof) and applications - orthogonal transformation and quadratic forms to canonical forms - Nature of quadratic forms.

UNIT-II SEQUENCES AND SERIES **12**

Convergence of sequence and series – Test for convergence: Comparison Test, D'Alembert Ratio Test, Leibnitz Test, Integral test – Binomial series, Exponential series and logarithmic series: Summations and approximations.

UNIT-III APPLICATIONS OF DIFFERENTIAL CALCULUS **12**

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes - Evolute as envelope of normals.

UNIT-IV FUNCTIONS OF SEVERAL VARIABLES **12**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT-V APPLICATION OF INTEGRATION **12**

Centre of Gravity – Moment of inertia - Double integrals in Cartesian and polar coordinates – Change of order of integration - Area of a curved surface - Triple integrals – Volume of Solids.

Total Contact Hours : 60

Course Outcomes:

On completion of the course students will be able to

- Apply the concept of Eigenvalues and eigenvectors, diagonalization of a matrix for solving problems.
- Develop skills in solving problems involving sequences and series.
- Analyze, sketch and study the properties of different curves and to handle functions of several variables and problems of maxima and minima.
- Obtain the centre of gravity, moment of inertia for rigid bodies and also surface area and volume using multiple integrals.
- Process the data collected and analyze the data for central tendencies.

Text Books:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. T Veerarajan, Engineering Mathematics –I, Mc Graw Hill Education, 2014

Reference Books / Web links:

1. Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2. Erwin Kreyszig," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3. Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA19151.1	3	3	3	3	3	2	-	-	-	-	2	2	3	2	1
MA19151.2	3	3	3	3	3	2	-	-	-	-	2	2	3	2	1
MA19151.3	3	3	3	3	2	1	-	-	-	-	2	2	3	2	1
MA19151.4	3	3	2	2	2	1	-	-	-	-	1	1	3	1	1
MA19151.5	3	3	2	2	2	1	-	-	-	-	1	1	3	1	1
Average	3	3	2.6	2.6	2.4	1.4	-	-	-	-	1.6	1.6	3	1.6	1

Subject Code	Subject Name	Category	L	T	P	C
PH19141	PHYSICS OF MATERIALS	BS	3	0	2	4

Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechanical Engineering & Mechatronics

Objectives:

- To enhance the fundamental knowledge in Physics and its applications relevant to mechanical engineering streams.
- To familiarize students in various experimental setups and instruments that are used to study / determine the various properties of materials.

UNIT-I MECHANICS & PROPERTIES OF MATTER 9

Basic definitions - Newton's laws – forces -solving Newton's equations - constraints and friction - cylindrical and spherical coordinates - potential energy function - conservative and non-conservative forces - central forces - conservation of angular momentum - non-inertial frames of reference - rotating coordinate system - centripetal and coriolis accelerations – Elasticity - stress-strain diagram - bending of beams - cantilever depression - Young's modulus determination - I-shape girders.

UNIT-II CRYSTAL PHYSICS 9

Basis – lattices - symmetry operations and crystal systems -Bravaislattics - atomic radius and packing fraction - SC, BCC, FCC, HCP lattices - Miller indices - diffraction by crystals - reciprocal lattice - interpreting diffraction patterns - crystal growth techniques-Czochralski and Bridgmann, crystal defects.

UNIT-III PHYSICS OF MATERIALS 9

Solid solutions - Hume-Rothery's rules –Gibb's phase rule - binary phase diagrams -isomporhpus systems - tie-line and lever rule - eutectic, eutectoid, peritectic, peritectoid, monotectic and syntectic systems - formation of microstructures - homogeneous and non-homogenous cooling – nucleation - iron-carbon phase diagram - eutectoid steel - hypo and hypereutectoid steel – diffusion - Fick's laws – T-T-T diagrams.

UNIT-IV ENGINEERING MATERIALS & TESTING 9

Metallic glasses – preparation and properties - Ceramics – types, manufacturing methods and properties - Composites – types and properties - Shape memory alloys – properties and applications - Nano-materials – top down and bottom up approaches – properties - Tensile strength – Hardness – Fatigue - Impact strength – Creep - Fracture – types of fracture.

UNIT-V QUANTUM PHYSICS 9

Blackbody problem -Planck's radiation law - duality of light -De Broglie hypothesis - properties of matter waves - wave packets –Schrodinger's equations (time dependent and time independent) - Born interpretation (physical significance of wave function) - probability current - operator formalism (qualitative) - expectation values - uncertainty principle - particle in a box -eigen function and eigen values -Dirac notation (qualitative).

Contact Hours : 45

List of Experiments

1. Determination of Laser characteristics (wavelength and angular spread).
2. Determination of Young's modulus by non-uniform bending method
3. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
4. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
5. Coupled oscillators - Two compound pendulums;
6. Experiment on moment of inertia measurement- Torsional pendulum by resonance,
7. LC circuit, LCR circuit and Resonance phenomena in LCR circuits;
8. Experiments on electromagnetic induction – BH-Curve experiment
9. Determination of thickness of a thin wire – Air wedge method
10. Determination of solar cell characteristics.
11. Measurement of hysteresis loss:B -H curve.
12. Determination of creep characteristics of a metallic wire

Contact Hours : 30
Total Contact Hours : 75

Course Outcomes:

On completion of the course students will be able to

- Understand foundational mechanics and elastic nature of materials and determine the elastic moduli of materials.
- Apply the basic knowledge of crystallography in materials preparation and treatments.
- Create binary phase diagrams and TTT charts and use them to analyse and measure the properties of alloys.
- Understand various engineering materials, test or measure their properties and use them in suitable applications.
- Understand the concepts of quantum theory and the nature of light and determine the characteristics of a given laser source.

Text Books:

1 Bhattacharya, D.K. & Poonam, T. *"Engineering Physics".* Oxford University Press, 2018.
2 Raghavan, V. *"Physical Metallurgy: Principles and Practice"*. PHI Learning, 2019.

Reference Books / Web links:

1 Balasubramaniam, R. *"Callister's Materials Science and Engineering".* Wiley India Pvt. Ltd., 2017.
2 Raghavan, V. *"Materials Science and Engineering: A First course"*. PHI Learning, 2019.
3 Resnick, R., Halliday, D., & Walker, J. *"Principles of Physics*", Wiley India Pvt., 2018.
4 Gaur, R.K. & Gupta, S.L. *"Engineering Physics".* DhanpatRai Publishers, 2018.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PH19141.1	3	2	1	1	2	1	-	1	1	1	1	2	2	1	1
PH19141.2	3	2	1	1	2	2	1	-	1	1	1	2	2	1	1
PH19141.3	3	2	1	1	2	1	2	-	1	1	1	2	2	1	1
PH19141.4	3	2	1	1	2	2	2	1	1	1	1	2	2	1	1
PH19141.5	3	2	1	1	2	2	2	2	1	1	1	2	2	1	1
Average	3	2	1	1	2	1.6	1.4	1.33	1	1	1	2	2	1	1

GE19101	ENGINEERING GRAPHICS	Category	L	T	P	C
		ES	2	2	0	4

Objectives:
- To understand the importance of the drawing in engineering applications
- To develop graphic skills for communication of concepts, ideas and design of engineering products
- To expose them to existing national standards related to technical drawings.
- To improve their visualization skills so that they can apply these skills in developing new products.
- To improve their technical communication skill in the form of communicative drawings

CONCEPTS AND CONVENTIONS (Not for Examination) 1

Importanceofgraphicsinengineeringapplications–Useofdraftinginstruments– BIS conventions and specifications–Size, layout and folding of drawing sheets– Lettering and dimensioning. Basic Geometrical constructions.

UNIT-I PLANECURVES AND FREE HAND SKETCH 8

Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method– Construction of cycloids, Construction of involutes of square and circle drawing of tangents and normal to the above curves.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three-Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

UNIT-II PROJECTION OFPOINTS, LINES AND PLANESURFACE 9

Orthographic projection- principles-Principal planes- projection of points. First angle projection - Projection of straight lines inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method- Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT-III PROJECTIONOFSOLIDS 9

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method.

UNIT-IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENTOF SURFACES 9

Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of the section.

Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

UNIT-V ISOMETRIC AND PERSPECTIVE PROJECTIONS 9

Principles of isometric projection–isometric scale–Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders and cones.

Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Total Contact Hours : 45

Course Outcomes: After learning the course, the students should be able
- To construct different plane curves and free hand sketching of multiple views from pictorial objects.
- To comprehend the theory of projection and to draw the basic views related to projection of points, lines and planes
- To draw the projection of solids in different views
- To draw the projection of Sectioned solids and development of surfaces of solids
- To visualize and prepare Isometric and Perspective view of simple solids

Text Book (s):

1 Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2 Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2017.

Reference Books(s) / Web links:

1. Varghese P I., "Engineering Graphics", McGraw Hill Education (I) Pvt.Ltd., 2013.
2. Venugopal K. and PrabhuRaja V., "Engineering Graphics", New Age International (P)Limited, 2008.
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2017.
4. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill Publishing Company Limited, New Delhi, 2018.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19101.1	2	1	2	1	1	1	1	1	1	1	2	2	2	2	3
GE19101.2	2	1	2	1	1	1	1	1	1	1	2	2	2	2	3
GE19101.3	2	1	2	1	1	1	1	1	1	1	2	2	2	2	3
GE19101.4	1	1	2	1	1	1	1	1	1	1	2	2	2	2	3
GE19101.5	2	1	2	1	1	1	1	1	1	1	2	2	2	2	3
Average	1.8	1	2	1	1	1	1	1	1	1	2	2	2	2	3

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
GE19121	ENGINEERING PRACTICES LABORATORY – Civil & Mechanical	ES	0	0	2	1

Objectives:

To provide exposure to the students with hands on experience on various basic engineering practices in Civil and Mechanical Engineering.

List of Experiments

CIVIL ENGINEERING PRACTICE

1. Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.
2. Preparation of basic plumbing line sketches for wash basins, water heaters, etc.
3. Hands-on-exercise: Basic pipe connections – Pipe connections with different joining components.

Carpentry Works:

4. Study of joints in roofs, doors, windows and furniture.
5. Hands-on-exercise: Woodwork, joints by sawing, planning and chiselling.

MECHANICAL ENGINEERING PRACTICE

6. Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
7. Gas welding practice.

Basic Machining:

8. Simple Turning and Taper turning
9. Drilling Practice

Sheet Metal Work:

10. Forming & Bending:
11. Model making – Trays and funnels
12. Different type of joints.

Machine Assembly Practice:

13. Study of centrifugal pump
14. Study of air conditioner

Total Contact Hours : 30

Course Outcomes:

- Able to perform plumbing activities for residential and industrial buildings considering safety aspects while gaining clear understanding on pipeline location and functions of joints like valves, taps, couplings, unions, reducers, elbows, etc.
- Able to perform wood working carpentry activities like sawing, planning, cutting, etc. while having clear understanding of the joints in roofs, doors, windows and furniture.
- Able to produce joints like L joint, T joint, Lap joint, Butt joint, etc. through arc welding process while acquiring in depth knowledge in the principle of operation of welding and other accessories
- Able to perform operations like Turning, Step turning, Taper turning, etc. in lathe and Drilling operation in drilling machine
- Able to perform sheet metal operations like Forming, Bending, etc. and fabricating models like Trays, funnels, etc.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19121.1	3	3	3	3	3	1	1	-	2	1	3	3	2	2	3
GE19121.2	3	3	3	3	2	2	2	-	2	1	3	3	1	2	2
GE19121.3	3	3	3	3	3	1	1	-	2	1	3	3	2	2	2
GE19121.4	3	3	2	2	2	1	1	-	2	1	3	3	1	2	2
GE19121.5	3	3	2	2	2	1	1	-	2	1	3	3	2	2	2
Average	3	3	2.6	2.6	2.6	1.2	1.2	-	2	1	3	3	1.4	2	2.2

Subject Code	Subject Name	Category	L	T	P	C
MC19101	ENVIROMENTAL SCIENCE AND ENGINEERING	MC	3	0	0	0

Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Biomedical Engineering, Civil Engineering, Mechanical Engineering & Mechatronics
and
B.Tech. – Biotechnology, Chemical Engineering & Food Technology
and
Common to II sem. B.E. – Computer Science and Engineering, Electrical and Communication Engineering & Electrical and Electronics Engineering
and
B.Tech. – Information Technology

Objectives:

- To understand the importance of natural resources, pollution control and waste management.
- To provide the students about the current social issues and environmental legislations.

UNIT-I NATURAL RESOURCES 9

Environment -definition - scope and importance - forest resources -use and overexploitation -water resources -use and over utilization - dams - benefits and problems - water conservation -energy resources - growing energy needs - renewable and non-renewable energy sources - use of alternate energy sources -land resources -land degradation - role of an individual in conservation of natural resources.

UNIT-II ENVIRONMENTAL POLLUTION 9

Definition - causes, effects and control measures of air pollution -chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, and ozone depletion- noise pollution -mitigation procedures - control of particulate and gaseous emission (Control of SO_2, NO_X, CO and HC).

Water pollution - definition-causes-effects of water pollutants–marine pollution-thermal pollution-radioactive pollution-control of water pollution by physical, chemical and biological processes–waste water treatment-primary, secondary and tertiary treatment.

Soil pollution: definition-causes-effects and control of soil pollution.

UNIT-III SOLID WASTE MANAGEMENT 9

Solid wastes - sources and classification of solid wastes -solid waste management options - sanitary landfill, recycling, composting, incineration, energy recovery options from wastes

Hazardous waste -definition -sources of hazardous waste-classification (biomedical waste, radioactive waste, chemical waste, household hazardous waste)-characteristics of hazardous waste ignitability (flammable) reactivity, corrosivity, toxicity -effects of hazardous waste -case study- Bhopal gas tragedy - disposal of hazardous waste-recycling , neutralization, incineration, pyrolysis, secured landfill - E-waste management -definition-sources-effects -electronic waste recycling technology.

UNIT-IV SOCIAL ISSUES AND THE ENVIRONMENT 9

Sustainable development -concept, components and strategies - social impact of growing human population and affluence, food security, hunger, poverty, malnutrition, famine - consumerism and waste products - environment and human health - role of information technology in environment and human health -disaster management– floods, earthquake, cyclone and landslide.

UNIT-V TOOLS FOR ENVIRONMENTAL MANAGEMENT 9

Environmental impact assessment (EIA) structure -strategies for risk assessment–EIS-environmental audit-ISO 14000-precautionary principle and polluter pays principle- constitutional provisions- - pollution control boards and pollution control acts- environmental protection act1986- role of non-government organizations- international conventions and protocols.

Contact Hours : 45

Course Outcomes:

On completion of the course students will be able to

- Be conversant to utilize resources in a sustainable manner.
- Find ways to protect the environment and play proactive roles.
- Apply the strategies to handle different wastes
- Develop and improve the standard of better living.
- Be conversant with tools of EIA and environmental legislation.

Text Books:

1 Benny Joseph, "Environmental Science and Engineering", 2nd edition, Tata McGraw-Hill, New Delhi,2008.

2 Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004.

Reference Books / Web links:

1 Dharmendra S. Sengar, "Environmental law", Prentice hall of India Pvt Ltd, New Delhi,2007.

2 ErachBharucha, "Textbook of Environmental Studies", 3rd edition, Universities Press(I) Pvt Ltd, Hyderabad, 2015.,

3 G. Tyler Miller and Scott E. Spoolman, "Environmental Science", 15th edition, Cengage Learning India PVT, LTD, Delhi, 2014.

4 Rajagopalan, R, "Environmental Studies-From Crisis to Cure", 3rdedition, Oxford University Press,2015.

5 De. A.K., "Environmental Chemistry", New Age International, New Delhi,1996.

6 K. D. Wager, Environmental Management, W. B. Saunders Co., Philadelphia, USA, 1998.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC19101.1	3	2	3	2	1	3	3	2	1	1	1	2	1	1	1
MC19101.2	3	2	3	2	1	3	3	2	1	1	2	2	1	1	1
MC19101.3	3	2	3	1	1	3	3	2	1	1	1	1	1	1	1
MC19101.4	3	2	3	1	2	2	3	2	2	2	1	2	1	1	1
MC19101.5	3	2	2	1	1	2	3	1	1	2	1	1	-	-	1
AVG.	3	2	2.8	1.4	1.2	2.6	3	1.8	1.2	1.4	1.2	1.6	1	1	1

SEMESTER – II

Subject Code	Subject Name	Category	L	T	P	C
MA19251	DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS	BS	3	1	0	4

Common to II sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechatronics & Mechanical Engineering and B. Tech. - Biotechnology, Food Technology & Chemical Engineering

Objectives:

- To handle practical problems arising in the field of engineering and technology using differential equations.
- To solve problems using the concept of Vectors calculus, Complex analysis, Laplace transforms.

UNIT-I SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS 12

Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters – Cauchy's and Legendre's linear equations - Simultaneous first order linear equations with constant coefficients.

UNIT-II PARTIAL DIFFERENTIAL EQUATIONS 12

Formation of partial differential equations - Solutions of standard types of first order partial differential equations - Lagrange's linear equation -- Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT-III VECTOR CALCULUS 12

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelopipeds.

UNIT-IV ANALYTIC FUNCTIONS 12

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping and Bilinear transformation-Cauchy's integral theorem and Cauchy's integral formula (proof excluded) – Taylor's series and Laurent's series – Singularities – Residues – Residue theorem (without proof), simple problems.

UNIT-V LAPLACE TRANSFORM 12

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions, periodic functions. Inverse Laplace transform – Problems using Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

Total Contact Hours : 60

Course Outcomes:

On completion of course students will be able to

- Apply various techniques in solving ordinary differential equations.
- Develop skills to solve different types of partial differential equations
- Use the concept of Gradient, divergence and curl to evaluate line, surface and volume integrals.
- Use the concept of Analytic functions, conformal mapping and complex integration for solving Engineering problems.
- Use Laplace transform and inverse transform techniques in solving differential equations.

Text Books:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. T Veerarajan, Engineering Mathematics –II, Mc Graw Hill Education, 2018

Reference Books / Web links:

1. Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2. Erwin Kreyszig," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3. Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.
4. T Veerarajan, Transforms and Partial Differential Equations, Third Edition, 2018.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA19251.1	3	3	3	3	3	2	-	-	-	-	2	2	3	2	1
MA19251.2	3	3	3	3	3	2	-	-	-	-	2	2	3	2	1
MA19251.3	3	3	3	3	2	1	-	-	-	-	2	2	3	2	1
MA19251.4	3	3	2	2	2	1	-	-	-	-	1	1	3	1	1
MA19251.5	3	3	2	2	2	1	-	-	-	-	1	1	3	1	1
Average	3	3	2.6	2.6	2.4	1.4	-	-	-	-	1.6	1.6	3	1.6	1

Subject Code	Subject Name	Category	L	T	P	C
CY19241	ENGINEERING CHEMISTRY	BS	3	0	2	4

Common to II sem. B.E. – Aeronautical Engineering, Automobile Engineering, Mechanical Engineering and Mechatronics

Objectives:

- To understand the theoretical and practical principles of corrosion and its control
- To familiarise the fundamentals of chemical energy conversions in batteries and fuels
- To acquaint knowledge on alloys and analytical techniques

UNIT-I CORROSION AND PROTECTIVE COATINGS 9

Cause and effects of corrosion - theories of chemical and electrochemical corrosion –emf series- types of corrosion: Galvanic, water-line , intergranular and pitting corrosion – passivity - factors affecting rate of corrosion - corrosion control methods- cathodic protection -sacrificial anode and impressed current cathodic methods - corrosion inhibitors - metal cladding - anodizing - electroplating - electroless plating - factors influencing electroplating - polarisation - decomposition potential - over voltage - current density - electrolyte concentration- additives - organic coatings - paints - constituents - functions - special paints - fire retardant - water repellent - temperature indicating and luminous paints.

UNIT-II ENERGY STORAGE DEVICES 9

Batteries - primary battery - alkaline battery - secondary battery (Lead acid storage battery, Nickel - Cadmium battery and Lithium – ion battery) -flow battery -components, working principle and applications of hydrogen-oxygen, solid oxide, direct methanol and proton exchange membrane fuel cells.

UNIT-III PHASE RULE AND ALLOYS 9

Phase rule - definition of terms - one component system -water system - reduced phase rule - thermal analysis - two component system- eutectic system - lead silver system - safety fuses and solders.

Alloys - purpose of alloying - function and effects of alloying elements - properties of alloys - classification of alloys - Ferrous alloys - nichrome and stainless steel - Non-ferrous alloys - brass and bronze - heat treatment of alloys (annealing, hardening, tempering, normalising, carburizing and nitriding)

UNIT-IV FUNDAMENTAL SPECTROSCOPIC TECHNIQUES AND THERMAL ANALYSIS 9

Principles of spectroscopy - UV,visible and IR spectroscopy principle - instrumentation (block diagram) - applications. Principles, block diagram, instrumentation and applications of TGA, DTA, DSC and Flame photometry

UNIT-V FUELS AND COMBUSTION 9

Fuels- classification -coal-ranking of coal- proximate and ultimate analysis metallurgical coke - manufacture by Otto-Hoffmann method - Petroleum processing and fractions -knocking - octane number and cetane number - synthetic petrol - Fischer Tropsch and Bergius processes -power alcohol, biodiesel- Gaseous fuels CNG and LPG.

Combustion-calorific value- Dulongs formula-problems- flue gas analysis – Orsat apparatus–theoretical air for combustion – problems

Contact Hours : 45

List of Experiments

1. Determination of corrosion rate on mild steel by weight loss method
2. Estimation of DO by winkler's method
3. Determination of total, temporary and permanent hardness by EDTA method.
4. Estimation of alkalinity by indicator method.
5. Estimation of chloride by argentometric method
6. Estimation of extent of corrosion of Iron pieces by potentiometry
7. Estimation of mixture of acids by conductometry.
8. Estimation of acid by pH metry
9. Estimation of copper / ferrous ions by spectrophotometry.
10. Estimation of sodium and potassium in water by flame photometry.

11 Determination of flash and fire point of lubricating oil
12 Determination of cloud and pour point of lubricating oil
13 Determination of phase change temperature of a solid.

Contact Hours : 30
Total Contact Hours : 75

Course Outcomes:

On completion of the course students will be able to

- Analyse type of corrosion and identify suitable corrosion control method
- Construct electrochemical cells and measure its potential
- Modify metal properties by alloying
- Characterize various material systems
- Understand the role of fuels in day to day applications

Text Books:

1 P. C. Jain and Monika Jain, "Engineering Chemistry", DhanpatRai Publishing Company (P) Ltd,New Delhi, 2015.
2 O.G.Palanna, "Engineering Chemistry", McGraw Hill Education (India) PVT, Ltd,New Delhi, 2017.

Reference Books / Web links:

1 C. N. Banwell and E.M. McCash, "Fundamentals of Molecular Spectroscopy", 4th Edn, Tata Mc Graw-Hill Edition, 1995
2 Shashi Chawla, "A Text Book of Engineering Chemistry", Dhanpat Rai & Co, New Delhi, 2017.
3 Sharma Y.R., "Elementary Organic Spectroscopy", Sultan Chand & Sons, New Delhi, 2014.
4 Sharma B. K.,"AnalyticalChemistry",Krishna Prakashan Media (P) Ltd., Meerut, 2005.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CY19241.1	3	2	2	2	1	1	2	1	1	1	1	2	2	1	1
CY19241.2	3	2	2	1	2	1	2	1	2	1	2	2	2	1	1
CY19241.3	3	2	2	2	2	1	1	-	1	1	1	1	1	1	-
CY19241.4	2	1	1	1	1	-	-	-	1	-	-	1	1	-	-
CY19241.5	3	2	2	2	2	1	2	1	1	1	2	2	2	1	1
Average	2.8	1.8	1.8	1.6	1.6	1	1.75	1	1.2	1	1.5	1.6	1.6	1	1

Subject Code	Subject Name (Lab oriented Theory Courses)	Category	L	T	P	C
EE19242	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING (COMMON TO AERO, CSE, CHEM, CIVIL, FT AND IT)	ES	3	0	2	4

Objectives:

- To introduce electric circuits and provide knowledge on the analysis of circuits using network theorems.
- To impart knowledge on the phenomenon of resonance in RC, RL and RLC series and parallel circuits.
- To provide knowledge on the principles of electrical machines and electronic devices.
- To learn the concepts of different types of electrical measuring instruments and transducers.
- To teach methods of experimentally analyzing electrical circuits, electrical machines, electronic devices and transducers.

UNIT-I DC CIRCUITS 9

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff 's current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.

UNIT-II AC CIRCUITS 9

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections

UNIT-III ELECTRICAL MACHINES 9

Construction, Principles of operation and characteristics of; DC machines, Transformers (single and three phase), Synchronous machines , three phase and single phase induction motors.

UNIT-IV ELECTRONIC DEVICES & CIRCUITS 9

Types of Materials – Silicon & Germanium- N type and P type materials – PN Junction –Forward and Reverse Bias – Semiconductor Diodes –Bipolar Junction Transistor – Characteristics –-Field Effect Transistors – Transistor Biasing – Introduction to operational Amplifier –Inverting Amplifier –Non-Inverting Amplifier.

UNIT-V MEASUREMENTS & INSTRUMENTATION 9

Introduction to transducers - Classification of Transducers: Resistive, Inductive, Capacitive, Thermoelectric, piezoelectric, photoelectric, Hall effect - Classification of instruments - PMMC and MI Ammeters and. Voltmeters – Multimeter - Digital Storage Oscilloscope.

Contact Hours : 45

List of Experiments

1. Verification of Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Load test on Single phase Transformer.
4. Load test on Single phase Induction motor.
5. Characteristics of P-N junction Diode.
6. Half wave and Full wave Rectifiers.
7. Characteristics of CE based NPN Transistor.
8. Inverting and Non- Inverting Op-Amp circuits.
9. Characteristics of LVDT, RTD and Thermistor.

Contact Hours : 30
Total Contact Hours : 75

Course Outcomes:

On completion of the course, the students will be able to

- analyse DC and AC circuits and apply circuit theorems.
- realize series and parallel resonant circuits.
- understand the principles of electrical machines.
- understand the principles of different types of electronic devices, electrical measuring instruments and transducers.
- experimentally analyze the electric circuits, electrical machines, electronic devices, and transducers.

Text Book (s):

1. J.B.Gupta, "Fundamentals of Electrical Engineering and Electronics" S.K.Kataria & Sons Publications, 2002.
2. D P Kothari and I.J Nagarath, "Basic Electrical and Electronics Engineering", McGraw Hill Education (India) Private Limited, Third Reprint ,2016
3. Thereja .B.L., "Fundamentals of Electrical Engineering and Electronics", S. Chand & Co. Ltd., 2008

Reference Books(s) / Web links:

1. Del Toro, "Electrical Engineering Fundamentals", Pearson Education, New Delhi, 2007
2. John Bird, "Electrical Circuit Theory and Technology", Elsevier, First Indian Edition, 2006
3. Allan S Moris, "Measurement and Instrumentation Principles", Elseveir, First Indian Edition, 2006
4. Rajendra Prasad, "Fundamentals of Electrical Engineering", Prentice Hall of India, 2006
5. A.E.Fitzgerald, David E Higginbotham and Arvin Grabel, "Basic Electrical Engineering", McGraw Hill Education(India) Private Limited, 2009

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE19242.1	3	3	2	3	3	1	1	-	2	-	-	2	1	1	2
EE19242.2	3	3	2	3	3	1	1	-	2	-	-	-	1	1	2
EE19242.3	3	3	2	3	3	2	2	-	1	-	-	2	2	2	2
EE19242.4	3	3	2	3	3	2	2	-	2	-	2	2	1	2	2
EE19242.5	3	3	2	3	3	1	2	1	1	3	2	2	2	2	-
Average	3	3	2	3	3	1.4	2	1	2	3	2	2	1	2	2

GE19201	ENGINEERING MECHANICS (Common to Mech, Aero, Auto Civil and MCT)	Category	L	T	P	C
		ES	2	1	0	3

Objectives:

- To understand the basics of mechanics and apply the concept of equilibrium to solve problems of concurrent forces.
- To understand the concept of equilibrium and to solve problems of rigid bodies.
- To learn about the center of gravity and moment of inertia of surfaces and solids.
- To learn the basic concepts of friction.
- To learn the concepts in kinematics and kinetics of rigid bodies in plane motion.

UNIT-I STATICS OF PARTICLES 9

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility.

UNIT-II EQUILIBRIUM OF RIGID BODIES 9

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – (Descriptive treatment only)

UNIT-III PROPERTIES OF SURFACES AND SOLIDS 9

Centroids and centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

UNIT-IV DYNAMICS OF PARTICLES **9**

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT-V FRICTION AND RIGID BODY DYNAMICS **9**

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

Total Contact Hours : 45

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

GE19201.1	Comprehend and analysis the forces in the system.
GE19201.2	Solve problems in engineering systems using the concept of static equilibrium.
GE19201.3	Determine the centroid of objects such as areas and volumes, center of mass of body and moment of inertia of composite areas.
GE19201.4	Solve problems involving kinematics and kinetics of rigid bodies in plane motion.
GE19201.5	Solve problems involving frictional phenomena in machines.

Text Book (s):

1 Beer, F.P and Johnston Jr. E.R, Cornwell and Sanghi ., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 11thEdition, McGraw-Hill Publishing company, New Delhi (2017).

2 Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.

Reference Books(s) / Web links:

1 Meriam J.L. and Kraige L.G., "Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, Wiley India,2017.

2 Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education 2010.

3 Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics" 4thEdition, Pearson Education 2006.

4 S S Bhavikatti, Engineering Mechanics, New Age International Publishers, 2016

5 Vela Murali, "Engineering Mechanics", Oxford University Press (2010)

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19201.1	3	2	2	2	1	1	-	-	-	-	-	1	3	2	3
GE19201.2	3	2	2	2	1	1	-	-	-	-	-	1	3	2	3
GE19201.3	3	2	2	2	1	1	-	-	-	-	-	1	3	2	3
GE19201.4	3	2	2	2	1	1	-	-	-	-	-	1	3	2	3
GE19201.5	3	2	2	2	1	1	-	-	-	-	-	1	3	2	3
Average	3	2	2	2	1	1	-	-	-	-	-	1	3	2	3

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
GE19122	ENGINEERING PRACTICES - ELECTRICAL AND ELECTRONICS	ES	0	0	2	1

Objectives:

- To provide hands on experience on various basic engineering practices in Electrical Engineering.
- To impart hands on experience on various basic engineering practices in Electronics Engineering.

List of Experiments

A. ELECTRICAL ENGINEERING PRACTICE

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring.
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of resistance to earth of an electrical equipment.

B. ELECTRONICS ENGINEERING PRACTICE

1. Study of Electronic components and equipment's – Resistor, colour coding, measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
2. Study of logic gates AND, OR, EOR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

Total Contact Hours : 30

Course Outcomes:

On completion of the course, the students will be able to

GE19122.1 fabricate electrical and electronic circuits
GE19122.2 formulate the house wiring
GE19122.3 design the AC-DC converter using diode and passive components

REFERENCE

1. Bawa H.S., "Workshop Practice", Tata McGraw – Hill Publishing Company Limited, 2007.
2. Jeyachandran K., Natarajan S. & Balasubramanian S., "A Primer on Engineering Practices Laboratory", Anuradha Publications, 2007.
3. Jeyapoovan T., Saravanapandian M. &Pranitha S., "Engineering Practices Lab Manual",Vikas Publishing House Pvt.Ltd, 2006.
4. Rajendra Prasad A. &Sarma P.M.M.S., "Workshop Practice", SreeSai Publication, 2002.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19122.1	3	3	3	2	-	-	2	-	3	-	-	3	1	2	1
GE19122.2	3	3	2	2	-	-	2	-	3	-	-	3	1	2	1
GE19122.3	3	3	3	2	-	-	2	-	3	-	-	3	1	2	1
GE19122.4	3	3	3	2	-	-		-	3	-	-	3	1	1	1
GE19122.5	3	3	3	2	-	-		-	3	-	-	3	1	2	1
Average	3	3	2.67	2	-	-	2	-	3	-	-	3	1	2	1

Subject Code	Subject Name (Laboratory Course)	Category	L	T	I	C
GE19211	PROBLEM SOLVING AND PROGRAMMING IN PYTHON	ES	1	0	4	3

(With effect from 2021 batch onwards)
Common to all branches of B.E / B.Tech programmes
(Except – CSE, CSBS, CSD, IT, AI/ML)

Course Objectives:

- To understand computers, programming languages and their generations and essential skills for a logical thinking for problem solving.
- To write, test, and debug simple Python programs with conditionals, and loops and functions
- To develop Python programs with defining functions and calling them
- To understand and write python programs with compound data- lists, tuples, dictionaries
- To search, sort, read and write data from/to files in Python.

List of Experiments

1. Study of algorithms, flowcharts and pseudocodes.
2. Introduction to Python Programming and Demo on Python IDLE / Anaconda distribution.
3. Experiments based on Variables, Datatypes and Operators in Python.
4. Coding Standards and Formatting Output.
5. Algorithmic Approach: Selection control structures.
6. Algorithmic Approach: Iteration control structures.
7. Experiments based on Strings and its operations.
8. Experiments based on Lists and its operations.
9. Experiments based on Tuples and its operations.
10. Experiments based on Sets and its operations.
11. Experiments based on Dictionary and its operations.
12. Functions: Built-in functions.
13. Functions: User-defined functions.
14. Functions: Recursive functions.
15. Searching techniques: Linear and Binary.
16. Sorting techniques: Bubble and Merge Sort.
17. Experiments based on files and its operations.

Contact Hours : 75

Course Outcomes:

On completion of the course, students will be able to:

- Understand the working principle of a computer and identify the purpose of a computer programming language and ability to identify an appropriate approach to solve the problem.
- Write, test, and debug simple Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Apply searching, sorting on data and efficiently handle data using flat files.

Text Books:

1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, Second edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2. Guido Van Rossum and Fred L. Drake Jr, An Introduction to Python - Revised and updated for Python 3.2, NetworkTheory Ltd., 2011.

Reference Books:

1. John V Guttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press , 2013.
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming inPython: An Inter-disciplinary

Approach, Pearson India Education Services Pvt. Ltd., 2016.

3. Timothy A. Budd, Exploring Python, Mc-Graw Hill Education (India) Private Ltd., 2015.
4. Kenneth A. Lambert, Fundamentals of Python: First Programs, Cengage Learning, 2012.
5. Charles Dierbach, Introduction to Computer Science using Python: A Computational ProblemSolving Focus, Wiley
   India Edition, 2013.
6. Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Scienceusing Python 3, Second edition, Pragmatic Programmers, LLC, 2013.

Platform Needed:

Python 3 interpreter for Windows/Linux

CO - PO – PSO matrices of course

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO3
GE19211.1	2	2	2	2	1	-	-	-	1	1	1	1	3	3	-
GE19211.2	2	1	1	1	1	-	-	-	-	-	1	1	3	2	-
GE19211.3	1	1	2	1	2	-	-	-	-	-	1	1	2	3	2
GE19211.4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
GE19211.5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2
Average	**1.8**	**1.6**	**2.2**	**1.6**	**1.8**	**-**	**-**	**-**	**1**	**1**	**1.4**	**1**	**2.4**	**2.4**	**2**

Note: Enter correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial

(High)If there is no correlation, put "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
MC19102	INDIAN CONSTITUTION AND FREEDOM MOVEMENT	MC	3	0	0	0

Objectives: To inculcate the values enshrined in the Indian constitution.

- To create a sense of responsible and active citizenship.
- To know about Constitutional and Non- Constitutional bodies.
- To understand sacrifices made by the freedom fighters.

UNIT-I INTRODUCTION: Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens. Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy. 9

UNIT-II Structure and Function of Central Government: Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review. 9

UNIT-III Structure And Function Of State Government And Local Body: State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati Raj: Introduction, Elected officials and their roles, ,Village level: Role of Elected and Appointed officials. **9**

UNIT-IV Constitutional Functions and Bodies: Indian Federal System – Center – State Relations – President's Rule – Constitutional Functionaries – Assessment of working of the Parliamentary System in India- CAG, Election Commission, UPSC, GST Council and other Constitutional bodies-. NITI Aayog, Lokpal, National Development Council and other Non –Constitutional bodies. 9

UNIT-V Indian Freedom Movement: British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India-Indian Freedom Struggle under Mahatma Gandhi-Non- Cooperation Movement-Civil Disobedience Movement- Quit India Movement-British Official response to National movement- Independence of India Act 1947-Freedom and Partition. 9

Total Contact Hours : 45

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

MC19102.1	Understand the functions of the Indian government.
MC19102.2	Understand and abide the rules of the Indian constitution.
MC19102.3	Gain knowledge on functions of state Government and Local bodies.
MC19102.4	Gain Knowledge on constitution functions and role of constitutional bodies and non-constitutional bodies.
MC19102.5	Understand the sacrifices made by freedom fighters during freedom movement.

Text Book (s):

1 Durga Das Basu, "Introduction to the Constitution of India ", Lexis Nexis, New Delhi., 21st ed 2013.
2 Bipan Chandra, History of Modern India, Orient Black Swan, 2009.
3 Bipan Chandra, India's Struggle for Independence, Penguin Books, 2016.
4 Maciver and Page, " Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.2nd ed, 2014.
5 P K Agarwal and K N Chaturvedi , Prabhat Prakashan, New Delhi, 1st ed , 2017.

Reference Books(s) / Web links:

1 Sharma, Brij Kishore, " Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.
2 U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC19102.1	-	-	-	-	-	-	2	2	-	-	-	1	-	-	-
MC19102.2	-	-	-	-	-	-	2	2	-	-	-	1	-	-	-
MC19102.3	-	-	-	-	-	-	2	2	-	-	-	1	-	-	-
MC19102.4	-	-	-	-	-	-	2	2	-	-	-	1	-	-	-
MC19102.5	-	-	-	-	-	-	2	2	-	-	-	1	-	-	-
Average	-	-	-	-	-	-	2	2	-	-	-	1	-	-	-

SEMESTER III

Subject Code	Subject Name	Category	L	T	P	C
MA19351	**TRANSFORMS AND STATISTICS**	BS	**3**	**1**	**0**	**4**

Objectives:

- To acquaint the student with different transform techniques used in wide variety of situations.
- To provide required skills to apply different statistical tools to analyze Engineering problems.

UNIT-I FOURIER SERIES **12**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series –Half range cosine series – Parseval's identity – Harmonic analysis.

UNIT-II BOUNDARY VALUE PROBLEMS **12**

Classification of PDE – Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (excluding insulated edges).

UNIT-III Z - TRANSFORMS AND DIFFERENCE EQUATIONS **12**

Z- transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) –Convolution theorem - Formation of difference equations – Solution of difference equations using Z- transform.

UNIT-IV TESTING OF HYPOTHESIS **12**

Statistical hypothesis - Large sample test based on Normal distribution for single mean and difference of means -Tests based on t, F and Chi-square test for single sample standard deviation. Chi-square tests for independence of attributes and goodness of fit.

UNIT-V DESIGN OF EXPERIMENTS **12**

One way and two way classifications - Completely randomized design – Randomized block design –Latin square design

Total Contact Hours : 60

Course Outcomes:

On completion of course students will be able to

- develop skills to construct Fourier series for different periodic functions and to evaluate infinite series.
- classify different types of PDE and solve boundary value problems.
- solve difference equations using Z – transforms that arise in discrete time systems.
- obtain statistical data from experiments and also analyze the same using statistical test.
- design experiments using suitable ANOVA techniques and draw conclusions.

Text Books:

1 Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.

2 Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt.Ltd.,New Delhi, Second reprint, 2012.

3 Veerarajan T., 'Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks' , Mc Graw Hill, 2016.

Reference Books / Web links:

1 Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.

2 Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, Wiley India, 2007.

3 Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.

4 Ross S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.

5 Spiegel M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.

6 Johnson R.A. and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA19351.1	3	3	2	3	-	-	-	-	-	-	-	2	3	2	-
MA19351.2	3	3	2	3	-	-	-	-	-	-	-	2	3	2	-
MA19351.3	3	3	2	3	-	-	-	-	-	-	-	2	3	2	-
MA19351.4	3	3	3	3	2	-	-	-	-	-	2	2	3	3	2
MA19351.5	3	3	3	3	2	-	-	-	-	-	2	2	3	3	2
Average	3	3	2.4	3	2	-	-	-	-	-	2	2	3	2.4	2

Subject Code	Subject Name	Category	L	T	P	C
AE19301	FUNDAMENTALS OF AEROSPACE ENGINEERING	PC	3	0	0	3

Objectives:

To introduce the concepts and evolution of flight.
To understand different types of flying vehicles**.**
To introduce basic aerodynamics, structural elements and propulsion of aircrafts
To introduce the fundamental space mechanics.

UNIT-I AIRCRAFT CONFIGURATIONS 7

History of flight-different types of flight vehicles, classification, components and functions of typical transport aircraft, three view diagram, helicopter and UAV parts and functions.

UNIT-II BASICS OF AERODYNAMICS 12

Physical properties and structure of the atmosphere, ISA, temperature, pressure and altitude relationships, Newton's law of motions applied to aeronautics - aerofoil and wing geometry, NACA series airfoils, generation of lift, Mach number and ranges, aerodynamic center, pressure coefficients, aspect ratio, types of drag- induced drag, lift and drag curves, sweepback on wing, basics of pitot tube.

UNIT-III AIRPLANE STRUCTURES AND MATERIALS 9

General types of construction, monocoque and semi-monocoque, typical wing and fuselage structure. metallic and non-metallic materials, use of aluminium alloy, magnesium alloy, titanium, stainless steel, plastics, composite materials and smart structures, applications.

UNIT-IV POWER PLANTS 10

Classification of propulsive engines -basics about piston, turbojet, turboprop and turbofan - use of propeller and jets for thrust production -equations, principles of operation of rocket, types of rockets and typical applications, exploration into space- India.

UNIT-V BASICS OF SPACE MECHANICS 7

Keplar laws, equation, two body problem, fundamentals of orbital mechanics, orbital elements. Orbital transfers, space environment-atmosphere, radiation and magnetic field, space debris.

Total Contact Hours : 45

Course Outcomes:

On completion of the course students will be able to

AE19301.1 Identify the component of aircraft
AE19301.2 Develop the knowledge on basic aerodynamics
AE19301.3 Identify suitable materials for aircraft structure
AE19301.4 Analyze the different types of power plants used in aircraft propulsion.
AE19301.5 Understanding the basics of space mechanics

Text Books:

1 Anderson, J.D., "Introduction to Flight", Tata McGraw-Hill, 2010..

Reference Books / Web links:

1 Kermode, A.C., "Mechanics of Flight", Pearson Education; 11th edition
2 Kermode, A.C, "Flight without Formula", Pearson Education; 5th edition

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19301.1	2	1	1	1	1	2	0	0	0	0	0	0	3	1	0
AE19301.2	3	2	1	3	1	0	0	1	0	0	1	2	3	1	1
AE19301.3	3	2	2	1	0	0	1	1	0	0	0	2	3	1	0
AE19301.4	3	1	2	1	0	1	1	0.5	0	0	0	2	3	1	0
AE19301.5	3	2	1	0	0	2	3	1	0	0	0	3	2	0	0
Average	2.8	1.6	1.4	1.4	1	1.67	1.67	0.87	0	0	1	2.25	2.8	1	1

Subject Code	Subject Name	Category	L	T	P	C
AE19302	MECHANICS OF MACHINES	PC	2	1	0	3

Objectives:

To understand the principles in the formation of mechanisms and their kinematics.
To understand the importance of cams and gear mechanism
To understand the effect of friction in different machine elements.
To understand the static and dynamic forces and toques acting on simple mechanical systems
To understand the importance of balancing of revolving and reciprocating masses in machine elements

UNIT-I KINEMATIC OF MECHANICS 8

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons, **develop a prototype of different mechanisms**

UNIT-II CAMS AND GEARS 11

Cams – classifications – displacement diagrams - layout of plate cam profiles– derivatives of followers motion - Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.

UNIT-III FRICTION 8

Sliding and Rolling Friction angle – friction in threads – Friction Drives – Friction clutches – Belt and rope drives - Ratio of tensions – Effect of centrifugal and initial tension– Condition for maximum power transmission – Open and crossed belt drive.

UNIT-IV FORCE ANALYSIS 9

Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members – Static Force analysis in simple machine members – Dynamic Force Analysis – Inertia Forces and Inertia Torque – D'Alembert's principle – superposition principle – dynamic Force Analysis in simple machine members.

UNIT-V BALANCING AND MECHANISM FOR CONTROL 9

Static and Dynamic balancing – Single and several masses in different planes –Balancing of reciprocating masses- primary balancing and concepts of secondary balancing Gyroscopes –Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

Total Contact Hours : 45

Course Outcomes:

On completion of course students will be able to

AE 19302.1	Assess different mechanisms with their working methods	L5
AE 19302.2	Apply the concepts of cams and gear mechanism	L3
AE 19302.3	Apply the concepts of friction in different machine elements	L3
AE 19302.4	Analyze the static and dynamic forces and toques acting on simple mechanical systems	L4
AE 19302.5	Analyze the unbalanced forces in revolving and reciprocating masses in machine elements	L4

Text Books:

1. Rattan S. S. - 'Theory of Machines' - McGraw Hill India Pvt. Ltd. - 2014 - 4th Edition
2. Ghosh A. and Mallick A. K. - 'Theory of Mechanisms and Machines' - Affiliated East West Press Pvt. Ltd., New Delhi - 2008

Reference Books / Web links:

1 Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 1984.
2 Ambekar A.G., "Mechanism and Machine Theory" Prentice Hall of India, New Delhi, 2007

3 Shigley J.E., Pennock G.R and Uicker J.J., “Theory of Machines and Mechanisms”, Oxford University Press, 2003

4 Ramamurthi. V, "Mechanisms of Machine", Narosa Publishing House, 2002.

5 Robert L. Norton, "Design of Machinery", McGraw-Hill, 2004.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE 19302.1	3	2	2	2	3	-	-	-	1	1	1	3	3	2	-
AE 19302.2	3	2	2	2	3	-	-	-	1	1	-	3	3	2	-
AE 19302.3	3	2	2	2	3	-	-	-	1	1	-	3	3	2	-
AE 19302.4	3	2	2	2	3	-	-	-	1	1	-	3	3	2	-
AE 19302.5	3	2	2	2	3	-	-	-	1	1	-	3	3	2	-
Average	3	2	2	2	3	-	-	-	1	1	1	3	3	2	-

Subject Code	Subject Name	Category	L	T	P	C
AE19341	**FLUID MECHANICS AND FLUID MACHINERY**	**PC**	**2**	**1**	**2**	**4**

Objectives:

- To give fundamental knowledge of fluid, its properties and behaviour
- To imbibe basic laws and equations used for analysis of static and dynamic fluid flows and to enable determining the losses in a flow system
- To introduce fluid boundary layer development concept
- To enable determining performance parameters of hydraulic pimps
- To enable determining performance parameters of turbines

UNIT-I PROPERTIES OF FLUIDS 9

Introduction-What is Fluid? -Application area of Fluid Mechanics, The No-Slip Condition, A brief history of Fluid Mechanics.
Classification of Fluid Flows- System and Control Volume **-** Continuum-Properties of Fluids and their influence on fluid motion. **Pressure**: -Pressure at a point – Variation of pressure with depth, The barometer and atmospheric pressure, Gauge and vacuum pressures-Static, dynamic and Stagnation Pressures- – measurement of pressure- Piezometer, U-tube and differential manometers-Pitot tube- Buoyancy. Recent developments in pressure measurements (steady & unsteady).

UNIT-II FLUID FLOW GOVERNING EQUATIONS 9

Modeling of Fluid Flow - Control Volume: Fixed and Moving - Infinitesimal Fluid Element: Moving and Fixed - Substantial Derivative - Reynolds Transport Theorem - Type of fluid flows - Governing Equations of Fluid Flows: Continuity, momentum and energy equations in integral and differential form in Cartesian co-ordinate system. Refractive and Surface flow visualization techniques-Plots of Fluid flow data-Equation of continuity for one dimensional flow.

UNIT-III FLUID KINEMATICS AND DYNAMICS 9

Fluid dynamics: Surface and body forces -Euler's and Bernoulli's equations for flow along a stream line, Total energy line-Hydraulic gradient line. General energy equation.
Closed conduit flow: Reynold's experiment- Reynolds number-The Entrance Region-Entry Length-Laminar flow in pipes-Darcy Weisbach equation- Turbulent Flow in Pipes-Minor losses in pipes- Pipes in series and Pipes in parallel-Measurement of flow: Venturi meter and orifice meter, Flow through nozzle-basics. Recent developments in friction and discharge measurements.

UNIT-IV BOUNDARY LAYER CONCEPTS AND DIMENSIONAL ANALYSIS 9

Boundary Layer Concepts: Definition, boundary layer thickness, displacement thickness, momentum thickness and energy thickness, characteristics along thin plate, Development of laminar and turbulent boundary layers, boundary layer in transition, separation of boundary layer, submerged objects – drag and lift-Drag force on a flat plate due to Boundary layer.
Dimensional Analysis and Modeling: Need for dimensional analysis-Dimensional Homogeneity – Dimensional Analysis and Similarity –The Method of Repeating Variables and the Buckingham Pi Theorem – Similitude –Types of similitude - Dimensionless parameters- Application of dimensionless parameters – Model analysis.

UNIT-V TURBINES 9

Basics of turbo machinery: Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.
Hydraulic Turbines: Classification of turbines, Heads and efficiencies, impulse and reaction turbines, Pelton wheel, Francis turbine - working principle, work done, efficiencies, hydraulic design –draft tube theory- functions and efficiency.
Performance of hydraulic turbines: Turbine scaling laws- Specific speed, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer.

Contact Hours : 45

List of Experiments

1 Determination of the coefficient of discharge for given orifice and venturi meters
2 Determination of friction factor for a given set of pipes.
3 Determination of characteristics curves of centrifugal pump.
4 Determination of performance curves of Pelton wheel turbine.
5 Experimental verification of Bernoulli's theorem
6 Determination of metacentric height
7 Flow visualization studies on various models at different Reynolds number

Contact Hours : 15
Total Contact Hours : 60

Course Outcomes:
On completion of the course students will be able to

AE19341.1 **define** and **distinguish** and perform calculations to determine fluid properties (L1)
AE19341.2 **apply** conservation principles to **formulate** governing equations for fluid flows. (L2, L6)
AE19341.3 **apply** fluid kinematic and dynamic relations to **measure** losses and discharge through pipes of different arrangements (L4)
AE19341.4 **outline** boundary layer properties and **develop** non-dimensional numbers to **model** fluid dynamic situations (L2, L3)
AE19341.5 **classify, compare, analyze and experiment** to determine the performance parameters of turbines. (L1, L2, L4)

Text Books:
1 Yunus A. Cengel and John M. Cimbala. "Fluid Mechanics Fundamentals and Applications", McGraw Hill Edition 2006, Sixth Reprint 2009.
2 Frank M White, "Fluid Mechanics", McGraw Hill, 8th Edition, 2015

Reference Books:
1 Dr. R. K. Bansal "A Textbook of Fluid Mechanics and Hydraulic Machines", Laxmi Publications, New Delhi, Revised Ninth Edition.
2 Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2010
3 Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, "Fluid Mechanics and Machinery", 2011.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19341.1	3	3	-	-	2	-	-	-	-	-	-	1	2	2	1
AE19341.2	3	2	1	1	1	1	1	-	-	-	-	1	-	-	-
AE19341.3	3	3	2	1	-	1	1	-	-	-	-	-	2	2	-
AE19341.4	3	3	-	3	2	-	-	-	-	-	-	2	2	2	1
AE19341.5	3	3	2	1	-	1	1	-	-	-	-	1	2	2	-
Average	3	3	1.7	1.5	2	1	1	-	-	-	-	1.25	2	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19342	**SOLID MECHANICS** (Lab oriented Theory Course)	PC	2	1	2	4

Objectives:

- Understand the theoretical basis about the stress, strain and elastic modulus concepts in various components
- Assess shear stresses, bending moments and stress variation through mathematical models of beams subjected to axial load, transverse load, couples and combination of loads.
- Understand the principles underlying in the deflection of solid structural member such as a beam subjected to different types of loads.
- Apply the basic mechanical principles to solve practical problems related to springs and shafts subjected to axial load, torsion, bending, transverse shear and combined loading.
- Analyze the state of stress and strain at any point in a member.

UNIT-I INTRODUCTION **9**

Definition of stress, strain and their relations - stress-strain curves – Lateral strain, Poisson's ratio & volumetric strain – Elastic moduli & the relationship between them Bars of varying section – composite bars – Temperature stresses.

UNIT-II STRESSES IN BEAMS **9**

Shear force & bending moment diagrams for various types of beams with different loading conditions - bending and shear stress variation in beams of symmetric sections like rectangular, circular, I and T sections

UNIT-III DEFLECTION OF BEAMS **9**

Deflection of beams subjected to different loading conditions through Double integration method – Macaulay's method - Area moment method

UNIT-IV TORSION – SPRINGS **9**

Torsion: Torsion of solid and hollow circular shafts – shear stress variation.
Springs: Open and closed-coiled helical springs – stresses in helical springs.

UNIT-V BIAXIAL STRESSES **9**

Stresses in thin-walled pressure vessels – combined loading of circular shaft with bending, torsion and axial loadings – Mohr's circle and its construction – determination of principal stresses.

Total Contact Hours : 45

List of Experiments

1 Tension test on a mild steel rod
2 Shear force and bending moment diagram using ANSYS
3 Deflection of simply supported and cantilever beam subjected to concentrated loads. Verifying the values through the MATLAB.
4 Torsion test on mild steel rod and deflection of open and closed coil helical springs.
5 Unsymmetrical bending of beam

Contact Hours : 15
Total Contact Hours : 60

Course Outcomes:

AE19342.1 Design and conduct experiments on mechanical testing and also could analyze and interpret data
AE19342.2 Apply shear force and bending moment diagrams to analyse the resistance offered by the beam and able to solve practical problems and through the software.
AE19342.3 Apply computational skills to formulate and solve problems related to the deflections of beams subjected to mechanical loads.
AE19342.4 Describe and recognize the behaviour of materials upon normal external loads on springs and shafts
AE19342.5 Identify, formulate, and solve structural engineering problems.

Text Books:

1 R. Subramanian, “Strength of Materials”, Oxford University Press, Third edition, 2016

Reference Books / Web links:

1 Dym,C.L, and Shames,I.H., „Solid Mechanics‟, McGraw Hill, Kogakusha, Tokyo, 1973.

2 William Nash, "Strength of Materials", Tata McGraw Hill, 2004

3 Timoshenko and Young “Strength of Materials” Vol. I & II

4 Stephen Timoshenko, „Strength of Materials‟, Vol I & II, CBS Publishers and Distributors, Third Edition.

5 Timoshenko,S. and Young, D.H., “Elements of Strength of Materials”, T.Van Nostrand Co. Inc., Princeton, N.J., 1977.

CO-PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19342.1	2	3	2	1	1	0	-	-	-	-	-	1	2	2	-
AE19342.2	3	3	2	1	1	1	-	-	-	-	-	1	3	2	-
AE19342.3	3	3	3	2	1	1	-	-	-	-	-	1	3	2	-
AE19342.4	3	3	3	2	0	1	-	-	-	-	-	2	3	2	-
AE19342.5	3	3	3	2	0	1	-	-	-	-	-	2	3	1	-
Average	2.8	3	2.6	1.6	1	1	0	0	0	0	0	1.4	2.8	1.8	0

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
CS19411	PYTHON PROGRAMMING FOR MACHINE LEARNING	ES	1	0	4	3

(With effect from 2021 batch onwards)
Common to all branches of B.E / B.Tech programmes
(Except – CSE, CSBS, CSD, IT, AI/ML)

Course Objectives:

- To understand the relationship of the data collected for decision making.
- To know the concept of principle components, factor analysis and cluster analysis for profiling and interpreting the data collected.
- To lay the foundation of machine learning and its practical applications.
- To develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
- To prepare for real-time problem-solving in data science and machine learning.

List of Experiments

1. NumPy Basics: Arrays and Vectorized Computation
2. Getting Started with pandas
3. Data Loading, Storage, and File Formats
4. Data Cleaning and Preparation
5. Data Wrangling: Join, Combine, and Reshape
6. Plotting and Visualization
7. Data Aggregation and Group Operations
8. Time Series
9. Supervised Learning
10. Unsupervised Learning
11. Representing Data and Engineering Features
12. Model Evaluation and Improvement

Contact Hours : 75

Course Outcomes:

On completion of the course, the students will be able to:

- Develop a sound understanding of current, modern computational statistical approaches and their application to a variety of datasets.
- Use appropriate packages for analyzing and representing data.
- Analyze and perform an evaluation of learning algorithms and model selection.
- Compare the strengths and weaknesses of many popular machine learning approaches.
- Apply various machine learning algorithms in a range of real-world applications.

Text Books:

1. Wes McKinney, Python for Data Analysis - Data wrangling with pandas, Numpy, and ipython, Second Edition, O'ReillyMedia Inc, 2017.
2. Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python - A Guide for Data Scientists,
   First Edition, O'Reilly Media Inc, 2016.

Reference Books:

1. AurélienGéron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Media
   Inc, 2019.

Platform Needed:

Python 3 interpreter for Windows/Linux

CO - PO – PSO matrices of course

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO3
CS19411.1	2	2	2	2	1	-	-	-	1	2	-	1	3	3	3
CS19411.2	2	2	1	1	2	-	-	-	-	-	-	1	2	1	3
CS19411.3	2	3	2	1	2	-	-	-	1	1	-	1	2	3	2
CS19411.4	1	1	1	-	1	-	-	-	-	1	1	-	1	2	3
CS19411.5	3	3	2	3	3	-	-	-	2	1	-	1	2	3	3
Average	**2**	**2.2**	**1.6**	**1.75**	**1.8**	**-**	**-**	**-**	**1.33**	**1.25**	**1**	**1**	**2**	**2.4**	**2.8**

Subject Code	Subject Name	Category	L	T	P	C
MC19301	**ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE**	MC	**3**	**0**	**0**	**0**

Common to all Branches

Objectives:

This course aims at imparting basic principles of thought process, reasoning and inference. Sustainability is the core of Indian traditional knowledge system connecting society and nature. Holistic life style of yogic science and wisdom are important in modern society with rapid technological advancements and societal disruptions. The course mainly focuses on introduction to Indian knowledge system, Indian perspective of modern science, basic principles of Yoga and holistic healthcare system, Indian philosophical, linguistic and artistic traditions.

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

UNIT-I **INTRODUCTION TO INDIAN KNOWLEDGE SYSTEM** **6**

Basic structure of the Indian Knowledge System –Veda – Upaveda - Ayurveda, Dhanurveda-Gandharvaveda, Sthapathyaveda and Arthasasthra. Vedanga (Six forms of Veda) – Shiksha, Kalpa, Nirukta, Vyakarana, Jyothisha and Chandas- Four Shasthras - Dharmashastra, Mimamsa, Purana and Tharkashastra.

UNIT-II **MODERN SCIENCE AND YOGA** **6**

Modern Science and the Indian Knowledge System – a comparison - Merits and demerits of Modern Science and the Indian Knowledge System - the science of Yoga-different styles of Yoga – types of Yogaasana, Pranayam, Mudras, Meditation techniques and their health benefits – Yoga and holistic healthcare – Case studies.

UNIT-III **INDIAN PHILOSOPHICAL TRADITION** **6**

Sarvadharshan/Sadhdharshan – Six systems (dharshans) of Indian philosophy - Nyaya, Vaisheshika, Sankhya, Yoga, Vedanta-Other systems- Chavarka, Jain (Jainism), Boudh (Buddhism) – Case Studies.

UNIT-IV **INDIAN LINGUISTIC TRADITION** **6**

Introduction to Linguistics in ancient India – history – Phonetics and Phonology – Morphology – Syntax and Semantics-Case Studies.

UNIT-V **INDIAN ARTISTIC TRADITION** **6**

Introduction to traditional Indian art forms – Chitrakala (Painting), Murthikala / Shilpakala (Sculptures), Vaasthukala, Sthaapathya kala (Architecture), Sangeeth (Music), Nruthya (Dance) and Sahithya (Literature) – Case Studies.

Total Contact Hours : 30

Course Outcomes: On completion of the course students will be able to

1 Understand basic structure of the Indian Knowledge System
2 Apply the basic knowledge of modern science and Indian knowledge system in practise
3 Understand the importance Indian Philosophical tradition
4 Appreciate the Indian Linguistic Tradition.
5 Understand the concepts of traditional Indian art forms

Text Book (s):

1 V. Sivaramakrishnan (Ed.), Cultural Heritage of India-course material, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014.
2 Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan.
3 Swami Jitatmanand, Holistic Science and Vedant, Bharatiya Vidya Bhavan.
4 Fritzof Capra, Tao of Physics.
5 Fritzof Capra, The Wave of life.

Reference Books(s) / Web links:

1 VN Jha (Eng. Trans.), Tarkasangraha of Annam Bhatta, International Chinmay Foundation, Velliarnad, Arnakulam.
2 Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata.
3 GN Jha (Eng. Trans.), Ed. RN Jha, Yoga-darshanam with Vyasa Bhashya,Vidyanidhi Prakashan, Delhi 2016.
4 RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakashan, Delhi 2016.

CO-PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC19301.1	-	-	-	-	-	1	1	3	2	-	-	1	-	-	-
MC19301.2	-	-	-	-	-	1	1	3	2	-	-	1	-	-	-
MC19301.3	-	-	-	-	-	1	1	3	2	-	-	1	-	-	-
MC19301.4	-	-	-	-	-	1	1	3	2	-	-	1	-	-	-
MC19301.5	-	-	-	-	-	1	1	3	2	-	-	1	-	-	-
Average	-	-	-	-	-	1	1	3	2	-	-	1	-	-	-

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
AE19311	**COMPUTER AIDED MODELING LABORATORY**	PC	0	0	4	2

Prerequiste:

20 hrs practical session on 2D drawing & drafting using AutoCAD

Objectives:

- Ability to gain practical experience in handling 2D drafting and 3D modelling software
- Ability to draw and model the components in 2D & 3D views
- Ability to perform modelling and kinematics on various machine components
- To develop in students' graphic skills for communication of concepts, ideas of engineering products
- To familiarize with technical drawings

List of Experiments

1 Introduction to 3D Modelling software
2 Drafting of 3D isometric models
3 Drafting of a gear
4 Creation & drafting of 3D assembly model of Flange coupling.
5 Creation of drafting of 3D assembly model of Plummer Block
6 Creation of drafting of assembly model of Screw Jack
7 Creation of drafting of assembly model of Universal Joint
8 Creation of drafting of assembly model of Foot Step Bearing
9 Creation of drafting of assembly model of Knuckle Joint
10 Kinematics of four bar mechanism
11 Kinematics of gears.
12 Introduction to geometric dimensioning & tolerancing (GD&T)
13 3D printing of a modeled machine component (live demo)
14 Mini-Project

Total Contact Hours : 30

Course Outcomes:

AE19311.1	Describe the graphic skills for communication of concepts, ideas of engineering products.	L2
AE19311.2	Design 3D assembly using modeling software.	L6
AE19311.3	Create kinematics on various machine assemblies	L6
AE19311.4	Create drafting on 3D assembled models	L6
AE19311.5	Get job opportunities on design based industries	L6

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19311.1	3	2	3	1	3	1	-	1	2	1	1	3	3	2	1
AE19311.2	3	2	3	1	3	1	-	1	2	1	1	3	3	2	1
AE19311.3	3	2	3	1	3	1	-	1	2	1	1	3	3	2	1
AE19311.4	3	2	2	1	3	1	-	1	2	1	1	3	3	2	1
AE19311.5	3	2	2	1	3	1	-	1	2	1	1	3	3	2	1
Average	3	2	2.6	1	3	1	-	1	2	1	1	3	3	2	1

SEMESTER IV

Subject Code	Subject Name	Category	L	T	P	C
MA19451	**NUMERICAL METHODS**	BS	3	1	0	4

Objectives:

- To provide the necessary basic concepts of a few numerical methods.
- To provide procedures for solving numerically different kinds of problems occurring in the field of Engineering and Technology.

UNIT-I SOLUTION OF EQUATIONS 12

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel.

UNIT-II INTERPOLATION 12

Interpolation with equal intervals - Newton's forward and backward difference formulae - Interpolation with unequal intervals – Newton's divided difference interpolation - Lagrange's interpolation – Cubic Splines

UNIT-III NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule and Simpson's 3/8 rule – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal rule.

UNIT-IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 12

Single Step methods: Taylor's series method - Euler's method - Modified Euler's method – Fourth order Runge - Kutta method for solving first order equations - Multi step methods: Milne's and Adams- Bash forth predictor corrector methods for solving first order equations.

UNIT-V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 12

Finite difference method for solving second order differential equations - Finite difference techniques for the solution of two-dimensional Laplace and Poisson equations on rectangular domain – One dimensional heat flow equation by implicit and explicit methods – One Dimensional Wave Equation by Explicit method.

Total Contact Hours : 60

Course Outcomes:

On completion of course students will be able to

- solve algebraic equations that arise during the study of Engineering problems.
- use various interpolation techniques for solving problems in Engineering.
- use numerical methods to solve problems involving numerical differentiation and integration.
- solve initial value problems numerically that arise in Science and Engineering.
- solve boundary value problems that encounter in different fields of Engineering study.

Text Books:

1. Kandasamy P., Thilagavathy K., and Gunavathy,S., 'Numerical Methods', Chand and Co., 2007.
2. Grewal B.S., and Grewal. J.S.,"Numerical methods in Engineering and Science",Khanna Publishers, 9th Edition, New Delhi, 2007.
3. Sastry S.S, "Introductory Methods of Numerical Analysis", Prentice- Hall of India PVT. LTD., 4th edition, New Delhi, 2006.

Reference Books / Web links:

1. Veerarajan T., Ramachandran T., 'Numerical Methods with Programs in C and C++' Tata McGraw Hill., 2007.
2. Jain M.K., Iyengar, S.R., and Jain, R.K., 'Numerical Methods for Scientific and Engineering Computation', New Age Publishers. 6th edition, 2007.
3. Chapra S.C., and Canale. R.P, "Numerical Methods for Engineers", 7th Edition, McGrawHill, New Delhi, 2015.
4. Brian Bradie "A friendly introduction to Numerical analysis", Pearson Education, Asia, New Delhi, 2007.
5. Sankara Rao K., "Numerical methods for Scientists and Engineers", Prentice Hall of IndiaPrivate, 3rd Edition, New Delhi, 2007.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA19451.1	3	3	2	3	1	-	-	-	-	-	-	2	3	1	-
MA19451.2	3	3	2	3	1	-	-	-	-	-	-	2	3	1	-
MA19451.3	3	3	2	3	1	-	-	-	-	-	-	2	3	1	-
MA19451.4	3	3	2	3	1	-	-	-	-	-	-	2	3	1	1
MA19451.5	3	3	2	3	1	-	-	-	-	-	-	2	3	1	1
Average	3	3	2	3	1	-	-	-	-	-	-	2	3	1	1

Subject Code	Subject Name	Category	L	T	P	C
AE19401	AERODYNAMICS - I	PC	2	1	0	3

Course Objectives:

- To introduce fundamental aerodynamic theories and aerodynamic characteristics of airfoils and wings
- To familiarize students with viscous flows

UNIT-I AERODYNAMIC FORCES AND MOMENTS 9

Euler equation, incompressible Bernoulli's equation. Streamlined and bluff-bodies. Airfoil nomenclature and classification, Centre of pressure, aerodynamic centre and aerodynamic moment, generation of lift, drag and moment, incompressible flows over airfoils, calculation of lift and drag from measured pressure distribution. Low speed wind tunnels.

UNIT-II POTENTIAL FLOWS 9

Circulation and vorticity, Stoke's theorem, streamline, stream function. Irrotational flow, potential function, equipotential lines, governing equation for irrotational and incompressible fluid flow, elementary flows and their combinations. Ideal Flow over a circular cylinder, D'Alembert's paradox, Magnus effect, Kutta Joukowski's theorem, real flow over smooth and rough cylinder.

UNIT-III AIRFOILS 9

Low speed aerodynamic characteristics of symmetric and cambered airfoils. Concept of point vortex, line vortex and vortex sheet, Kutta condition, Kelvins circulation theorem and starting vortex, Classical thin airfoil theory - symmetric & cambered airfoils.

UNIT-IV WINGS 9

Finite wing nomenclature. Incompressible flow over wing, vortex filament, bound vortex, horse shoe vortex, downwash, induce angle of attack and drag. Type of drag, Biot- savart law and Helmholtz's vortex theorem. Prandtl's lifting line theory and limitations. Elliptic lift distributions, expression for induced angle of attack and induce drag. Two dimensional and three-dimensional wings lift curve slope and effect of aspect ratio. High lift devices.

UNIT-V VISCOUS FLOWS 9

Boundary layer equations for a steady, two-dimensional incompressible flow, boundary layer growth over a flat plate, critical Reynolds number, Blasius solution - self-similar solutions and other important results. Basics of turbulent flow – one and two equation models.

Total Hours : 45

Course Outcomes:

On completion of the course students will be able to

AE19401.1 **classify** airfoils and label their nomenclature; **apply** governing equations to formulate necessary subsidiary equation in order to determine the aerodynamic forces

AE19401.2 **explain** potential flow theories and **solve** their combinations.

AE19401.3 **estimate** the aerodynamic characteristics of airfoils

AE19401.4 **estimate** the aerodynamic characteristics of wings

AE19401.5 **formulate** and **solve** boundary layer problems

Text Books:

1 Anderson, Jr., J.D., Fundamentals of Aerodynamics, McGraw-Hill Education; 6th edition, 2016

Reference Books:

1 Bertin, J.J., Aerodynamics for Engineers, Fourth edition, Pearson Education, 2011

2 Arnold M. Kuethe and Chuen–Yen Chow, "Foundations of Aerodynamics: Bases of Aerodynamic Design", John Wiley & Sons; 5th edition, 1997

2 McCormick, B.W., Aerodynamics, Aeronautics, & Flight Mechanics, second edition, John Wiley, 2009

3 Jan Roskam and Chuan-Tau Lan, Airplane Aerodynamics and Performance, DAR corporation, third edition, 1997

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19401.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19401.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19401.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19401.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19401.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19403	**ADVANCED STRENGTH OF MATERIALS**	PC	**2**	**1**	**0**	**3**

Objectives:

- To provide the students an understanding on the linear static analysis of determinate and indeterminate aircraft structural components.
- To make the students understand the various energy methods to compute the strain energy in axial, bending, torsion and shear loadings.
- To impart the knowledge on column structural member
- To interpret the failure behavior of materials using failure theories.
- To make the students understand the various induced stresses.

UNIT-I STATICALLY DETERMINATE & INDETERMINATE STRUCTURES 10

Plane truss analysis – method of joints – method of sections – Principle of super position, Clapeyron"s three moment equation and moment distribution method for indeterminate beams.

UNIT-II ENERGY METHODS 9

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

UNIT-III COLUMNS 10

Columns with different end conditions – Euler's column curve – inelastic buckling – effect of initial curvature – columns with eccentricity – theory of beam columns – beam columns with different end and loading conditions

UNIT-IV FAILURE THEORIES AND IT'S APPLICATIONS 9

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

UNIT-V INDUCED STRESSES 7

Impact loading – Fatigue – Types of Fatigue – Fatigue Life Curves — Creep – Various stages of creep – Stress Relaxation.

Total Contact Hours : 45

Course Outcomes:

AE19403.1	Analyse the statically determinate and indeterminate using the principle of iterative methods and theorem of three moments.	L5
AE19403.2	Make use of classical methods determine the deflections of beams, frames and arches	L3
AE19403.3	Understand the stability, Euler buckling load and problems in column design.	L2
AE19403.4	Analyse the failure of the brittle and ductile materials in comparison with simple mechanical tests.	L4
AE19403.5	Interpret and Predict material failure for the induced stresses caused due to the dynamic and other environmental effects.	L2

Text Books:

1 Timoshenko and Gere, "Mechanics of Materials", Tata McGraw Hill, 1993.
2 R. Subramanian, "Strength of Materials", Oxford University Press, Third edition.

Reference Books:

1. Donaldson, B.K., "Analysis of Aircraft Structures - An Introduction", McGraw Hill, 1993.
2. Bruhn E F, "Analysis and Design of Flight Vehicle Structures", Tri-State Off-set Company, USA, 1985
3. Peery, D.J. and Azar,J.J., "Aircraft Structures", 2nd Edition, McGraw – Hill, N.Y, 1999.

CO-PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19403.1	3	2	2	3	2	0	-	-	-	2	-	1	2	2	-
AE19403.2	3	2	2	2	2	0	-	-	-	2	-	1	2	2	-
AE19403.3	3	2	1	2	2	1	-	-	-	2	-	1	2	2	-
AE19403.4	3	2	2	2	2	2	-	-	-	2	-	1	2	-	-
AE19403.5	3	2	2	2	2	1	-	-	-	2	-	1	2	2	-
Average	3	2	1.8	2.2	2	1.3	-	-	-	2	-	1	2	1.6	-

Subject Code	Subject Name (Lab oriented Theory Courses)	Category	L	T	P	C
AE 19441	**AERO ENGINEERING THERMODYNAMICS**	**PC**	**2**	**1**	**2**	**4**

Thermodynamics is the science of energy transfer and its effect on physical properties of the substances. This course deals with the thermodynamic laws and its applications, properties of pure substances and its applications and basics of heat transfer. Practical experiments are included in this course to make the subject understanding better.

Objectives:

- To apply the first law of thermodynamics to open & closed system; to assess the specific heats of solid fuels. (V)
- To estimate the COP of refrigerator and air conditioning unit. (V)
- To analyze the exergy for the flow and non-flow processes. (IV)
- To analyze the Rankine cycle. (IV)
- To distinguish the air standard cycles and enlighten the basic concepts of heat transfer. (V)

UNIT-I BASIC CONCEPT AND FIRST LAW 9

Concept of continuum, macroscopic approach, thermodynamic systems – closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics- concept of temperature and heat, internal energy, specific heat capacities, enthalpy - concept of ideal and real gases. First law of thermodynamics - applications to closed and open systems, Numerical Problems (Coding).

UNIT-II SECOND LAW AND ENTROPY 9

Second law of thermodynamics – Kelvin Planck and Clausius statements of second law. Reversibility and irreversibility - Carnot theorem. Carnot cycle, reversed Carnot cycle, efficiency, COP - thermodynamic temperature scale - Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy, Numerical Problems (Coding).

UNIT-III THERMODYNAMIC AVAILABILITY 9

Basics – energy in non-flow processes: expressions for the energy of a closed system – equivalence between mechanical energy forms and exergy – flow of energy associated with heat flow – exergy consumption and entropy generation, Numerical Problems (Coding).

UNIT-IV PROPERTIES OF PURE SUBSTANCE AND POWER CYCLE 9

Properties of pure substances – thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, P-V, P-T, T-S, H-S diagrams, thermodynamic properties of steam - standard Rankine cycle, Numerical Problems (Coding).

UNIT-V BASICS OF HEAT TRANSFER AND AIR STANDARD CYCLES 9

Otto, diesel and Brayton cycles - air standard efficiency - mean effective pressure – reheat and regeneration cycle. Conduction in parallel, radial and composite wall – basics of convective and radiation heat transfer, Numerical Problems (Coding).

Contact Hours : 45

List of Experiments

1	Draw the Valve timing diagram of 4-Stroke engine and the Port timing diagram of 2-Stroke engine.
2	Performance test on a 4-Stroke engine (Load test)
3	Determination of specific heat of solid by Bomb calorimeter.
4	Determine the COP of a Refrigeration unit and the Air-conditioning unit.
5	Determination of effectiveness of a parallel flow and counter flow heat exchanger and calculate the overall heat transfer coefficient (u) in the parallel flow heat exchanger.
6	Determination of convective heat transfer coefficient during free and forced convection.
7	Determination of thermal conductivity of a composite wall and a metal by Guarded hot plate method.

Contact Hours : 15
Total Contact Hours : 60

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

AE19441.1	Apply the first law of thermodynamics to open and closed system and to assess the specific heats of the solid fuel. (V)
AE1941.2	Estimate the COP of refrigerator and air conditioning unit. (V)
AE19441.3	Analyze the exergy for the flow and non flow processes. (IV)
AE19441.4	Analyze the Rankine cycle. (IV)
AE19441.5	Distinguish the air standard cycles and estimate the heat transfer coefficients. (V)

Text Book (s):

1	Nag. P. K., "Engineering Thermodynamics", 6th Edition, Tata McGraw-Hill, New Delhi, 2017.
2	Rathakrishnan E., "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice-Hall India, 2006.

Reference Books(s):

1	Yunus A. Cengel and Michael A. Boles, "Thermodynamics: An Engineering Approach" McGraw-Hill Science/Engineering/Math; 7thedition 2010.
2	Holman.J.P., "Thermodynamics", 3rd Edition, McGraw-Hill, 2007.
3	Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2017.
4	Merala C, Pother, Craig W, Somerton, "Thermodynamics for Engineers", Schaum Outline Series, Tata McGraw-Hill, New Delhi, 2013.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19441.1	3	3	2	3	1	2	1	-	-	1	2	-	3	3	1
AE19441.2	3	3	2	2	1	2	1	-	-	1	2	-	3	3	1
AE19441.3	3	1	2	2	1	1	1	-	-	1	2	-	3	3	1
AE19441.4	3	1	2	3	1	1	1	-	-	1	2	-	3	3	1
AE19441.5	3	3	3	3	1	2	1	-	-	1	2	2	3	3	3
Average	3	2.2	2.2	2.6	1	1.6	1	0	0	1	2	2	3	3	1.4

Subject Code	Subject Name	Category	L	T	P	C
AE19442	AIRCRAFT MATERIALS AND PROCESSES	PC	3	0	2	4

Objectives:

- To make familiarize the students in the basic casting techniques.
- To understand the principle and equipment's involved in various welding processes.
- To make the students comfortable to execute experiments in machining
- To introduce the students about various plastic manufacturing processes.
- Make the students to understand constructional details and programming of CNC machines.

UNIT-I FERROUS AND NON-FERROUS MATERIALS 9

Aluminium alloys, magnesium alloys, titanium alloys, plain carbon and low carbon steels. Super alloys, Nickel based super alloy, cobalt based super alloys and Iron based super alloys- manufacturing process associated with super alloys

UNIT-II CASTING AND JOINING 9

Casting types, types of core making, moulding tools- permanent moulding- pressure die casting, centrifugal casting. Classification of welding processes. Principles of oxy acetylene gas welding, submerged arc welding, TIG – MIG, Laser beam welding, Electron beam welding, and defects in welding.

UNIT-III MACHINING 9

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

UNIT-IV HEAT TREATMENT OF ALLOYS 9

Corrosion resistance materials used for space vehicles heat treatment of carbon steels–aluminium alloys, magnesium alloys and titanium alloys–effect of alloying treatment, heat resistance alloys–tool and die steels, magnetic alloys.

UNIT-V CNC MACHINING AND ADVANCED MANUFACTURING 9

Numerical Control machine tools – CNC types, Construction details, Special features, Machining centre – Tool magazines and transfer systems, Automatic tool changer – Part Programming Fundamentals – CNC and Manual part programming – Micro machining – Wafer machining – Rapid prototyping Technology: 3D Printing, Additive layer manufacturing –Rapid Manufacturing, applications and advancements.

Total Contact Hours : 45

List of Experiments

1. Making of mould using sing and split piece patterns
2. Preparation of welded butt joints
3. Taper turning using Lathe machine
4. Step turning, drilling and boring using Capstan / Turret late
5. Cube formation using shaper
6. Key way cutting in slotter
7. Spur gear cutting in milling machine
8. Cylindrical grinding
9. CNC machining - part programming
10. CNC Machining- part programming

Contact Hours : 30

Total Contact Hours : 75

Course Outcomes:
On completion of the course students will be able to

AE19442.1 Familiarize with the basic casting concepts.
AE19442.2 Know the various welding processes.
AE19442.3 Use different machining process for component production
AE19442.4 Familiarize with the various plastic moulding processes
AE19442.5 Understand and carry out simple experiments in CNC machines.

Text Books:

1 Hajra Choudhury, "Elements of Workshop Technology", Vol. I and II, Media Promoters and Publishers Pvt., Ltd., Mumbai, 2005
2 Roy. A. Linberg, "Process and Materials of Manufacture", PHI, 2000.

Reference Books / Web links:

1 Jain. R.K. and S.C. Gupta, "Production Technology", Khanna Publishers. 16 th Edition,2001
2 Serope Kalpajian, Steven R.Schmid, "Manufacturing Processes for Engineering Materials", Fourth Edition, Pearson Education, Inc. 2007

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19442.1	2	1	3	2	3	1	1	2	1	1	1	1	3	1	1
AE19442.2	3	2	3	3	3	1	1	2	3	1	2	1	3	3	1
AE19442.3	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1
AE19442.4	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
AE19442.5	3	1	1	1	1	1	1	2	3	1	2	1	2	3	1
Avg.	2.4	1.2	1.8	1.6	1.8	1	1	1.6	1.8	1	1.4	1	2.2	1.8	1

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
AE19411	AERODYNAMICS LABORATORY	PC	0	0	4	2

OBJECTIVES

- To visulalize and understand the low speed flows
- To practice techniques which predict/measure aerodynamics forces
- To understand the interactions of flow fields

List of Experiments

1. Calibration of subsonic wind tunnel.
2. Smoke flow visualization at low speeds.
3. Tuft flow visualization on airfoil model at low speeds.
4. Surface pressure distribution on a symmetrical airfoil at an angle of incidence and calculation of lift and pressure drag.
5. Surface pressure distribution on a cambered airfoil at an angle of incidence and calculation of lift and pressure drag.
6. Estimation of drag using pitot-static probe wake survey.
7. Measurement of aerodynamic loads using wind tunnel force balance.
8. Surface pressure distribution on an airfoil (infinite wing) with flap.
9. Pressure distribution over smooth and rough circular cylinders.
10. Surface pressure distribution around cylinder models in multiple model arrangement.

TOTAL: 45 PERIODS

OUTCOME

- Ability to use the fundamental aerodynamic principles for aircraft testing applications.
- Ability to conduct wind tunnel experiments
- Ability to perform flow visualization experiments
- Ability to estimate aerodynamic forces using laboratory equipment
- Ability to interpret experimental results with fundamental flow principles

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl.No	Equipments	Quantity
1	Subsonic Wind tunnel (including all accessories)-	1
2	Multi-tube Manometer	1
3	Pitot static tube and Pitot rake	1 each
5	Airfoil and cylinder models	6
6	Smoke flow generator	1
7	Force balance	1
8	Angle of attack modulator	1

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19411.1	3	2	3	1	3	1	-	1	2	1	1	3	3	2	1
AE19411.2	3	2	3	1	3	1	-	1	2	1	1	3	3	2	1
AE19411.3	3	2	3	1	3	1	-	1	2	1	1	3	3	2	1
AE19411.4	3	2	2	1	3	1	-	1	2	1	1	3	3	2	1
AE19411.5	3	2	2	1	3	1	-	1	2	1	1	3	3	2	1
Average	3	2	2.6	1	3	1	-	1	2	1	1	3	3	2	1

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
AE19412	AIRCRAFT COMPONENT DRAWING	PC	0	0	4	2

Objectives:

- Ability to gain practical experience in handling 2D drafting and 3D modelling software
- Ability to draw and model the components in 2D & 3D views
- Ability to perform surface modeling on a/c and its parts
- To Develop in students' graphic skills for communication of concepts, ideas of engineering products
- To familiarize with technical drawings

List of Experiments

1. Introduction to surface modelling
2. Drafting of basic 3D models
3. Drafting of aircraft wing
4. Drafting of aircraft fuselage
5. Drafting of empennage
6. Drafting of aircraft engine turbine
7. Drafting of landing gear tyre
8. Drafting of aircraft control column
9. Drafting of a typical aircraft. (Numerical Master Geometry)
10. Drafting of a typical DRONE (Numerical Master Geometry)
11. Drafting of a typical helicopter (Numerical Master Geometry)
12. Drafting of typical space system.
13. 3D printing of an aircraft structure
14. Mini-project

Total Contact Hours : 30

Course Outcomes:

AE19412.1	Explain graphic skills for communication of concepts, ideas of engineering products.	L2
AE19412.2	Design surface modeling using modeling software.	L6
AE19412.3	Create surface modeling in a/c and its parts	L6
AE19412.4	Create drafting on 3D models	L6
AE19412.5	Get job opportunities on design-based industries	L6

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19412.1	3	2	3	1	3	1	-	1	2	1	1	3	3	2	1
AE19412.2	3	2	3	1	3	1	-	1	2	1	1	3	3	2	1
AE19412.3	3	2	3	1	3	1	-	1	2	1	1	3	3	2	1
AE19412.4	3	2	2	1	3	1	-	1	2	1	1	3	3	2	1
AE19412.5	3	2	2	1	3	1	-	1	2	1	1	3	3	2	1
Average	3	2	2.6	1	3	1	-	1	2	1	1	3	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
GE19421	SOFT SKILLS - I	EEC	0	0	2	1

Program Learning Goals:

This program will help our students to build confidence and improve their English communication in order to face the corporate world as well as providing them with opportunities to grow within an organisation.

Course Objectives:

The major course objectives are:

a. To help students break out of shyness.

b. To build confidence

c. To enhance English communication skills.

d. To encourage students' creative thinking to help them frame their own opinions,

Learning and Teaching Strategy:

The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

Week	Activity Name	Description	Objective
1	Introduction	The trainer and the college facilitator talk to the students about the course and in turn the students introduce themselves.	To set expectations about the course and the students are made aware of the rules and regulations involved in this program
2	If I ruled the world	This is a quick and useful game by getting students to form a circle and provide their point of view. Each student then repeats what the other has said and comes up with their own opinion.	The aim of this activity is to for students to get to know each other and also develop their listening skills as well as learning how to agree and disagree politely.
3	Picture Narrating	This activity is based on several sequential pictures. Students are asked to tell the story taking place in the sequential pictures by paying attention to the criteria provided by the teacher as a rubric. Rubrics can include the vocabulary or structures they need to use while narrating.	The aim of this activity is to make the students develop creative way of thinking.
4	Brainstorming	On a given topic, students can produce ideas in a limited time. Depending on the context, either individual or group brainstorming is effective and learners generate ideas quickly and freely. The good characteristics of brainstorming are that the students are not criticized for their ideas so students will be open to sharing new ideas.	The activity aims at making the students speak freely without the fear of being criticized. It also encourages students to come up with their own opinions.

5	Debate	Is competition necessary in regards to the learning process?	The aim of this activity is to develop the students ability to debate and think out of the box
6	Short Talks	Here the students are given topics for which they take one minute to prepare and two minutes to speak. They can write down points but can't read them out they can only use it as a reference.	The activity aims at breaking the students' shyness and encouraging them to standup in front of the class and speak. It also aims at creating awareness that they are restricted for time so they only speak points that are relevant and important.
7	Debate	Will posting students' grades on bulletin boards publicly motivate them to perform better or is it humiliating?	This activity aims at enhancing the students unbiased thought process when it comes to exams and grades as well as develop their skills to debate
8	The Art of diplomacy	The facilitator proceeds to share multiple concepts of conversation and helps the participants to identify the various methods of being diplomatic and how do deal with misinformation.	The aim of the lesson is to provide an opportunity for the participants to learn about body language and choosing the appropriate words for conversation.
9	Debate	Are humans too dependent on computers?	The aim of this activity is to test the students debating skills and thought process with a topic that affects everybody in daily life.
10	Story Completion	The teacher starts to tell a story but after 2 sentences he/she asks students to work in groups to create the rest of the story which includes the plot and the ending.	This activity aims at building their narrating skills as well as their creativity and ability to work in a team.
11	Role play debate	Students scrutinize different points of view or perspectives related to an issue. For example, a debate about the question "Should students be required to wear uniforms at school?" might yield a range of opinions. Those might include views expressed by a student (or perhaps two students – one representing each side of the issue), a parent, a school principal, a police officer, a teacher, the owner of a clothing store, and others.	The aim of this activity is to get students to speak based on other people's perspective instead of their own. The students take the role of various characters and debate accordingly.
12	I Couldn't Disagree More	This is a game where students practice rebuttal techniques where one student provides a thought or an idea and the other students starts with the phrase I couldn't disagree more and continues with his opinion	The aim of this activity is to improve general communication skills and confidence.
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

Course Learning Outcome:

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

1. Be more confident
2. Speak in front of a large audience
3. Be better creative thinkers
4. Be spontaneous
5. Know the importance of communicating in English.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19421.1	-	-	-	-	-	-	-	-	1	3	-	1	-	1	2
GE19421.2	1	-	-	-	-	-	1	-	1	3	1	1	-	1	2
GE19421.3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	1
GE19421.4	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
GE19421.5	-	-	-	-	-	-	-	-	-	3	-	-	-	-	2
Average	0.2	0	0	0	0.4	0	0.2	0	0.4	3	0.2	0.4	0	0.4	1.4

SEMESTER V

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Subject Code	Subject Name	Category	L	T	P	C
AE19501	AERODYNAMICS – II	PC	2	1	0	3

Objectives:
To make the student understand the concepts of compressible aerodynamics. Also to introduce the design concepts of transonic and supersonic wing sections.

UNIT-I FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW 9

Isentropic relations, definition of compressibility of flow and its measure, speed of sound, Mach number, flow regimes, compressible Bernoulli's equation. Mach lines/waves/cones.

1D, ISENTROPIC FLOWS

Steady one-dimensional flow equations, area- velocity relation, isentropic flow through variable area duct, critical conditions, characteristic Mach number, Area-Mach number relation, maximum discharge velocity, mass flow rate, effect of stagnation conditions, back pressure. Choked flow, isentropic flow, ideally expanded, over-expanded, under-expanded flows-appearance of normal shock, Brief outline of operation of supersonic wind tunnels employing convergent-divergent nozzles. Types of supersonic wind tunnels.

UNIT-II 1D, NON-ISENTROPIC FLOWS 9

Normal shock waves: basic equations, relations across a normal shock, calculation of normal shock wave properties, measurements of airspeed in supersonic flows. Entropy rise across normal shock and its relation to pressure rise. Hugoniot equation. Moving normal shock waves - one-dimensional piston motion in a constant area tubes, Jump start, propagation of shock wave in front and expansion wave behind, x-t diagram, particle velocity, pressure density & temperature relations. Rayleigh flows and Fanno flows.

UNIT-III OBLIQUE SHOCKS AND EXPANSION WAVES 11

Oblique shock relations, Supersonic flow over wedges with attached shock, large wedge angle and shock detachment, Oblique shock charts: strong shock and weak shock boundary, pressure, density and entropy rise, Oblique shock of vanishing strength and Mach wave, Mach angle and Mach line, supersonic compression by turning, smooth nearly isentropic turn, Numerical exercise with oblique shock charts,

Regular reflection from solid wall, pressure deflection diagram, phenomenological description of shock wave-boundary layer interaction at the wall, intersection of shocks, Mach reflection and slip stream. Numerical exercises with shock reflection and shock intersection. Detached shock wave in front of bluff 2-D body.

Supersonic expansion by turning, Prandtl-Meyer function & expansion fan, Shock expansion theory-application to supersonic airfoils.

UNIT-IV COMPRESSIBLE SUBSONIC, TRANSONIC FLOWS 8

Subsonic Flow: The velocity potential, perturbation potential, linearized governing equation in two dimension, the pressure coefficient-Prandtl-Glauert compressibility correction, application to swept wings, critical Mach no, drag divergence Mach no.

Transonic Flow: The sound barrier. Buffeting, supercritical airfoils, swept wings at transonic-speeds, 2nd order equation for transonic flows, Wing-body combination, Whitcomb's Transonic area rule: application to transonic aircraft.

UNIT-V LOADS ON SUPERSONIC AIRFOILS AND WINGS 9

Linearized supersonic flow-governing equations, boundary conditions. Pressure coefficient, application to supersonic airfoils-- Lift, drag, pitching moment. Wedge, flat plate, diamond and biconvex airfoils at small angle of attack. Air loads over flat rectangular wings of finite span, Delta wing with supersonic leading edge and subsonic leading edge.

Method of Characteristics – Supersonic Nozzle Design

Brief outline of the method of characteristics-Statement (without proof) of compatibility relations, application to supersonic nozzle design.

TOTAL 45 PERIODS

TEXT BOOKS

1. Anderson, J.D., Modern compressible Flow with Historical Perspective, third ed., McGraw-Hill, 2017.
2. Rathakrishnan E., Gas Dynamics, Prentice- Hall of India, 2017.

REFERENCES

1. Robert D. Zucker & Oscar Biblarz, "Fundamentals of Gas Dynamics", John Wiley & Sons, 2nd Ed, 2002
2. James E. A. John & Theo G., "Gas Dynamics", Pearson; 3rd edition, 2006.
3. Carscallen, William E. Oosthuizen, Patrick H, "Introduction to Compressible Fluid Flow", CRC Press, II Edition, 2014.
4. Liepmann, H. W., and Roshko, A., Elements of Gas Dynamics, John Wiley, 2013.
5. S. M. Yahya, "Fundamentals of Compressible Flow", New Age Publications, 2009.

Course Outcomes:

On completion of the course students will be able to

AE19501.1 Apply the fundamental flow equations and basic solution techniques in solving compressible quasi-one-dimensional flows – Nozzle flows

AE19501.2 Apply the fundamental flow equations and basic solution techniques in solving compressible one dimensional flows – normal shock waves, Rayleigh and Fanno flows.

AE19501.3 Analyze one-dimensional flows with shock waves, expansion waves.

AE19501.4 Calculate the aerodynamic characteristics of airfoils and wings of use in compressible subsonic, transonic flight conditions.

AE19501.5 Perform calculations associated with supersonic airfoils.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19501.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19501.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19501.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19501.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19501.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19502	PROPULSION - I	PC	2	1	0	3

OBJECTIVES

- To introduce basic concepts and salient features of engine components of jet-propelled engines which are operated in atmosphere to students. To familiarize with hypersonic propulsion.

UNIT I FUNDAMENTALS OF AIR BREATHING ENGINES 9

Operating principles of piston engines – thermal efficiency calculations – classification of piston engines - illustration of working of gas turbine engine – the thrust equation – factors affecting thrust –effect of pressure, velocity and temperature changes of air entering compressor – methods of thrust augmentation – characteristics of turboprop, turbofan and turbojet – performance characteristics.

UNIT II INLETS AND NOZZLES 10

Internal flow and Stall in subsonic inlets – relation between minimum area ratio and eternal deceleration ratio – diffuser performance – supersonic inlets – starting problem on supersonic inlets –shock swallowing by area variation – real flow in nozzles and nozzle efficiency – losses in nozzles –equilibrium flow and frozen flow in nozzles– ejector and variable area nozzles - thrust reversal.

UNIT III COMPRESSORS FOR JET ENGINES 9

Principle of operation of centrifugal compressor and axial flow compressor– Work done and pressure rise – velocity diagrams – degree of reaction – free vortex and constant reaction designs of axial flow compressor – performance characteristics of centrifugal and axial flow compressors– stage efficiency calculations - cascade testing

UNIT IV TURBINES FOR JET ENGINES 9

Principle of operation of axial flow turbines– limitations of radial flow turbines- Work done and pressure rise – Velocity diagrams – degree of reaction – free vortex and constant nozzle angle designs – performance characteristics of axial flow turbine– turbine blade cooling methods – stage efficiency calculations – basic blade profile design considerations – matching of compressor and turbine.

UNIT V JET ENGINE COMBUSTORS AND RAMJET PROPULSION 8

Classification of combustion chambers – combustion chamber performance – effect of operating variables on performance – flame stabilization. Operating principle of ramjet engine – various components of ramjet engines and their efficiencies –Combustion in ramjet engine – critical, subcritical and supercritical modes of operation -ramjet engine and its performance characteristics – sample ramjet design calculations – flame stability problems in ramjet combustors –integral ram rockets. Coding for jet engine problems.

TOTAL: 45 PERIODS

Course Outcomes:

On completion of the course students will be able to

AE19502.1 To understand the working of various airbreathing engines
AE19502.2 To understand the design features of inlets and perform necessary calculations
AE19502.3 To understand the design features of compressors and perform necessary calculations
AE19502.4 To understand the design features of turbines and perform necessary calculations
AE19502.5 To understand the design features of combustors and perform necessary calculations

TEXT BOOKS

1. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Addison – Wesley Longman INC, 1999.
2. James Award, "Aerospace Propulsion System"

REFERENCES

1. Cohen, H. Rogers, G.F.C. and Saravana muttoo, H.I.H. “Gas Turbine Theory”, Longman, 1989.
2. Oates, G.C., “Aero thermodynamics of Aircraft Engine Components”, AIAA Education Series, New York, 1985.
3. Rathakrishnan., E, "Gas Dynamics”, Fifth edition Published by PHI Learning, 2014.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19502.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19502.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19502.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19502.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19502.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19504	**AIRCRAFT STRUCTURES**	**PC**	**2**	**1**	**0**	**3**

OBJECTIVES

- To provide the students various methods for analysis of aircraft wings and fuselage.
- To provide the the behavior of major aircraft structural components.

UNIT I UNSYMMETRICAL BENDING 9

Bending of symmetric beams subject to skew loads - bending stresses in beams of unsymmetrical sections – generalized “K” method, neutral axis method, principal axis method.

UNIT II SHEAR FLOW IN OPEN SECTIONS 9

Thin walled beams – concept of shear flow – the shear centre and its determination – shear flow distribution in symmetrical and unsymmetrical thin-walled sections – structural idealization – shear flow variation in idealized sections.

UNIT III SHEAR FLOW IN CLOSED SECTIONS 9

Bredt - Batho theory – single-cell and multi-cell tubes subject to torsion – shear flow distribution in thin-walled single & multi-cell structures subject to combined bending torsion – with walls effective and ineffective in bending – shear centre of closed sections.

UNIT IV BUCKLING OF PLATES 8

Bending of thin plates – rectangular sheets under compression - local buckling stress of thin walled sections – crippling strength estimation — load carrying capacity of sheet stiffener panels – effective width.

UNIT V STRESS ANALYSIS OF WING AND FUSELAGE 10

Loads on an aircraft – the V-n diagram – shear force and bending moment distribution over the aircraft wing and fuselage – shear flow in thin-webbed beams with parallel and non-parallel flanges – complete tension field beams – semi-tension field beam theory.

TOTAL 45 PERIODS

TEXT BOOKS

1. Megson T M G , "Aircraft Structures for Engineering Students", Elsevier Ltd, 2007
2. Peery, D.J., and Azar, J.J., "Aircraft Structures", 2nd edition, McGraw – Hill, N.Y., 1999

3. Bruhn. E.H., "Analysis and Design of Flight Vehicles Structures", Tri-state off-set Company, USA, 1985.

REFERENCES

1. Rivello, R.M., "Theory and Analysis of Flight Structures", McGraw Hill, 1993.
2. Howard D Curtis, "Fundamentals of Aircraft Structural Analysis", WCB-McGraw Hill, 1997

Course Outcomes:

On completion of the course students will be able to

AE19504.1 To perform calculations on unsymmetric bending

AE19504.2 To perform shear flow calculations in open sections

AE19504.3 To perform shear flow calculations in closed sections

AE19504.4 To perform buckling calculations in plates

AE19504.5 To perform stress analysis calculations on wing and fuselage structures

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19504.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19504.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19504.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19504.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19504.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19505	**FLIGHT DYNAMICS**	**PC**	**2**	**1**	**0**	**3**

OBJECTIVE:

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

UNIT I CRUISING FLIGHT PERFORMANCE 9

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

UNIT II MANOEUVERING FLIGHT PERFORMANCE 10.

Range and endurance - Climbing and gliding flight (Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide) -Turning performance (Turning rate turn radius). Bank angle and load factor – limitations on turn - V-n diagram and load factor.

UNIT III STATIC LONGITUDINAL STABILITY 10

Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes -Inherently stable and marginal stable airplanes – Static, Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion - Effects of fuselage and nacelle - Influence of CG location - Power effects - Stick fixed neutral point - Stick free stability-Hinge moment coefficient

- Stick free neutral points-Symmetric maneuvers - Stick force gradients - Stick _ force per 'g' - Aerodynamic balancing.

UNIT IV LATERAL AND DIRECTIONAL STABILITY 8

Dihedral effect - Lateral control - Coupling between rolling and yawing moments - Adverse yaw effects - Aileron reversal - Static directional stability - Weather cocking effect - Rudder requirements – One engine inoperative condition - Rudder lock.

UNIT V DYNAMIC STABILITY 10

Introduction to dynamic longitudinal stability: - Modes of stability, effect of freeing the stick – Brief description of lateral and directional. dynamic stability - Spiral, divergence, Dutch roll, auto rotation and spin.

TOTAL: 45 PERIODS

Course Outcomes:

On completion of the course students will be able to

AE19505.1 An understanding of cruising flight performance

AE19505.2 An understanding of maneuvering flight performance

AE19505.3 To Find the effect of major components on static longitudinal stability

AE19505.4 An understanding of the dihedral effect, rolling power and control effectiveness of aileron

AE19505.5 To get familiarized with the longitudinal, directional and lateral dynamics of the airplane

TEXT BOOKS

1. Perkins C.D. &Hage R.E. Airplane performance, stability and control, John Wiley & Sons 1976.
2. Nelson, R.C. Flight Stability & Automatic Control, McGraw Hill, 1998.

REFERENCES

1. McCormick, B.W. Aerodynamics, Aeronautics & Flight Mechanics John Wiley, 1995.
2. Babister, A.W. Aircraft Stability and response, Pergamon Press, 1980
3. Etkin, B., Dynamics of Flight Stability and Control, Wiley, third edition 1995. 4.Pamadi, B.N. Performance, Stability, Dynamics, and Control of Airplanes, AIAA Education Series, 2004.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19505.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19505.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19505.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19505.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19505.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19541	AIRCRAFT SYSTEMS AND INSTRUMENTS	PC	2	0	2	3

OBJECTIVES

- To impart knowledge of the aircraft control systems
- To gain knowledge on hydraulic and pneumatic systems of aircraft
- Basic knowledge of piston and jet engine fuel and lubrication systems
- To impart knowledge on aircraft environment systems
- To gain knowledge on flight and engine instruments.

UNIT I AIRPLANE CONTROL SYSTEMS 8

Conventional Systems – power assisted and fully powered flight controls – push pull rod and cable system – operating principles – modern control systems – FBW and FBL systems – auto pilot system.

UNIT II AIRCRAFT SYSTEMS 12

Hydraulic systems – Study of typical hydraulic systems Boeing 727 components – hydraulic systems operation – selector valves-accumulators-Control valves – pneumatic systems – Schematic diagram and operation – brake system- typical brake system Boeing 757 – landing gear systems – components – shock strut operation-retraction systems.

UNIT III ENGINE SYSTEMS 8

Typical fuel systems – piston and jet engines – components – typical fuel lubricating systems - piston and jet engines – starting and ignition systems – piston and jet engines

UNIT IV AIRCONDITIONING AND PRESSURIZING SYSTEM 8

Basic air cycle systems – vapour cycle systems - air cycle machine cooling system – cooling pack-oxygen systems –Typical oxygen system Cessna– fire protection systems-fire extinguishing agents-de-icing and anti-icing system-pneumatic de-icing of large aircraft-thermal anti-icing. -probe anti-icing.

UNIT V AIRCRAFT INSTRUMENTS 9

Flight and engine instruments – accelerometers, air speed indicators – Mach meters – altimeters – vibrometers - typical Boeing system with air data computer- gyroscopic instruments– principles and operation – study of various types of engine instruments – tachometers – oil temperature gauges-EGT-EPR- fuel quantity indicators-operation and principles.

TOTAL: 45 PERIODS

List of Experiments

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

Contact Hours : 30
Total Contact Hours : 75

Course Outcomes:

On completion of the course students will be able to

AE19541.1 Understands the aircraft control systems
AE19541.2 Acquires knowledge on hydraulic and pneumatic systems of aircraft
AE19541.3 Understands piston and jet engine fuel and lubrication systems
AE19541.4 Understands the aircraft environment systems
AE19541.5 Identify flight and engine instruments

TEXT BOOKS

1. Kroes, Watkins and Delp, "Aircraft Maintenance and Repair", Tata McGraw Hill, 2010

REFERENCES

1. Pallet, E.H.J, "Aircraft Instruments & Principles", Pitman & Co 1993.
2. Kroes and Wild,"Aircraft Power plants", Tata McGraw Hill 2010
3. Instrument Flying Handbook: FAA-H-8083-15B, Sky Pony Press; Clr Csm edition, 2017.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19541.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19541.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19541.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19541.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19541.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19511	AIRCRAFT STRUCTURES LAB	PC	0	0	4	2

OBJECTIVES

- To enable the students, understand the behavior of aircraft structural components under different loading conditions.
- To study the failure of different component under different loading condition

LIST OF EXPERIMENTS

1. Determination of deflection of a beam under different end conditions
2. Verification of superposition theorem
3. Verification of Maxwell's reciprocal theorem
4. Determination of member forces in the truss
5. Determination of principal stresses due to combined loading in circular cross-sectional beam
6. Determination of Shear entre of a channel section
7. Fabrication of a Composite Laminate using Glass fiber as per ASTM standard
8. Determination of strength value in tapered beam section
9. Estimation of buckling load in column with both ends are hinged.
10. Determination of natural frequency in Forced vibration of a cantilever beam
11. Determination of deflection in the cantilever frame
12. Identify the fringe pattern in the using photo elastic models

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No.	Name of the Equipment	Quantity
1	Beams with weight hangers and dial gauges	6
2	Truss model and	1
3	Frame model	1
4	Circular Cross sectional beam with strain indicator	1
5	Constant strength beam set up	1
6	Column set up with dial gauges	2
7	Vibration set up with accessories	1
8	Photo elasticity set up	1

Course Outcomes:

On completion of the course students will be able to

AE19511.1 Be able to understand the importance of aircraft structures which are the load carrying members.

AE19511.2 The analytical ability of calculating the bending stresses in beams of un-symmetrical sections

AE19511.3 To perform buckling load calculations on columns

AE19511.4 To understand vibration character of cantilever beam

AE19511.5 To gain experimental understanding of photo elastic models

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19511.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19511.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19511.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19511.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19511.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19512	AIRFRAME REPAIR AND AERO ENGINE LABORATORY	PC	0	0	4	2

OBJECTIVES

- To build skills of riveting, patch work, and welding

LIST OF EXPERIMENTS

1. Aircraft wood gluing on a single and double scarf joints.
2. TIG & MIG welding of single & double V-joints.
3. Patch repair work on Perspex plate.
4. Riveting of lap and butt joints on an aluminum plate.
5. Bending and flaring of aluminum tube.
6. Making a channel and angle section by bending aluminum strip.
7. Performing aircraft magnetic compass swing (direct reading type).
8. Performing mooring on bolted and riveted joints
9. Dismantling of a piston engine and components identification
10. Inspection of Piston Engine - cleaning, and perform NDT checks.
11. Identification of Jet Engine – components &defects.
12. Static balancing of Propeller.
13. Starting procedure of Piston engine in Cessna Aircraft

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl.No.	Name of the Equipment	Quantity
1	Shear cutter pedestal type	1
2	Drilling Machine	1
3	Bench Vices	1
4	Radius Bend bars	1
5	Pipe Flaring Tools	1
6	Welding machine	1
7	Glass fibre, epoxy resin	1
8	Strain gauges and strain indicator	1

Course Outcomes:

On completion of the course students will be able to

AE19512.1 Ability to join the different types of aircraft wood
AE19512.2 Develop skills on riveting, mooring and patch work
AE19512.3 Differentiate the welding process and weld the materials
AE19512.4 Able to dismantle piston and jet engine, clean, and perform NDT test
AE19512.5 Able to perform the checks for aircraft symmetry, levelling and jacking

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19512.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19512.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19512.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19512.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19512.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
GE19521	SOFT SKILLS - II	EEC	0	0	2	1

Course Objectives:

The major course objectives are:

e. To help students break out of shyness.
f. To build confidence
g. To enhance English communication skills.
h. To encourage students' creative thinking to help them frame their own opinions,

Week	Activity Name	Description	Objective
1	The News hour	Students are made to read news articles from the English newspapers. The students also have to find words and their meaning from the article they have not come across before and share it with the group. They then use these words in sentences of their own	The aim of this activity is not only to get the students to read the newspaper but also aims at enhancing the students' vocabulary.
2	Court Case	The facilitator provides the participants the premise of a story and proceeds to convert the story into a court case. The students are required, department-wise to debate and provide their points to win the case for their clients.	The aim of the lesson is to encourage creative and out-of-the -box thinking to ensure a good debate and defense skills.
3	The ultimate weekend	The students design activities they are going to do over the weekend and they have to invite their classmates to join in the activity. The students move around the class and talk to other students and invite them.	The aim of this activity is to develop the art of conversation among students. It also aims at practicing the grammatical structures of "going to" "have to" and asking questions.
4	The Four Corners	This is a debate game that uses four corners of the classroom to get students moving. The following is written on the 4 corners of the room "Strongly Agree, Somewhat Agree, Somewhat Disagree and Strongly Disagree". The topics are then given to the class and students move to the corner that they feel best explains their opinions	This activity aims at getting students to come up with their own opinions and stand by it instead of being overshadowed by others and forcing themselves to change based on others opinions.
5	Debate	Boarding school or day school? Which is more beneficial for a student?	The aim of this activity is to encourage students to draw up feasible points on the advantages and benefits of both. And enhance their debating ability
6	Grand Master	The facilitator starts the session by keeping an individual in mind, upon which the students guess it only through "Yes or No" questions. Post few trials the students are given same opportunity to do the same with the crowd.	The aim of the lesson is designed to teach the art of questioning. It also helps to enhance the students' speaking and listening skills.
7	Debate	Does violence on the TV and Video games influence children negatively?	This activity aims at encouraging the students to debate on real life

			scenarios that most students spend a lot of time on.
8	Turn Tables	This is a speaking activity where the students need to speak for and against the given topics when the facilitator shouts out 'Turn Table'.	The aim of this activity is to make the participants become spontaneous and have good presence of mind.
9	Debate	Do marks define the capabilities of a student?	This debate activity aims at allowing the students to argue on this worrisome adage of marks.
10	FictionAD	The Participants are asked to create an Ad for a challenging topic only using fictional characters.	The activity aims at developing their creativity and presentation skills.
11	Debate	Are social networking sites effective, or are they just a sophisticated means for stalking people?	This activity aims at refining the students debating skills on a very real life situation
12	Talent Hunt	Talent Hunt is a fun activity where the students are selected at random and supported to present any of their own skills.	The aim of this activity is designed to evoke their inner talents and break the shyness and the fear of participating in front of a crowd
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits.	The aim is to do both give feedback to students as well as obtain feedback on the course from them.

Course Learning Outcome:

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

1. Be more confident
2. Speak in front of a large audience without hesitation
3. Think creatively
4. Speak impromptu
5. Communicate in English

Learning Resources:

Kings Learning work sheets.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19521.1	-	-	-	-	-	-	-	-	2	3	1	1	-	1	1
GE19521.2	-	-	-	-	-	-	-	-	2	3	2	-	-	2	2
GE19521.3	-	1	-	-	-	-	-	-	2	3	1	1	-	1	1
GE19521.4	-	-	-	-	-	-	-	-	2	3	-	-	-	2	1
GE19521.5	-	1	-	-	-	-	-	-	2	3	1	1	-	2	1
Average	0	0.4	0	0	0	0	0	0	2	3	1.25	0.6	0	1.6	1.2

SEMESTER VI

Subject Code	Subject Name	Category	L	T	P	C
AE19601	FINITE ELEMENT METHOD	PC	2	1	0	3

OBJECTIVES

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

UNIT I INTRODUCTION 8

Review of various approximate methods – variational approach and weighted residual approach–application to structural mechanics problems. Finite difference methods–governing equation and convergence criteria of finite element method.

UNIT II DISCRETE ELEMENTS 10

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

UNIT III CONTINUUM ELEMENTS 8

Plane stress, plane strain and axisymmetric problems. Derivation of element matrices for constant and linear strain triangular elements and axisymmetric element.

UNIT IV ISOPARAMETRIC ELEMENTS 9

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

UNIT V FIELD PROBLEM AND METHODS OF SOLUTIONS 10

Heat transfer problems, steady state fin problems, derivation of element matrices for two dimensional problems, torsion problems. Bandwidth – elimination method and method of factorization for solving simultaneous algebraic equations – Features of software packages, sources of error.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Tirupathi.R. Chandrapatha and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Printice Hall India, Third Edition, 2003.
2. Rao. S.S., "Finite Element Methods in Engineering," Butterworth and Heinemann, 2001
3. Reddy J.N., "An Introduction to Finite Element Method", McGraw Hill, 2000.

REFERENCES

1. Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw Hill, 2000.
2. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.
3. Robert D Cook, David S Malkus, Michael E Plesha, "Concepts and Applications of Finite Element Analysis", 4th edition, John Wiley and Sons, Inc., 2003.
4. Larry J Segerlind, "Applied Finite Element Analysis", 2nd Edition, John Wiley and Sons, 1984.

Course Outcomes:

On completion of the course students will be able to

AE19601.1 Will obtain an overall understanding of Finite Element analysis
AE19601.2 Will be able to perform discrete element analysis
AE19601.3 Will be able to perform continuum element analysis
AE19601.4 Will be able to perform isoparametric element analysis
AE19601.5 Will be able to apply FEM methods to typical engineering situations

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19601.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19601.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19601.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19601.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19601.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19602	**PROPULSION - II**	**PC**	**2**	**1**	**0**	**3**

OBJECTIVES:

- To impart knowledge in non air-breathing and hypersonic propulsion methods to students so that they are familiar with various propulsion technologies associated with space launch vehicles, missiles and space probes.

UNIT I HYPERSONIC AIRBREATHING PROPULSION 9

Introduction to hypersonic air breathing propulsion, hypersonic vehicles and supersonic combustion-need for supersonic combustion for hypersonic propulsion – salient features of scramjet engine and its applications for hypersonic vehicles – problems associated with supersonic combustion – engine/airframe integration aspects of hypersonic vehicles – various types scramjet combustors – fuel injection schemes in scramjet combustor.

UNIT II FUNDAMENTALS OF CHEMICAL ROCKET PROPULSION 10

Introduction to chemical rocket propulsion-applications of chemical rocket motors with advantages and disadvantages –Operating principle– specific impulse of a rocket – internal ballistics – performance considerations of rockets – various feed systems -preliminary concepts in nozzle-less propulsion – air augmented rockets – pulse rocket motors – static testing of rockets & instrumentation –safety considerations.

UNIT III SOLID ROCKET PROPULSION 9

Selection criteria of solid propellants– types of igniters – estimation of solid propellant adiabatic flame temperature - propellant grain design considerations – erosive burning in solid propellant rockets – combustion instability – strand burner and T-burner.

UNIT IV LIQUID AND HYBRID ROCKET PROPULSION 9

Selection of criteria liquid propellants and injectors for liquid propellant rockets -thrust control and cooling in liquid propellant rockets and the associated heat transfer problems – combustion instability in liquid propellant rockets – peculiar problems associated with operation of cryogenic - combustion mechanism in hybrid propellant rockets – applications and limitations.

UNIT V ADVANCED PROPULSION TECHNIQUES 8

Electric rocket propulsion– types of electric propulsion techniques - Ion propulsion – Nuclear rocket – comparison of performance of these propulsion systems with chemical rocket propulsion systems – future applications of electric propulsion systems - Solar sail.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1993.
2. Mathur, M.L., and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers and Distributors, Delhi, 1988.

Course Outcomes:

On completion of the course students will be able to

AE19602.1 Understanding various propulsion systems

AE19602.2 Differentiate various rocket propulsion systems

AE19602.3 Knowledge about the applications and principles of liquid and solid-liquid propulsion systems

AE19602.4 Develop hybrid propulsion and cryogenic in rocketry

AE19602.5 Acquire knowledge in electric propulsion systems

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19602.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19602.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19602.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19602.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19602.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19603	CONTROL ENGINEERING	PC	3	0	0	3

OBJECTIVES

- To introduce the mathematical modelling of systems, open loop and closed loop systems and analyses in time domain and frequency domain.
- To impart the knowledge on the concept of stability and various methods to analyze stability in both time and frequency domain.
- To introduce sampled data control system.

UNIT I INTRODUCTION 9

Historical review, Simple pneumatic, hydraulic and thermal systems, Series and parallel system, Analogies, mechanical and electrical components, Development of flight control systems.

UNIT II OPEN AND CLOSED LOOP SYSTEMS 9

Feedback control systems – Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios.

UNIT III CHARACTERISTIC EQUATION AND FUNCTIONS 9

Laplace transformation, Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

UNIT IV CONCEPT OF STABILITY 10

Necessary and sufficient conditions, Routh-Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response.

UNIT V SAMPLED DATA SYSTEMS 8

Z-Transforms Introduction to digital control system, Digital Controllers and Digital PID controllers

TOTAL: 45 PERIODS

TEXT BOOKS

1. OGATO, Modern Control Engineering, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.

2. Azzo, J.J.D. and C.H. Houpis Feed back control system analysis and synthesis, McGraw-Hill international 3rs Edition, 1998.

REFERENCES

1. Kuo, B.C. "Automatic control systems", Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.
2. Houpis, C.H. and Lamont, G.B. "Digital control Systems", McGraw Hill Book co., U.S.A. 1995.
3. Naresh K Sinha, "Control Systems", New Age International Publishers, New Delhi, 1998.

Course Outcomes:

On completion of the course students will be able to

AE19603.1 Ability to understand the importance of mathematical modeling of a system

AE19603.2 Ability to Demonstrate the concept and needs of feedback control systems and its application

AE19603.3 Ability to Determine the response of different order systems for various step inputs

AE19603.4 Ability to Determine the (absolute) stability of a closed-loop control system

AE19603.5 Ability to understand the concept of data system sampling and digital controller

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19603.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19603.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19603.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19603.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19063.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19641	FLIGHT VEHICLE DESIGN	PC	3	0	2	4

UNIT I OVERVIEW OF DESIGN PROCESS 9

Introduction, Requirements, Phases of design, Conceptual Design Process, Initial Sizing, Take-off weight build up, Empty weight estimation, Fuel fraction estimation, Take- off weight calculation, Thrust to Weight Ratio & Wing Loading: Thrust to Weight Definitions, Statistical Estimate of T/W. Thrust matching, Spread sheet in design, Wing Loading and its effect on Stall speed, Take-off Distance, Catapult take-off, and Landing Distance. Wing Loading for Cruise, Loiter, Endurance, Instantaneous Turn rate, Sustained Turn rate, Climb, & Glide, Maximum ceiling.

UNIT II CONFIGURATION LAYOUT & LOFT 9

Conic Lofting, Conic Fuselage Development, Conic Shape Parameter, Wing-Tail Layout & Loft. Aerofoil Linear Interpolation. Aerofoil Flat-wrap Interpolation. Wing aerofoil layout-flap wrap. Wetted area determination. Special considerations in Configuration Layout: Aerodynamic, Structural, Detectability. Crew station, Passenger, and Payload arrangements. Design of Structural Components: Fuselage, Wing, Horizontal & Vertical Tail. Spreadsheet for fuselage design. Tail arrangements, Horizontal & Vertical Tail Sizing. Tail Placement. Loads on Structure. V-n Diagram, Gust Envelope. Loads distribution, Shear and Bending Moment analysis.

UNIT III ENGINE SELECTION & FLIGHT VEHICLE PERFORMANCE 9

Turbojet Engine Sizing, Installed Thrust Correction, Spread Sheet for Turbojet Engine Sizing. Propeller Propulsive System. Propeller design for cruise. Take-off, Landing & Enhanced Lift Devices. Ground Roll, Rotation, Transition, Climb, Balanced Field Length, Landing Approach, Braking. Enhanced lift design -Passive & Active.

UNIT IV STATIC STABILITY & CONTROL 9

Longitudinal Static Stability, Pitch Trim Equation. Effect of Airframe components on Static Stability. Lateral stability. Contribution of Airframe components. Directional Static stability. Contribution of Airframe components. Aileron Sizing, Rudder Sizing. Flying qualities. Cooper Harper Scale. Environmental constraints, Aerodynamic requirements.

UNIT V DESIGN ASPECTS OF SUBSYSTEMS 9

Flight Control system, Landing Gear and subsystem, Propulsion and Fuel System Integration, Air Pressurisation and Air Conditioning System, Electrical & Avionic Systems, Structural loads, Safety constraints, Material selection criteria.

TOTAL: 60 PERIODS

TEXT BOOKS

1. Aircraft Design - A Conceptual Approach- Daniel P. Raymer, AIAA Education Series, IVth Edition © 2006
2. Design of Aircraft-Thomas C. Corke, Pearson Edition. Inc. © 2003.

REFERENCES

1. Aeroplan Design -VOL 1 to 9 - J Roskam, Roskam Aviation & Engineering Corporation, 1989.
2. Introduction to Aircraft Design - John Fielding, Cambridge University Press, 2009 3. Standard Handbook for Aeronautical & Astronautical Engineers, Editor Mark Davies, TMH, 2010.
3. General Aviation Aircraft Design: Applied Methods and Procedures, SNORRI GUDMUNDSSON, Butterworth-Heinemann, 2014

List of Exercises

1. Comparative configuration study of different types of airplanes [1]
2. Comparative study on specification and performance data of aircraft [1]
3. Comparative graphs preparation and selection of main parameters for the design [1]
4. Preliminary weight estimations, selection of main parameters [1]
5. Airfoil selection, wing layout [2]
6. Drag estimation [2]
7. V-*n* diagram for the design study and gust and maneuverability envelopes [2]
8. Load estimation of wings and fuselage [2]
9. Power plant selection [3]
10. Detailed performance calculations [3]
11. Stability estimates [4]
12. Sizing of tail and control surfaces [4]
13. Balancing and Maneuvering loads on tail plane, aileron and rudder [4]
14. Selection of suitable subsystems [5]
15. Preparation of a detailed design report with drawings

Course Outcomes:

On completion of the course students will be able to

AE19641.1 Be able to perform weight estimation calculations
AE19641.2 Be able perform design calculations pertaining to configuration layout and flight envelope
AE19641.3 Be able perform design calculations for engine selection
AE19641.4 Be able perform design calculations for control surface selection
AE19641.5 Will gain an understanding of various sub-systems

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19641.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19641.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19641.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19641.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19641.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

GE19304 FUNDAMENTALS OF MANAGEMENT FOR ENGINEERS

L	T	P	C
3	0	0	3

OBJECTIVES

- To enable the students to study the evolution of Management, to study the functions and principles of management and to learn the application of the principles in an organization.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers -managerial roles and skills – Evolution of Management – Scientific, human relations, system and contingency approaches – Types of Business organization - Sole proprietorship, partnership, company-public and private sector enterprises - Organization culture and Environment – Current trends and issues in Management.

UNIT II PLANNING 9

Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management – Planning Tools and Techniques-Decision making steps and process.

UNIT III ORGANISING 9

Nature and purpose – Formal and informal organization – organization chart – organization structure types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and development, Performance Management, Career planning and management.

UNIT IV DIRECTING 9

Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership –communication – process of communication – barrier in communication – effective communication –communication and IT.

UNIT V CONTROLLING 9

System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – reporting.

TOTAL: 45 PERIODS

TEXTBOOKS

1. Stephen P. Robbins & Mary Coulter, “Management”, 10th Edition, Prentice Hall (India) Pvt. Ltd.,2009.
2. JAF Stoner, Freeman R.E and Daniel R Gilbert “Management”, 6th Edition, Pearson Education,2004.

REFERENCES

1. Stephen A. Robbins & David A. Decenzo & Mary Coulter, “Fundamentals of Management”7th Edition, Pearson Education, 2011.
2. Robert Kreitner & Mamata Mohapatra, “Management”, Biztantra, 2008.
3. Harold Koontz & Heinz Weihrich “Essentials of management” Tata Mc Graw Hill, 1998.

Tripathy PC & Reddy PN, “Principles of Management”, Tata McGraw Hill, 1999.

OUTCOMES

- GE19304.1 Understands the evolution of Management
- GE19304.2 Gains knowledge on the functions of management
- GE19304.3 knowledge on planning function in details
- GE19304.4 Knowledge on organizing, directing and controlling
- GE19304.5 Knowledge on application of the principles in an organization
-

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE19304.1	3	1	1		3	-	-	2	-	-	-	-	2	2	-
GE19304.2	3	1	2	-	3	-	-	-	-	-	-	1	2	2	-
GE19304.3	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
GE19304.4	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
GE19304.5	1	2	2		1	-	-	2	-	2	-	2	1	1	-
Average	2.6	1.6	1.8	-	2.6	-	-	2	-	2	-	1.25	1.8	1.8	-

Subject Code	Subject Name	Category	L	T	P	C
AE19611	JET PROPULSION LABORATORY	PC	0	0	4	2

OBJECTIVES

- To enable the students, understand the behavior supersonic flows
- To study the different expansion levels of jets.

LIST OF EXPERIMENTS

1. Principle of operation and calibration of supersonic jet rig.
2. Effect of inlet total pressure on the flow development of supersonic C-D nozzle.
3. Mach number distribution in C-D nozzle for un-choked inlet total pressure(s).
4. Mach number distribution in C-D nozzle for choked inlet total pressure(s).
5. Pitot Pressure study of an over-expanded jet.
6. Pitot Pressure study of correctly-expanded jet.
7. Pitot Pressure study of an under-expanded jet.
8. Pitot Pressure measurements to study characteristic decay of subsonic jet.
9. Pitot Pressure measurements to study radial spread of subsonic jet.
10. Use of Shadow graph system to visualize shock waves.
11. Noise Characteristics of jets.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl.No.	Name of the Equipment	Quantity
1	Supersonic Jet Rig Setup (includes compressors, reservoir and settling chamber and pressure gauges)	1
2	Pressure Regulating Valves	2
3	C-D nozzle models	2
4	Gang manometer	1
5	Pitot tube	1
6	Multi-Channel Pressure scanner	1
7	Flow Visualization setup	1
8	Anechoic Chamber with microphone and DAQ	1

Course Outcomes:

On completion of the course students will be able to

AE19611.1 Be able to perform experiments using supersonic free jet facility
AE19611.2 Be able to identify the flow features of jets at different expansion levels
AE19611.3 Be able to perform experiments to estimate jet decay and spread character
AE19611.4 Be able to visualize various flow features of jets using optical techniques
AE19611.5 Be able to perform preliminary aero-acoustic experiments

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19611.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19611.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19611.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19611.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19611.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19612	INNOVATION AND DESIGN THINKING FOR ENGINEERINGS	EEC	0	0	4	2

Objectives:

- Work in a group and to identify the potential areas in the field of engineering.
- Recognize the creative thinking skills to compare and contrast the several existing solutions for the identified problem.
- Understand the project plan for creating a solution for the work identified.
- Acquire fundamental principles of planning and carrying out the work plan of the project through observations, discussions and decision-making processes.
- Understand on preparing the project report and present the findings of the work conducted.

Design thinking is a comprehensive approach to solutions, which stimulates creativity in working groups of participants. It is an innovating process, which allows the development of new solutions for a selected problem. Concepts are created and then revised in various cycles and tested using prototypes. This holistic approach with creative solutions enables companies to develop innovations.

GUIDELINE FOR REVIEW AND EVALUATION

The students may be grouped into 2 or 3 should select an existing engineering component/ assembly and they should identify, define, ideate, fabricate and test. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor. A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a committee constituted by the Head of the Department. At the end semester examination, the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

Scheme for Internal Evaluation:

S. No.	Description	Marks
1	Review - I	15
2	Review - II	15
3	Review - III	20

Course Outcomes:

On completion of the course students will be able to

AE19612.1 Work in a group and identify the potential research areas in the field of engineering.

AE19612.2 Apply their creative thinking skills to Compare and contrast the several existing solutions for the problems identified.

AE19612.3 Formulate and propose a plan for creating a solution for the work identified.

AE19612.4 Apply fundamental principles of planning and carrying out the work plan of the project through observations, discussions and decision-making process

AE19612.5 Prepare the project report and present the findings of the work conducted.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19612.1	2	2	1	1	-	-	-	-	3	2	3	2	2	-	2
AE19612.2	2	2	1	1	-	1	-	-	3	2	3	2	2	-	2
AE19612.3	2	2	2	1	1	1	-	-	3	2	3	2	2	-	2
AE19612.4	2	2	2	1	-	1	-	-	3	2	3	2	2	-	2
AE19612.5	2	2	2	-	1	-	-	-	3	3	3	2	2	-	2
Average	2	2	1.6	0.8	0.4	0.6	-	-	3	2.2	3	2	2	-	2

Subject Code	Subject Name	Category	L	T	P	C
GE19621	PROBLEM SOLVING TECHNIQUES	EEC	0	0	2	1

Course Objectives: To improve the numerical ability and problem-solving skills.

Course Topics:

S. No.	Topics
1	Numbers system
2	Reading comprehension
3	Data arrangements and Blood relations
4	Time and Work
5	Sentence correction
6	Coding & Decoding, Series, Analogy, Odd man out and Visual reasoning
7	Percentages, Simple interest and Compound interest
8	Sentence completion and Para-jumbles
9	Profit and Loss, Partnerships and Averages
10	Permutation, Combination and Probability
11	Data interpretation and Data sufficiency
12	Logarithms, Progressions, Geometry and Quadratic equations.
13	Time, Speed and Distance

Handling the topics: through AMCAT training

Course Outcomes:

On completion of the course students will be able to

AE19621.1 Have mental alertness
AE19621.2 Have numerical ability
AE19621.3 Solve quantitative aptitude problems with more confident
AE19621.4 Able to develop new solution techniques
AE19621.5 Able to interpret problems with clarity

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19621.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19621.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19621.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19621.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19621.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19721	**SUMMER INTERNSHIP**	**EEC**	**0**	**0**	**2**	**1**

A 4-week industry internship is a compulsory course requirement during summer vacation (pre-semester). Evaluation marks to be carried over to present semester. Every student of the course is expected to work in the industry for a period of 4 weeks, during the months of May to June, after completing four semesters of the academic program. The Industry Internship Placement process is held to help the students find internships and at the same time, help recruiters find students to intern with their firms' challenging projects.

Course Outcomes:

On completion of the course students will be able to

AE19721.1 Understand the working procedures in industry
AE19721.2 Gain knowledge about contemporary technologies
AE19721.3 Gain hand on experience on various processes
AE19721.4 Apply new methods to investigate complex engineering problems
AE19721.5 Gain motivation towards lifelong learning

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19721.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19721.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19721.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19721.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19721.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

SEMESTER VII

AE19701	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide basic understanding of fundamental concepts involved in CFD
- To comprehend numerical techniques involved in CFD

UNIT I FUNDAMENTAL CONCEPTS 9

Introduction - Governing equations of fluid dynamics. Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations - Well posed problems.

UNIT II GRID GENERATION 9

Structured grids. Types and transformations. Generation of structured grids. Unstructured grids – Mesh refinement – Adaptive mesh

UNIT III GRID DISCRETIZATION 9

FINITE DIFFERENCE SCHEME: Derivation of finite difference equations – Simple Methods –Explicit and Implicit time dependent methods. Stability properties of explicit and implicit methods
FINITE VOLUME TECHNIQUES: Finite Volume Techniques -Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Accuracy

UNIT IV FLOW FIELD ANALYSIS AND TURBULENCE 9

Staggered grid, SIMPLE algorithm and its variants - Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models

UNIT V CFD METHODS IN AEROSPACE ENGINEERING 9

Numerical solution for C-D nozzle isentropic flows, local similar solutions of boundary layer equations, Time dependent solutions of gas dynamic problems, Numerical solution of 1D conduction-convection energy equation using time dependent methods – using both implicit and explicit schemes.

TOTAL: 45 PERIODS

OUTCOMES

- able to describe the concepts involved in CFD simulation
- able to develop CFD model for simple flow systems, simulate and better understand underlying physics
- Should be able to use the various discretization methods, solution procedures and turbulence modeling to solve momentum transfer and heat transfer problems.

TEXT BOOKS

1. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd. Second Edition – 2007
2. John D. Anderson, JR" Computational Fluid Dynamics", McGraw-Hill Book Co., Inc., New

REFERENCES

1. C.Y.Chow, "Introduction to Computational Fluid Dynamics", John Wiley, 1979.
2. A.A. Hirsch, 'Introduction to Computational Fluid Dynamics", McGraw-Hill, 1989.
3. T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002
4. C.A.J. Fletcher, "Computational Techniques for Fluid Dynamics 1" Springer Verlag,1995.

After successful completion of the course students will demonstrate the following outcomes:

Course Outcomes:

On completion of the course students will be able to

AE19701.1 Derive the governing equations and understand the behavior of the equations.

AE19701.2 Derive the governing equations and understand the behavior of the equations.

AE19701.3 Analyze variations of SIMPLE schemes for incompressible flows and variations of Flux Splitting algorithms for compressible flows.

AE19701.4 Analyze variations of SIMPLE schemes for incompressible flows and variations of Flux Splitting algorithms for compressible flows.

AE19701.5 Understand the stepwise procedure to completely solve a fluid dynamics problem using computational methods.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19701.1	2	-	-	2	1	-	-	-	-	-	-	1	2	2	1
AE19701.2	3	2	3	-	3	-	-	-	-	-	-	1	2	2	1
AE19701.3	3	2	2	-	3	-	-	-	-	-	-	1	2	2	1
AE19701.4	-	-	3	3	-	-	2	-	-	-	-	-	-	-	-
AE19701.5	-	-	3	3	-	-	2	-	-	-	-	-	-	-	-
Average	2.6	2	2.5	2.6	2.3	-	2	-	-	-	-	1	2	2	1

AE19741 **AVIONICS**

L	T	P	C
3	0	2	4

OBJECTIVES

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

UNIT I : INTRODUCTION TO AVIONICS **9**

Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies – Introduction to Microprocessor and memories.

UNIT II : DIGITAL AVIONICS ARCHITECTURE **8**

Avionics system architecture – data buses – MIL-STD-1553B – ARINC – 420 – ARINC – 629

UNIT III : FLIGHT DECKS AND COCKPITS **9**

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

UNIT IV: INTRODUCTION TO NAVIGATION SYSTEMS **10**

Radio navigation – VOR/DME, Hyperbolic navigation-LORAN and OMEGA, Landing system-ILS, MLS, Inertial Navigation Systems (INS)- INS block diagram – Satellite navigation systems – GPS.

UNIT V : SOFTWARE ASSESSMENT AND AUTO PILOT **9**

Fault tolerant systems -Software Assessment and Validation -Civil and Military standards - Certification of Civil Avionics. Auto pilot – Basic principles, Longitudinal and lateral auto pilot.

TOTAL: 45 PERIODS

OUTCOMES

- Students will be able to understand the concept of designing avionics systems
- Be able to understand the principle of digital avionics systems
- Able to know the practical and working of flight deck equipment
- Students understand the principle and working of navigation system
- Be able to understand the air data systems and auto pilot

TEXTBOOKS

1. Collinson.R.P.G. "Introduction to Avionics", Chapman and Hall, 1996.
2. Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J., U.S.A. 1993.

REFERENCES

1. Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004
2. Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000
3. Pallet.E.H.J., "Aircraft Instruments and Integrated Systems", Longman Scientific

AVIONICS LABORATORY

LIST OF EXPERIMENTS

1. Addition/Subtraction of 8 bit and 16-bit data for control surface deflection.
2. Sorting of Data in Ascending & Descending order for voting mechanism.
3. Sum of a given series with and without carry for identifying flap data.
4. Greatest in a given series & Multi-byte addition in BCD mode.
5. Addition/Subtraction of binary numbers using adder and Subtractor circuits.
6. Multiplexer & Demultiplexer Circuits
7. Encoder and Decoder circuits.
8. MIL-Std – 1553 Data Buses Configuration with Message transfer.
9. Stability analysis using Root locus, Bode plot techniques.
10. Design of lead, lag and lead –lag compensator for aircraft dynamics.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No	Details of Equipment	Quantity	Experiment Nos.
1.	Microprocessor 8085 Kit	10	1,2,3,4
2.	Adder/Subtractor Binary bits Kit	10	5
3.	Encoder Kit	10	7
4.	Decoder Kit	10	7
5.	Multiplexer Kit	10	6
6.	Demultiplexer Kit	10	6
7.	Computers	10	8,9,10,11
8.	MATLAB software	-	10,11
9.	MILSTD 1553	2	8

After successful completion of the course students will demonstrate the following outcomes:

Course Outcomes:

On completion of the course students will be able to

AE19741.1 Students will be able to understand the concept of designing avionics systems

AE19741.2 Be able to understand the principle of digital avionics systems

AE19741.3 Able to know the practical and working of flight deck equipment

AE19741.4 Students understand the principle and working of navigation system

AE19741.5 Be able to understand the air data systems and auto pilot

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19741.1	3		-		3	2	2		3	3			2	3	1
AE19741.2	1		1		2	-	-		3	2			2	2	-
AE19741.3	2		-		2	-	-		-	-			2	-	-
AE19741.4	2		-		-	2	-		3	3			-	3	1
AE19741.5	2	2	-		1	2	2		-	2			1	2	-
Average	2	0.4	0.2	0	1.6	1.2	0.8	0	1.8	2	0	0	1.4	2	0.4

AE19711	PROJECT WORK (PHASE I)	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review.
- To train the students in preparing project reports and to face reviews and viva voce examination.

The students in a group of 2 to 3 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive phase 1 report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A phase 1 project report is required to be submitted at the end of the semester. Evaluation is based on oral presentation and the phase 1 project report jointly by internal examiners constituted by the Head of the Department.

TOTAL:30 PERIODS

OUTCOMES:

Course Outcomes:
On completion of the project students will be able to

AE19711.1 Demonstrate a sound technical knowledge of their selected project topic.
AE19711.2 Undertake problem identification, formulation, and solution.
AE19711.3 Design engineering solutions to complex problems utilizing a systematic approach.
AE19711.4 Conduct an engineering project.
AE19711.5 Communicate with engineers and the community at large in written an oral form.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19711.1	2	3	3	2	1	-	2	-	3	-	1	-	3	3	2
AE19711.2	2	3	3	2	1	-	2	-	3	-	1	-	3	3	2
AE19711.3	2	3	3	2	3	1	2	-	3	-	1	-	3	3	-
AE19711.4	1	-	-	-	-	2	2	2	3	3	2	2	2	3	-
AE19711.5	1	1	-	-	-	2	2	2	3	3	2	2	2	3	3
Average	1.6	2.5	3	1.5	1.66	1.66	2	1.33	3	3	1.4	2	2.6	3	2.33

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AE19712	STRUCTURAL AND FLOW ANALYSIS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES

- To make students understand the concept of computer aided simulations
- To make the students familiarize with structural analysis software tool.
- To enable students, perform basic flow simulations using available commercial software

LIST OF EXPERIMENTS

Structural Simulation Exercises

1. Structural analysis of a truss.
2. Structural analysis of beam with distributed load.
3. Structural analysis of a tapered wing
4. Structural analysis of a fuselage structure
5. Structural analysis of a composite laminate structure
6. Structural analysis of a landing gear
7. Thermo structural analysis of a composite laminate structure
8. Vibration analysis of spring-mass systems
9. Modal analysis of Beams.
10. Harmonic, transient and spectrum analysis of simple systems

Flow Simulation Exercises

11. Simulation of laminar boundary layer over a flat plate
12. Simulation of laminar flow through pipe
13. Simulation of turbulent flows through pipe.
14. Simulation of subsonic flow over a streamlined body
15. Simulation of subsonic flow over a bluff body
16. Simulation of unsteady flow past a cylinder
17. Simulation of supersonic flow over a slender body
18. Analysis of supersonic flow over a blunt body

TOTAL: 45 PERIODS

OUTCOMES

- Will be able to design and model structural and fluid System components
- will be able to perform structural analysis using simulation software packages
- Will be familiarised to concepts of FEM and CFDin analytical software
- will be able to understand different analytical reports from simulation
- Ability to get job opportunities on structural analysis-based industries

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl.No	Equipment	Qty
1	Internal server (or) Work station	1
2	Computers	30
3	Modelling packages(i) CATIA OR Pro E (ii) ANSYS or NASTRAN	30 licenses
4	UPS	1
5	Printer	1

After successful completion of the course students will demonstrate the following outcomes:

Course Outcomes:

On completion of the course students will be able to

AE19712.1 Understand the concept of computer aided flow simulations using CFD software
AE19712.2 Generate computational meshes appropriate to the given fluid flow problem statement
AE19712.3 Simulate the internal and external 2D flows and analyze the results
AE19712.4 Simulate flow over streamlined bodies and bluff bodies and analyze the results
AE19712.5 Simulate laminar and turbulent flows and analyze the results

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19712.1	3	3	1	1	3	1	1	-	1	1	-	1	3	3	3
AE19712.2	3	3	1	1	3	1	1	-	2	1	-	1	3	3	3
AE19712.3	3	3	2	2	3	1	1	-	2	1	-	1	3	3	3
AE19712.4	3	3	2	2	3	1	1	-	2	1	-	1	3	3	3
AE19712.5	3	3	2	2	3	1	1	-	2	1	-	1	3	3	3
Average	3	3	1.6	1.6	3	1	1	-	1.8	1	-	1	3	3	3

AE19713	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR AERONAUTICAL ENGINEERING	L	T	P	C
		0	0	4	2

OBJECTIVES

To enable students to use the concepts of Artificial Intelligence and Machine Learning in the field of Aeronautical Engineering. Students have to choose any one of the following topics and carry out a mini-project and submit a report.

LIST OF TOPICS

1. Application of AI and ML in jet engine health monitoring system
2. Application of AI and ML in aircraft structural health monitoring
3. AI powered system assist in the reduction of fuel consumption
4. AI in boosting operational performance of aircrafts
5. AI to enhance aerodynamic shape optimisation in UAVs
6. Smart Maintenance using AI and ML
7. Foreign Object Detection (FOD) analysis using AI
8. Machine learning of UAV-enabled networks
9. UAV trajectory optimization using machine learning
10. Target analysis and corrections using AI
11. Passenger and Threat Identification using AI and ML

OUTCOMES

After completion of the course, students will be able to

- Apply the concepts of AI and ML in the field of Propulsion
- Apply the concepts of AI and ML in the field of Aircraft Structures
- Apply the concepts of AI and ML in the field of Aerodynamics and Flight Dynamics
- Apply the concepts of AI and ML in the field of Aircraft Maintenance
- Apply the concepts of AI and ML in the field of UAVs

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19711.1	2	3	3	2	1	-	2	-	3	-	1	-	3	3	2
AE19711.2	2	3	3	2	1	-	2	-	3	-	1	-	3	3	2
AE19711.3	2	3	3	2	3	1	2	-	3	-	1	-	3	3	-
AE19711.4	1	-	-	-	-	2	2	2	3	3	2	2	2	3	-
AE19711.5	1	1	-	-	-	2	2	2	3	3	2	2	2	3	3
Average	1.6	2.5	3	1.5	1.66	1.66	2	1.33	3	3	1.4	2	2.6	3	2.33

SEMESTER VIII

AE19811	PROJECT WORK (PHASE II)	L	T	P	C
		0	0	16	8

OBJECTIVES:

- To utilize the knowledge gained from literature survey and continue to solve the chosen problem (in phase 1) till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

The students in a group of 2 to 3 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL:30 PERIODS

OUTCOMES:

Course Outcomes:
On completion of the project students will be able to

AE19811.1 Demonstrate a sound technical knowledge of their selected project topic.
AE19811.2 Undertake problem identification, formulation, and solution.
AE19811.3 Design engineering solutions to complex problems utilizing a systematic approach.
AE19811.4 Conduct an engineering project.
AE19811.5 Communicate with engineers and the community at large in written an oral form.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
AE19811.1	2	3	3	2	1	-	2	-	3	-	1	-	3	3	2
AE19811.2	2	3	3	2	1	-	2	-	3	-	1	-	3	3	2
AE19811.3	2	3	3	2	3	1	2	-	3	-	1	-	3	3	-
AE19811.4	1	-	-	-	-	2	2	2	3	3	2	2	2	3	-
AE19811.5	1	1	-	-	-	2	2	2	3	3	2	2	2	3	3
Average	1.6	2.5	3	1.5	1.66	1.66	2	1.33	3	3	1.4	2	2.6	3	2.33

PROFESSIONAL ELECTIVES

AE19A11	EXPERIMENTAL AERODYNAMICS	Category	L	T	P	C
		PE	3	0	0	3

Objectives:

- To describe flow visualization techniques and to highlight in depth discussion of analog methods.
- To describe about calibration and instrumentation of various wind tunnels and force measurements.
- To provide details, operating principles and limitations of pressure, velocity, temperature, mass and volume flow measurements.
- To understand the concepts in data acquisition systems, error estimation and uncertainty analysis.

UNIT-I MEASUREMENTS IN FLUIDS 9

Fundamentals measurements in fluid mechanics:

Objectives of experimental studies – Fluid mechanics measurements -Measurement systems – Quantities associated with fluid flow measurements- Experiments on Taylor-Proudman theorem and Ekman layer – Measurements in boundary layers

Flow visualization and analogue methods:

Principles of Flow Visualization – Visualization techniques-Smoke tunnel-design and application – Compressible flows –Interferometer – Fringe-Displacement method – Schlieren system – Shadowgraph- Analogue methods-Heleshaw apparatus-Hydraulic analogy – Hydraulic jumps – Electrolytic tank.

UNIT-II INSTRUMENTATION AND CALIBRATION OF WIND TUNNELS 9

Power losses-subsonic and supersonic wind tunnels – Compressor tunnel matching-mass flow-Running time of blow down tunnels- Instrumentation and calibration of low speed wind tunnels - Wind tunnel balance – principles, types and classifications - balance calibration-boundary correction- Calibration of supersonic and hypersonic tunnels -Ludwieg tube-operating principle -Hypersonic simulation requirements.

UNIT-III PRESSURE AND VELOCITYMEASUREMENTS 9

Pressure measurement techniques:

Introduction-Barometers – Manometers – Dial type pressure gauge – Pressure transducers –Pitot, static and Pitot-Static tube - factors and characteristics –Pitot, static and Pitot-Static probes –Yaw effect-static pressure measurement in compressible Flows-Determination of flow direction –Low pressure measurements – Preston and Stanton Tubes - Sound measurements – Dynamic pressure gauges.

Velocity measurement:

Velocity and Mach number from pressure measurements– Laser Doppler Velocimetry (LDV) – Particle Image Velocimetry (PIV) – Hot-wire anemometry –Constant current and Constant temperature Hot-Wire anemometer – Hot-wire probes – Hot-wire bridge for classroom demonstration – effect of compressibility and limitations.

UNIT-IV TEMPERATURE, MASS AND VOLUME FLOW MEASUREMENTS 9

Temperature measurements Techniques:
Temperature scales – Temperature measurements – by thermal expansion and electrical effects – Practical Thermocouple measurements – The Resistance temperature detector – Pyrometer – Temperature measuring problems in fluid flow – Dynamic response of temperature sensors.
Mass and volume flow measurements:
Direct – indirect methods – Volume flow meter – Direct mass flow meter.

UNIT-V DATA ACQUISITION SYSTEMS AND UNCERTAINTY ANALYSIS 9

Data acquisition and processing – Signal conditioning - Estimation of measurement errors – External estimate of the error – Internal estimate of the error – Uncertainty analysis - Uncertainty calculation - Uses of uncertainty analysis.

Total Contact Hours: 45

Course Outcomes:

- Knowledge on measurement techniques in aerodynamic flow.
- Acquiring basics of wind tunnel measurement systems
- Specific instruments for flow parameter measurement like pressure, velocity, temperature etc

Textbook(s):

- Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids," CRC Press –Taylor & Francis, 2007.
- Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press, Taylor & Francis, 2006.

Reference Books(s) / Web links:

- Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press, Taylor & Francis, 2006.
- NAL-UNI Lecture Series 12: Experimental Aerodynamics, NAL SP 98 01 April 1998

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19A11.1	3	2	2	-	-	-	-	-	-	-	-	1	2	2	-
AE19A11.2	3	2	2	-	-	-	-	-	-	-	-	1	2	2	1
AE19A11.3	3	2	2	-	-	-	-	-	-	-	-	1	2	2	1
AE19A11.4	3	2	2	-	-	-	-	-	-	-	-	1	2	2	1
AE19A11.5	3	2	2	-	-	-	-	-	-	-	-	1	2	2	-
Average	3	2	2	-	-	-	-	-	-	-	-	1	2	2	1

Subject Code	Subject Name	Category	L	T	P	C
AE19A12	APPLIED AERODYNAMICS	PE	3	0	0	3

OBJECTIVES

- To familiarize the learner with non-aeronautical uses of aerodynamics such as road vehicle, building aerodynamics and problems of flow induced vibrations.

UNIT I ATMOSPHERE 9

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows

UNIT II WIND ENERGY COLLECTORS 9

Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory

UNIT III VEHICLE AERODYNAMICS 9

Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of racing car, trains and Hovercraft

UNIT IV BUILDING AERODYNAMICS 9

Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, Building codes, Building ventilation and architectural aerodynamics

UNIT V FLOW INDUCED VIBRATIONS **9**

Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.

TOTAL: 45 PERIODS

OUTCOMES

- Use of aerodynamics for non- aerodynamics such as vehicle, building.
- Solve the problems and able to analyse vibrations during flow

TEXT BOOKS

1. M.Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and Road vehicles", Plenum press, New York, 1978.
2. Sachs. P., "Winds forces in Engineering", Pergamum Press, 1978.

REFERENCES

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

After successful completion of the course students will demonstrate the following outcomes:

AE19A12.1 Understand the atmospheric winds and boundary layer
AE19A12.2 Understand working and solve problems related to wind energy collectors
AE19A12.3 Understand various aerodynamic aspects of ground vehicles
AE19A12.4 Understand various aerodynamic aspects of building structures
AE19A12.5 Understand the types of flow induced vibrations and effect of Reynolds number on them.

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19A12.1	3	2	2	-	-	3	3	-	-	-	-	1	2	2	-
AE19A12.2	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1
AE19A12.3	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1
AE19A12.4	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1
AE19A12.5	3	2	2	-	-	3	3	-	-	-	-	1	2	2	-
Average	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1

AE19A13	HYPERSONIC AERODYNAMICS	L	T	P	C
		3	0	0	3

UNIT I FUNDAMENTALS OF HYPERSONIC AERODYNAMICS 9

Introduction to hypersonic aerodynamics-differences between hypersonic aerodynamics and supersonic aerodynamics-concept of thin shock layers-hypersonic flight paths, hypersonic similarity parameters-shock wave and expansion wave relations of in viscid hypersonic flows.

UNIT II SIMPLE SOLUTION METHODS FOR HYPERSONIC IN VISCID FLOWS 9

Local surface inclination Methods-Newtonian theory-modified Newtonian law-tangent wedge and tangent cone and shock expansion methods-approximate theory-thin shock layer theory.

UNIT III VISCOUS HYPERSONIC FLOW THEORY 9

Boundary layer equation for hypersonic flow-hypersonic boundary layers-self similar and non-self-similar boundary layers-solution methods for non-self-similar boundary layers, aerodynamic heating.

UNIT IV VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9

Introduction to the concept of viscous interaction in hypersonic flows-strong and weak viscous interactions-hypersonic viscous interaction similarity parameter-introduction to shock wave boundary layer interactions.

UNIT V INTRODUCTION TO HIGH TEMPERATURE EFFECTS 9

Nature of high temperature flows-chemical effects in air-real and perfect gases-Gibb's free energy and entropy-chemically reacting mixtures-recombination and dissociation.

TOTAL: 45 PERIODS

TEXT BOOKS

1. John. D. Anderson. Jr., "Hypersonic and High Temperature Gas Dyanmics", McGraw hill Series, New York, 1996.

REFERENCES

1. John. D. Anderson. Jr., "Modern compressible flow with historical perspective", McGraw Hill Publishing Company, New York, 1996.
2. John. T Bertin, "Hypersonic Aerothermodynamics", published by AIAA Inc., Washington. D.C., 1994.

After successful completion of the course students will demonstrate the following outcomes:

1.

AE19A13.1 Understand the fundamental concepts of hypersonic flows
AE19A13.2 Solve inviscid hypersonic flow properties using various methods
AE19A13.3 Solve viscous hypersonic flow properties using various methods
AE19A13.4 Understand the shock-boundary layer interactions in hypersonic flows
AE19A13.5 Understand the high-temperature effects in hypersonic flows

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19A13.1	2	1	1	-	-	-	1	-	-	-	-	1	3	1	-
AE19A13.2	3	3	1	-	-	-	1	-	-	-	-	1	3	3	-
AE19A13.3	3	3	1	-	-	-	1	-	-	-	-	1	3	3	-
AE19A13.4	3	2	1	-	-	-	1	-	-	-	-	1	3	2	-
AE19A13.5	3	2	1	-	-	-	1	-	-	-	-	1	3	2	-
Average	2.8	2.2	1	-	-	-	1	-	-	-	-	1	3	2.2	-

AE19A14	Subject Name (Theory course)	Category	L	T	P	C
	LAUNCH VEHICLE AERODYNAMICS	PE	3	0	0	3

Objectives:

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

UNIT-I BASICS OF HIGH-SPEED AERODYNAMICS 9

Compressible flows-Isentropic relations-mathematical relations of flow properties across shock and expansion waves-fundamentals of Hypersonic Aerodynamics.

UNIT-II BOUNDARY LAYER EFFECTS 9

Basics of boundary layer theory-compressible boundary layer-shock shear layer interaction- Aerodynamic heating-heat transfer effects on launch vehicle.

UNIT-III LAUNCH VEHICLE CONFIGURATIONS AND DRAG ESTIMATION 9

Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles- determination of aero elastic effects.

UNIT-IV AERODYNAMICS OF SLENDER AND BLUNT BODIES 9

Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles- determination of aero elastic effects.

UNIT-V AERODYNAMIC ASPECTS OF LAUNCHING PHASE 9

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

Total Contact Hours: 45

Course Outcomes:

- Learn the concept of high-speed aerodynamics and configurations of launch vehicles.
- Understand the effects of boundary layer while launching.
- Estimate drag forces experienced by the launch vehicles
- Know the forces on the vehicle during atmospheric flight.
- Understand the flow characteristics of launch vehicles.

Textbook(s):

1. Anderson J. D., “Fundamentals of Aerodynamics”, 5th Ed., McGraw-Hill, 2010. 2. Chin SS, “Missile Configuration Design”, Mc Graw Hill, New York, 1961.

2. Chin SS, “Missile Configuration Design”, Mc Graw Hill, New York, 1961.

Reference Books(s) / Web links:

1. Anderson J. D., “Hypersonic and High Temperature Gas Dynamics”, AIAA Education Series, 2 nd Ed., 2006.
2. Nielson, Jack N, Stever, Gutford, “Missile Aerodynamics”, AIAA, 1988.

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19A14.1	3	2	2	-	-	3	3	-	-	-	-	1	2	2	-
AE19A14.2	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1
AE19A14.3	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1
AE19A14.4	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1
AE19A14.5	3	2	2	-	-	3	3	-	-	-	-	1	2	2	-
Average	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1

AE19A15	Subject Name (Theory course)	Category	L	T	P	C
	MISSILE AERODYNAMICS	PE	3	0	0	3

Objectives:

To introduce different classes of missiles and rockets to students.
To impart adequate knowledge on various airframe components of missiles and their functions to students.
To give exposure to analyse the various forms of drag and its estimations to students.
To make the students familiarize with the concepts of staging and stage separation methods.
To make students learn the stability and control aspects of missiles.

UNIT-I BASICS ASPECTS OF MISSILE AERODYNAMICS 9

Classification of missiles-Aerodynamics characteristics and requirements of air to air missiles, air to surface missiles and surface to air missiles-Missile trajectories-fundamental aspects of hypersonic aerodynamics.

UNIT-II MISSILE CONFIGURATIONS AND DRAG ESTIMATION 9

Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehiclesdetermination of aero elastic effects.

UNIT-III AERODYNAMICS OF SLENDER BODIES 9

Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehiclesdetermination of aero elastic effects.

UNIT-IV LAUNCH AERODYNAMICS 9

Forces and moments acting on missiles-Lateral, rolling and longitudinal moments-missile dispersion-stability aspects of missile configuration-Aerodynamic control methods-Jet control methods-Stability derivatives.

UNIT-V STABILITY AND CONTROL OF MISSILES 9

Forces and moments acting on missiles-Lateral, rolling and longitudinal moments-missile dispersion-stability aspects of missile configuration-Aerodynamic control methods-Jet control methods-Stability derivatives.

Course Outcomes:

- Acquire enough knowledge on various configurations of missiles and rockets.
- Predict the aerodynamics characteristics of various airframes components.
- Acquire knowledge on unsteady flow characterizes of launch vehicles.
- Compare the aerodynamics performance of missiles determined form wind tunnel tests and CFD results.
- Determine the stability characteristics of missiles and necessary forces required to control.

Textbook (s):

1. Chin SS, Missile Configuration Design, McGraw Hill, New York, 1961.
2. Nielsen, Jack N, Stever, Gutford, "Missile Aerodynamics", McGraw Hill, New York, 1988.

Reference Books(s) / Web links:

1. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw-Hill Book Co., New York, 2011.
2. John D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", AIAA; 2ndedition, 2006.
3. John D. Anderson. Jr., "Modern Compressible flow with historical Perspective", McGraw Hill Publishing Company, 3rd edition, 2002.

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19A15.1	3	2	2	-	-	3	3	-	-	-	-	1	2	2	-
AE19A15.2	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1
AE19A15.3	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1
AE19A15.4	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1
AE19A15.5	3	2	2	-	-	3	3	-	-	-	-	1	2	2	-
Average	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1

AE19A16 **HELICOPTER THEOY**

L	T	P	C
3	0	0	3

OBJECTIVES

- To make student familiarize with the evolution of Helicopters as a flying machine.
- To familiarize students with the aerodynamic theories of rotor.
- To teach students design calculation procedures involved in selection of engine and control systems.
- To familiarize students with the static and dynamic stability concepts of rotorcraft.
- To familiarize students with the problems associated with vibrations of the main rotor system.

UNIT I INTRODUCTION 9

A history of helicopter flight; Fundamentals of Rotor Aerodynamics; Momentum theory analysis in hovering flight. Disk loading, power loading, thrust & power coefficients. Figure of merit, rotor solidity and blade loading coefficient. Power required in flight. Axial climb, descent, and autorotation. Blade Element Analysis: Blade element analysis in hovering and forward flight. Rotating blade motion. Types of rotors. Concept of blade flapping, lagging and coning angle. Equilibrium about the flapping hinge, and lead/lag hinge.

UNIT II BASIC HELICOPTER PERFORMANCE 9

Hovering and axial climb performance. Forward flight performance; Induced power, blade profile power, parasite power, tail rotor power, climb power total power. Effects of gross weight, density and altitude. Speed for minimum power, maximum range. Factors affecting forward speed, and ground effect.

UNIT III ROTOR AIRFOIL AERODYNAMICS 9

Rotor airfoil requirements, effects of Reynolds number and Mach number. Airfoil shape definition, Airfoil pressure distribution. Pitching moment. Maximum lift and stall characteristics, high angle of attack range. Rotor Wakes and Blade Tip Vortices: Flow visualization, Characteristics of rotor wake in hover, and forward flight. Other characteristics of rotor wake. Structure of the tip vortices. Flow topology of dynamic stall.

UNIT IV HELICOPTER FLIGHT DYNAMICS 9

Forward speed disturbance, vertical speed disturbance, pitching angular velocity disturbance, side-slip disturbance, yawing disturbance. Static stability of helicopters: longitudinal, lateral-directional. Dynamic stability aspects. Main rotor and tail rotor control.

UNIT V STANDARDS, SPECIFICATIONS AND TESTING ASPECTS 9

Scope of requirements. General and operational requirements. Military derivatives of civil rotorcraft. Structural strength and design for operation on specified surfaces. Rotorcraft vibration classification. Flight and Ground Handling Qualities-General requirements and definitions. Control characteristics, beak forces. Levels of handling qualities. Flight Testing- General handing flight test requirements and, basis of limitations. Conceptual Design of Helicopters: Overall design requirements. Design of main rotors, Fuselage design, Empennage design, Design of tail rotors, High speed rotorcraft.

TEXT BOOKS

1. Principles of Helicopter Aerodynamics - J. Gordon Leishman, Cambridge University Press, 2000.
2. Helicopter Performance Stability and Control by Prouty Raymond 2002
3. Antonio Filippone -Flight Performance of Fixed and Rotary Wing Aircraft, Elsevier Aerospace Engineering Services. (2006)

REFERENCES

1. Edward Seckel, Stability and Control of Airplanes and Helicopters, Elsevier, 1964
2. Helicopter Dynamics- ARS Bramwell, George Done, and David Balmford, 2nd Edition, Butterworth-Heinemann Publication, 2001.
3. Engineering Design Handbooks - Helicopter Engineering (Parts I, II & III), AMCP 706-203, 1974
4. Alastair K. Cooke, Eric W. H. Fitzpatrick, Helicopter Test and evaluation, , Blackwell Science, 2002.

After successful completion of the course students will demonstrate the following outcomes:

AE19A16.1 Acknowledge the evolution of rotary wing flying machines.

AE19A16.2 Understand and apply the ADT and BET in the aerodynamic design of helicopter rotors.

AE19A16.3 Understand and apply the performance relations in the design/selection of engine for helicopters

AE19A16.4 Understand the stability characteristics of simple helicopter configurations.

AE19A16.5 Identify the areas of vehicle design to be taken care to avoid problems associated with rotor vibrations

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19A16.1	2	-	-	1	-	-	1	-	1	-	-	1	2	-	-
AE19A16.2	3	2	1	1	-	-	1	-	1	-	-	1	3	3	1
AE19A16.3	3	2	1	1	-	-	1	-	1	-	-	1	3	3	1
AE19A16.4	3	2	1	1	-	-	1	-	1	-	-	1	3	3	1
AE19A16.5	3	2	1	1	-	-	1	-	1	-	-	1	3	2	-
Average	2.8	2	1	1	-	-	1	-	1	-	-	1	2.8	2.75	1

AE19A17 BOUNDARY LAYER THEORY

L	T	P	C
3	0	0	3

UNIT I VISCOUS FLOW EQUATIONS 9

Navier-Stokes Equations, Creeping motion, Couette flow, Poiseuille flow through ducts, Ekman drift, shear layer growth in jet flows.

UNIT II LAMINAR BOUNDARY LAYER 9

Development of boundary layer – Estimation of boundary layer thickness, Displacement thickness- Momentum and energy thicknesses for two-dimensional flow – Two-dimensional boundary layer equations – Similarity solutions - Blasius solution. Effect of pressure gradient on boundary layer.

UNIT III TURBULENT BOUNDARY LAYER 9

Physical and mathematical description of turbulence, two-dimensional turbulent boundary layer equations, Velocity profiles – Inner, outer and overlap layers, Transition from laminar to turbulent boundary layers, turbulent boundary layer on a flat plate, mixing length hypothesis.

UNIT IV APPROXIMATE SOLUTION TO BOUNDARY LAYER EQUATIONS 9

Approximate integral methods, digital computer solutions – Von Karman – Polhausen method.

UNIT V THERMAL BOUNDARY LAYER 9

Introduction to thermal boundary layer – Heat transfer in boundary layer - Convective heat transfer, importance of non-dimensional numbers – Prandtl number, Nusselt number, Lewis number etc.

TOTAL: 45 PERIODS

TEXTBOOKS

1. Frank White – Viscous Fluid flow – McGraw Hill, 1998

REFERENCES

1. H. Schlichting, "Boundary Layer Theory", McGraw-Hill, New York, 1979.
2. A. J. Reynolds, "Turbulent flows in Engineering", John Wiley & Sons, 1980.
3. Ronald L., Panton, "Incompressible fluid flow", John Wiley & Sons, 1984.
4. Tuncer Cebeci and Peter Bradshaw, "Momentum transfer in boundary layers", Hemisphere Publishing Corporation, 1977.

After successful completion of the course students will demonstrate the following outcomes:

AE19A17.1 Apply Navier-Stokes equations to various types of viscous flows
AE19A17.2 Estimate properties of laminar flow over a flat plate
AE19A17.3 Estimate properties of turbulent flow over a flat plate
AE19A17.4 Understand various solution methods for boundary layer equations
AE19A17.5 Understand the concept of thermal boundary layer and relevant non-dimensional numbers

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19A17.1	3	1	1	-	-	1	1	-	-	-	-	1	2	1	1
AE19A17.2	3	3	2	-	-	2	2	-	-	-	-	1	3	2	1
AE19A17.3	3	3	2	-	-	2	2	-	-	-	-	1	3	2	1
AE19A17.4	3	3	2	-	-	1	1	-	-	-	-	1	2	1	1
AE19A17.5	3	3	2	-	-	2	2	-	-	-	-	1	2	2	1
Average	3	2.6	2	-	-	1.6	1.6	-	-	-	-	1	2.4	1.6	1

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19A18	**TURBULENCE MODELING IN FLUID FLOWS**	PE	3	0	0	3

Objectives:

To familiarize the student with the concept of turbulence
To prepare the student to choose and mathematically model turbulent flows

UNIT-I Introduction to turbulence 9

Definition of turbulence in fluid flows. Physical turbulence, brief history of turbulence modeling. The closure problem: Reynolds averaging, correlations, RANS, Reynolds-Stress equation

UNIT-II Algebraic Models 9

Molecular Transport of Momentum. The Mixing-Length Hypothesis. Application to Free Shear Flows - The Far Wake, The Mixing Layer, The Jet. Modern Variants of the Mixing-Length Model - Cebeci-Srnith Model, Baldwin-Lomax Model, Application to Wall-Bounded Flows - Channel and Pipe Flow, Boundary Layers, Separated Flows. The ½ equation model. Range of applicability.

UNIT-III Turbulence Energy Equation Models 9

One-Equation Models, Two-Equation Models, Other Two-Equation Models, Closure Coefficients, Application to Free Shear Flows, Perturbation Analysis of the Boundary Layer, The Defect Layer, The Viscous Sublayer, Surface Boundary Conditions, Application to Wall-Bounded Flows, Low-Reynolds-Number Effects, Separated Flows, Range of Applicability

UNIT-IV Effects of Compressibility 9

Physical Considerations, Favre Averaging, Favre-Averaged Equations, Compressible-Flow Closure, approximations, Dilatation Dissipation, Compressible Law of the Wall, Compressible Boundary Layers, Shock-Induced Boundary-Layer Separation

UNIT-V Numerical Considerations and High-fidelity schemes 9

Multiple Time Scales and Stiffness, Numerical Accuracy Near Boundaries, Solid Surfaces, Turbulent/Nonturbulent Interfaces, Parabolic Marching Methods, Elementary Time-Marching Methods, Block-Implicit Methods, Solution Convergence and Grid Sensitivity. Introduction to LES and DNS.

Total Contact Hours: 45

Course Outcomes:

- To understand the background of turbulence modeling
- To be able to use algebraic models for turbulence models
- To understand the industry accepted k models in CFD
- To be aware of the effects of compressibility on the turbulence level
- To understand various numerical considerations during turbulent flow simulations

Textbook (s):

1. "Turbulence modeling for CFD" by David C Wilcox, DCW Industries, Canada, 1998

Reference Books(s) / Web links:

1. Turbulence: An Introduction for Scientists and Engineers, by Peter Davidson, OUP Oxford Press

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19A18.1	3	1	1	-	-	1	1	-	-	-	-	1	2	1	1
AE19A18.2	3	3	2	-	-	2	2	-	-	-	-	1	3	2	1
AE19A18.3	3	3	2	-	-	2	2	-	-	-	-	1	3	2	1
AE19A18.4	3	3	2	-	-	1	1	-	-	-	-	1	2	1	1
AE19A18.5	3	3	2	-	-	2	2	-	-	-	-	1	2	2	1
Average	3	2.6	2	-	-	1.6	1.6	-	-	-	-	1	2.4	1.6	1

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19A19	**INTRODUCTION TO AEROACOUSTICS**	PE	3	0	0	3

Objectives:

To familiarize the student with the classical literature on aeroacoustics
To enumerate analytical, computational and experimental methods

UNIT-I REVIEW OF CLASSICAL ACOUSTICS 9

Linearized equations of motion; classical wave equation: plane and spherical waves, wave propagation in homogeneous and inhomogeneous media

UNIT-II MODELS FOR ACOUSTIC SOUND SOURCES 9

point sources, monopoles, dipoles and quadrupoles, Green's function solutions for wave equations, Kirchhoff–Helmholtz theorem for rigid boundaries.

UNIT-III AEROACOUSTIC SOURCES 9

Lighthill's acoustic analogy, integral solutions and far-field approximations; effect of solid surface: Curle's theory and Ffowcs Williams–Hawkings' equation.

UNIT-IV COMPUTATIONAL APPROACHES 9

numerical aspects; direct methods: Reynolds-averaged Navier–Stokes equations (RANS), direct numerical simulations (DNS), application of large eddy simulations (LES); Hybrid methods: Flow-sound separation, numerical evaluation of Lighthill's integral.

UNIT-V JET ACOUSTICS 9

Noise sources from jet flows, mitigation methods. Experimental methods

Total Contact Hours: 45

Course Outcomes:

- To Review of classical acoustics
- To understand Models for acoustic sound sources
- To identify Aeroacoustic sources
- To be familiar with Computational approaches for aeroacoustics
- To be familiar with Jet acoustic experimental methods

Textbook (s):

1. Pierce, A D: Acoustics, Acoustical Society of America, 1989.

Reference Books(s) / Web links:

1. Blackstock, D T: Fundamentals of physical acoustics, Wiley, 2000.
2. Howe, M S: Hydrodynamics and sound, Cambridge, 2007.

3. Howe, M S: Theory of vortex sound, Cambridge, 2003.
4. Tam, C K W: Computational aeroacoustics, Cambridge, 2012.
5. Rienstra, S W and Hirschberg A: An introduction to acoustics, 2011.
6. Crighton, D G: Basic principles of aerodynamic noise generation, Prog. Aerospace Sci., 16 (1), 1975, pp. 31-96.
7. Crighton, D G, Dowling A P, Ffowcs Williams J E, Heckl M and Leppington F G:

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19A19.1	3	1	1	-	-	1	1	-	-	-	-	1	2	1	1
AE19A19.2	3	3	2	-	-	2	2	-	-	-	-	1	3	2	1
AE19A19.3	3	3	2	-	-	2	2	-	-	-	-	1	3	2	1
AE19A19.4	3	3	2	-	-	1	1	-	-	-	-	1	2	1	1
AE19A19.5	3	3	2	-	-	2	2	-	-	-	-	1	2	2	1
Average	3	2.6	2	-	-	1.6	1.6	-	-	-	-	1	2.4	1.6	1

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19B11	**HEAT TRANSFER**		3	0	0	3

Objectives:

- To understand the steady and unsteady heat transfer problems
- To analyse laminar and turbulent heat flow over vertical and parallel plates
- To understand the radiative heat transfer between black body and gray body
- To analyze heat exchanger performance by using the LMTD and E-NTU methods.
- To understand the heat transfer problems involved in various types of aerospace vehicles

UNIT-I HEAT CONDUCTION 9

Basic Modes of Heat Transfer – One dimensional steady state heat conduction: Composite Medium – Critical thickness – Effect of variation of thermal Conductivity – Extended Surfaces – Unsteady state. Heat Conduction: Lumped System Analysis – Heat Transfer in Semi-infinite and infinite solids – Use of Transient – Temperature charts – Application of numerical techniques.

UNIT-II CONVECTIVE HEAT TRANSFER 10

Free Convection: Introduction – Free convection in atmosphere free convection on a vertical flat plate – Empirical relation in free convection.
Forced convection: Introduction – Laminar and turbulent convective heat transfer analysis in flows between parallel plates, over a flat plate and in a circular pipe. Empirical relations, application of numerical techniques in problem solving.

UNIT-III RADIATIVE HEAT TRANSFER 9

Introduction to Physical mechanism – Radiation properties – Radiation shape factors – Heat exchange between non – black bodies – Radiation shields.

UNIT-IV HEAT EXCHANGERS 9

Classification – Temperature Distribution – Overall heat transfer coefficient, Heat Exchange Analysis – LMTD Method and E-NTU Method.

UNIT-V HEAT TRANSFER PROBLEMS IN AEROSPACE ENGINEERING 8

Heat Transfer problems in gas turbine combustion chambers – Rocket thrust chambers – Aerodynamic heating – Ablative heat transfer.

Total Contact Hours: 45

ourse Outcomes:

- Perform calculations of steady and unsteady conductive heat transfer problems and to find the amount of insulation required for minimum heat loss.
- Evaluate heat transfer coefficients for natural and forced convection inside ducts and over external surfaces.
- Calculate radiation shape factors and thus heat transfer between black body surfaces and between gray body surfaces.
- Analyze heat exchanger performance by using the LMTD and E-NTU methods.
- Understand the heat transfer problems/limitations involved in various types of aerospace vehicles.

SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic

- Problem solving sessions
- Flipped classroom - Comparing SOA with Client-Server and Distributed architectures

- Survey on various storage technologies
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS (if Any)

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

Textbook(s):

1. Sachdeva, S.C., "Fundamentals of Engineering Heat & Mass Transfer", Wiley Eastern Ltd., New Delhi, Fifth Ed, 2017.
2. Holman, J.P. "Heat Transfer", McGraw-Hill Book Co., Inc., New York, 10th Ed., 2017.

Reference Books(s) / Web links:

- David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine Frank P. Incropera, "Principals of Heat and Mass Transfer" Wiley; Seventh edition (2013)– 2002.
- Nag P., "Heat and Mass Transfer", Tata-McGraw Hill, 2011.
- Lienhard, J.H., "A Heat Transfer Text Book", Prentice Hall Inc., 1981.
- Yunus A. Cengel., "Heat Transfer – A practical approach", Second Edition, Tata McGraw-Hill, 2002.

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19B11.1	3	1	1	-	-	1	1	-	-	-	-	1	2	1	1
AE19B11.2	3	3	2	-	-	2	2	-	-	-	-	1	3	2	1
AE19B11.3	3	3	2	-	-	2	2	-	-	-	-	1	3	2	1
AE19B11.4	3	3	2	-	-	1	1	-	-	-	-	1	2	1	1
AE19B11.5	3	3	2	-	-	2	2	-	-	-	-	1	2	2	1
Average	3	2.6	2	-	-	1.6	1.6	-	-	-	-	1	2.4	1.6	1

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19B12	**DESIGN OF GAS TURBINE ENGINE COMPONENTS**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To introduce basic design concepts of jet engine and estimation of required thrust to students.
- To make students familiarize with the design parameter and off design calculations
- To give the students adequate exposure to design procedure to the rotating components of engine such as compressor and turbine along with staging.
- To make the students learn the aspects of combustion processes, flame stabilization issue, igniters design and NOx controls.
- To make students familiarize with the concept of design inlet and nozzle for various on - off design conditions.

UNIT-I GAS TURBINE ENGINE DESIGN FUNDAMENTALS 9

Design Process- compressible flow relationship; Constraint Analysis - Concept-Design toolspreliminary estimates; Mission analysis - Aircraft weight and fuel consumption data-Example problems on Constrain analysis, Mission analysis.

UNIT-II ON DESIGN AND OFF-DESING PARAMETRIC ANALYSIS 9

Total and static properties-corrected mass flow rate-Engine Cycle Design- One-Dimensional Through flow Area-Flow path force on components- aircraft constraint analysis, aircraft mission analysis, engine parametric (design point) analysis, engine performance (off-design) analysis, engine installation drag and sizing.

UNIT-III DESIGN OF ROTATING COMPONENTS 9

Fan and Compressor Aerodynamics-Diffusion factor-Aerofoil geometry-Flow path dimensionRadial variation-Turbine Aerodynamics- Constant axial velocity-adiabatic-selected Mach number-Mean line stage Design-stage pressure ratio-Airfoil geometry-radial variation-turbine cooling-range of turbine parameters-Engine life-Design Example –for fan-compressor-turbine.

UNIT-IV COMBUSTION CHAMBER DESIGN 9

Design: Combustion system components- Combustion- Chemical reactor theory. Combustor Stability map-Stirring and mixing-Total pressure loss-Fuels-Ignition-Combustion Systems of Main Burner Design: Air partitioning- Main burner component Design: Diffuser-types of burnerinner and outer casing design-Fuel nozzle-Dome and liner-Primary zone- swirler-Secondary holes-Dilution holes-Transition duct-Design of Afterburners-Design parameters-Diffuser-Fuel injection-Ignition-Flame stabilization – Flame spread and after burner length – Examples design calculation.

UNIT-V INLET AND NOZZLE DESIGN 9

Inlets and Exhaust Nozzles Design: Elements of a Successful Inlet-Engine Integration Program-Definition of Subsonic Inlet-Engine Operational Requirements- Definition of Supersonic Inlet-Engine Operational Requirements- Engine Impact on Inlet Design- Inlet Impact on Engine Design-Validation of Inlet-Engine System-Exhaust nozzle design-Nozzle types and their design -Jet control methods for reduction of infrared signature

Total Contact Hours: 45

Course Outcomes: Upon completion of this course, Students will be able to

- Do preliminary weight and fuel estimation for an aircraft mission.
- Identify variation in parametric analysis of ON and OFF design calculations
- Identify variation in parametric analysis of ON and OFF design calculations
- Estimate the total pressure losses and able to predict ignition delay.
- Determine the basic design factors affects ON and OFF design operation of inlets and nozzle on engine performance.

SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic

- Problem solving sessions
- Flipped classroom - Comparing SOA with Client-Server and Distributed architectures
- Survey on various storage technologies
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS (if Any) (UNIT/ Module Wise) – could suggest topic

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

Text Book(s):

1. Mattingly J.D., Heiser, W.H. and Pratt D.T, 'Aircraft Engine Design', 2nd Edition, AIAA Education Series, AIAA, 2002.
2. Oates G.C.,' Aircraft Propulsion Systems Technology and Design',1989, AIAA Education Series.
3. Saravanamuttoo H.I.H and Rogers, G.F.C. “Gas Turbine Technology”, Pearson Education Canada; 6th edition, 2008.

Reference Books(s) / Web links:

- Cumpsty N., “Jet Propulsion: A Simple Guide to the Aerodynamics and Thermodynamics Design and Performance of Jet Engines” , Cambridge University Press; 2nd edition, 2003
- Murthy S.N. and Curran E.T.,' High-Speed Flight Propulsion Systems', Volume 137, Progress in Astronautics and Aeronautics, AIAA,1991.
- Rathakrishnan E, 'Applied Gas Dynamics, John Wiley & Sons (Asia) Pvt Ltd, 2010.
- Treage I.E, Aircraft Gas Turbine Engine Technology, 3 rd edition, Glencoe McGraw-Hill, Inc. 1995

Subject Code Subject Name (Theory course) Category L T P C

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19B12.1	3	1	1	-	-	-	-	-	-	-	-	1	2	1	1
AE19B12.2	3	3	2	-	-	-	-	-	-	-	-	1	3	2	1
AE19B12.3	3	3	2	-	-	-	-	-	-	-	-	1	3	2	1
AE19B12.4	3	3	2	-	-	-	-	-	-	-	-	1	2	1	1
AE19B12.5	3	3	2	-	-	-	-	-	-	-	-	1	2	2	1
Average	3	2.6	2	-	-	-	-	-	-	-	-	1	2.4	1.6	1

AE19B13 **ADVANCED PROPULSION SYSTEMS** 3 0 0 3

Objectives:

- This course will cover the basic aspects of thermodynamic cycle analysis of air-breathing propulsion systems.
- This course is intended to impart knowledge on advanced air breathing propulsion systems like air augmented rockets.
- 3. This course will give the knowledge on the basic aspects of scramjet propulsion system.
- This course will provide in-depth knowledge about the nozzle performance.
- This course also presents vast knowledge on the operating principles of nuclear, electric

UNIT-I ADVANCED CRYOGENIC & LOX-HC ENGINES 9

Introduction to cryogenics and its applications, Properties of Cryogenic fluids, Engine cycles, system level analysis, testing, thrust chamber, turbo pumps, cryotanks. HC Engines. Engines for booster and upper stages. LOX Kerosene & LOX-Methane engines. Liquid Oxygen and Hydrocarbon, liquid rocket engine (LRE) for application as main engines & booster stages of Launchers. Different LRE cycles.

UNIT-II GREEN PROPELLANTS PROPELLANT-LESS PROPULSION 9

Environmental effects of space propellants (toxicity, pollution, performance aspects). Liquid bio-propellant (H2-O2, N2O4-, etc.) for main engines. Solid propellant (NH4ClO4) for the booster. Momentum exchange tether, electro-dynamic tether, Solar thermal propulsion for upper stages, solar sails, magnetic sails. Beamed energy -Earth to Orbit Propulsion.

UNIT-III MINIATURISED PROPULSION & ELECTRICAL PROPULSION SYSTEMS 9

Classification of mission requirement. Micropropulsion technologies; solid micro thruster, micro bi-propellant thruster, cold gas thruster, Integration aspects in micro-spacecraft. Electrical Propulsion Systems. State-of-the-art in electrical propulsion system, high-power gridded ion thruster (GIT), high – power Hall Effect thruster (HET), high- power applied-field magneto plasma dynamic thruster (MPDT), and double stage HET. Micro Ion thruster, Microchip laser thruster. Colloid thruster. Fundamentals of ion propulsion body design considerations.

UNIT-IV NUCLEAR PROPULSION 9

Nuclear rocket engine design and performance, nuclear rocket reactors, nuclear rocket nozzles, nuclear rocket engine control, radioisotope propulsion, basic thrusters configuration, thrusters technology, heat source development, nozzle development, nozzle performance of radio isotope propulsion systems. Testing of Nuclear rocket engines

UNIT-V OTHER ADVANCE PROPULSION TECHNOLOGIES 9

Super Conductivity-Property of material-super conductivity state, conduction, electrons propagation. Effect of temperature on material conductivity. Type-I and type-II materials. **Chemical propellant system -**advanced propellants, high energy density matter (HEDM), alternative design pulse detonation rocket.
Laser Propulsion System-General Concept. Laser accelerated Plasma Propellant. Test Techniques and safety for Advance Propulsion Technologies.

Total Contact Hours: 45

Course Outcomes:

- Able to Analyse in detail the thermodynamics cycles of air breathing propulsion systems.
- Able to gain idea on the concepts of supersonic combustion for hypersonic vehicles
- Able to demonstrate the fundamental requirements of supersonic combustors.
- Capable of estimating performance parameters of nuclear and electrical rockets
- Able to acquire knowledge on the concepts of engine-body installation on hypersonic vehicles

SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic

- Problem solving sessions
- Flipped classroom - Comparing SOA with Client-Server and Distributed architectures
- Survey on various storage technologies
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS (if Any) (UNIT/ Module Wise) – could suggest topic

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

Textbook(s):

1. Cumpsty, "Jet propulsion", Cambridge University Press, 2003.
2. Fortescue and Stark, "Spacecraft Systems Engineering", Wiley, 4th edition, 2011.
3. Sutton, GP, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 1998.

Reference Books(s) / Web links:

- William H. Heiser and David T. Pratt, "Hypersonic Air breathing propulsion", AIAA, Education Series, 2001.
- Hypersonic Airbreathing Propulsion William H. Heiser and David T. Pratt AIAA Education Series, 2001
- Advanced Space Propellant Systems Martin Tajmar Springer 2003

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19B13.1	3	1	1	-	-	-	-	-	-	-	-	1	2	1	1
AE19B13.2	3	3	2	-	-	-	-	-	-	-	-	1	3	2	1
AE19B13.3	3	3	2	-	-	-	-	-	-	-	-	1	3	2	1
AE19B13.4	3	3	2	-	-	-	-	-	-	-	-	1	2	1	1
AE19B13.5	3	3	2	-	-	-	-	-	-	-	-	1	2	2	1
Average	3	2.6	2	-	-	-	-	-	-	-	-	1	2.4	1.6	1

AE17B14	COMBUSTION AND FLAMES	L	T	P	C
		3	0	0	3

OBJECTIVE

- To familiarize the learner chemical kinetics of different types of combustions.

UNIT I REVIEW OF THERMODYNAMICS RELATIONS 9

Review of Thermodynamics, Chemical kinetics, Mass transfer definitions: Fick's law.

UNIT II CONSERVATION OF MASS AND ENERGY 9

Equations of conservation of species mass, momentum and energy, Schvab-Zel'dovich formulation, Rankine-Hugoniot relations.

UNIT III LAMINAR PREMIXED FLAMES 9

Flame speed, Flammability limits, Flame stabilization, Ignition and quenching. Burke-Schumann problem, Droplet Burning, Partially premixed flames,

UNIT IV PROPELLANT COMBUSTION 9

Solid propellant combustion, Spray combustion, Detonation: ZND model, Combustion instabilities.

UNIT V SUPERSONIC COMBUSTION 9

Introduction to turbulent premixed and diffusion flames, governing equation for chemically reacting viscous flow, Dissociation, Boundary layer equation for chemically reacting gas, Boundary- layer solutions.

TEXT BOOK

1. K. K. Kuo, Principles of Combustion, Second Edition.

REFERENCES

1. W. C. Strahle, Introduction to Combustion.
2. S. Mukunda, Understanding Combustion
3. J. D. Anderson, Hypersonic and High Temperature Gas Dynamics, Second Edition

After successful completion of the course students will demonstrate the following outcomes:

AE17B14.1	Understand the different types of thermodynamics relations applicable to combustion
AE17B14.2	Understand the different types of conservation laws
AE17B14.3	Understand the laminar premixed flames
AE17B14.4	Analyze the laminar diffusion flames
AE17B14.5	Understand the supersonic combustion

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE17B14.1	3	2	1	1	1	1	1	-	-	-	-	-	1	1	1
AE17B14.2	3	2	1	1	1	1	1	-	-	-	-	-	1	1	1
AE17B14.3	3	2	1	1	3	1	1	-	-	-	-	-	1	1	1
AE17B14.4	3	3	2	1	3	1	1	-	-	1	-	1	2	2	3
AE17B14.5	3	3	2	1	2	1	1	-	-	1	-	1	2	2	3
Average	3	2.4	1.4	1	2	1	1	-	-	1	-	1	1.4	1.4	1.8

AE19B15 **SPRAY THEORY** **L T P C**
3 0 0 3

OBJECTIVES

- This course covers the theory necessary to understand spray formation and evolution, as well as a host of spray applications.

UNIT I INTRODUCTION TO SPRAYS AND ATOMIZATION 9

Basic spray processes, Factors controlling spray formation. Number distributions, Mass/volume distributions, Empirical distributions, Theoretical distributions.

UNIT II ATOMIZERS AND THEIR DESIGNS 9

Sheet and ligament breakup: Instability analyses for ligaments and sheets, Design models based on instability analyses.
Drop formation: Static and dynamic force balances, Continuity considerations, Secondary atomization, Collisions and coalescence.

UNIT III ATOMIZATION AND SPRAY THEORY 9

Drop motion and spray-surroundings interactions: Steady trajectories (gas turbines, spray cooling, paint sprays), Entrainment.
Drop evaporation: Steady evaporation, Unsteady evaporation, Convective effects.

UNIT IV INTERNAL AND EXTERNAL SPRAYS 9

Internal fluid mechanics: Swirl atomizers, Impinging jet atomizers. **External spray characteristics:** Cone angle, Radial circumferential mass flux distributions.

UNIT V ATOMIZER PERFORMANCE AND MEASUREMENT TECHNIQUES 9

Atomizer performance: Modern design models for pressure-swirl atomizers, impinging jet atomizers, transient pressure (Diesel) atomizers.
Measurement techniques: Drop sizing by Malvern and P/DPA, Drop velocity by P/DPA, Mass flux distribution via patternators and P/DPA.

TOTAL: 45 PERIODS

TEXTBOOKS

1. Atomization and Sprays, by A.H. Lefebvre (Hemisphere: New York, 1989. ISBN 0-89116-603-3) and
2. Liquid Atomization, by L. Bayvel and Z. Orzechowski (Taylor and Francis: Washington DC, 1993. ISBN 0-89116-959-8).

After successful completion of the course students will demonstrate the following outcomes:

AE19PB15.1 Understand the factors controlling spray formation and spray distribution
AE19PB15.2 Analyze the drop formation
AE19PB15.3 Understand the different types of spray patterns
AE19PB15.4 Distinguish between internal and external spray patterns
AE19PB15.5 Analyze atomizer performance by using different model measuring techniques

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19PB15.1	3	3	2	3	2	2	1	-	-	1	-	-	2	2	2
AE19PB15.2	3	3	2	3	2	2	1	-	-	1	-	-	2	2	3
AE19PB15.3	3	3	2	3	2	2	1	-	-	1	-	-	2	2	3
AE19PB15.4	3	3	2	3	2	2	1	-	-	1	-	-	1	1	1
AE19PB15.5	3	3	3	3	3	3	3	-	-	1	-	2	3	3	3
Average	3	3	2.2	3	2.2	2.2	1.4	-	-	1	-	2	2	2	2.4

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19B16	**TURBO MACHINES**		**3**	**0**	**0**	**3**

Objectives:

- To classify the turbomachines based on energy interactions
- To study the performance characteristics of turbomachines under different operating conditions
- To inculcate knowledge in the thermal design of turbomachines
- To study the features and working of various turbomachines
- To Apply the concepts of energy transformation in turbo machines

UNIT-I INTRODUCTION 9

Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Unit and specific quantities, model studies and its numerical. (Note: Since dimensional analysis is covered in Fluid Mechanics subject, questions on dimensional analysis may not be given. However, dimensional parameters and model studies may be given more weightage.)

UNIT-II ENERGY EXCHANGE IN TURBO MACHINES 9

Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Problems.

UNIT-III STEAM TURBINES 9

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor, Numerical Problems.

Reaction turbine – Parsons's turbine, condition for maximum utilization factor, reaction staging. Numerical Problems

UNIT-IV HYDRAULIC TURBINES 9

Hydraulic Turbines: Classification, various efficiencies.

Pelton Wheel – Principle of working, velocity triangles, design parameters, maximum efficiency, and numerical problems.

Francis turbine – Principle of working, velocity triangles, design parameters, and numerical problems

Kaplan and Propeller turbines - Principle of working, velocity triangles, design parameters and Numerical Problems. Theory and types of Draft tubes.

UNIT-V CENTRIFUGAL PUMPS 9

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems.

Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems.

Total Contact Hours: 45

Course Outcomes: At the end of the course students can able to

- Compare the features and working of various turbomachines
- Apply the concepts of energy transformation in turbo machines
- Analyse the performance of Hydraulic pumps and turbines
- Design and evaluate the critical parameters involved in power generation
- Evaluate the performance of axial and centrifugal compressors

SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic

- Problem solving sessions
- Flipped classroom - Comparing SOA with Client-Server and Distributed architectures
- Survey on various storage technologies
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS (if Any)

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

Textbook(s):

1. Yahya S. M. “Turbines, Fans and Compressors”,4/e,Tata McGraw Hill Publishing Company Limited ,2011
2. Turbo Machines B.U.Pai Wiley India Pvt, Ltd 1st Edition
3. Fundamentals of Turbo Machinery B.K Venkanna PHI Publishers

Reference Books(s) / Web links:

- Turbines, Compressors & Fans S. M. Yahya Tata McGraw Hill Co. Ltd 2nd edition, 2002
- Principals of Turbo machines D. G. Shepherd The Macmillan Company 1964
- Fluid Mechanics & Thermodynamics of Turbo machines S. L. Dixon Elsevier 2005

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19B16.1	3	1	1	-	-	-	-	-	-	-	-	1	2	1	1
AE19B16.2	3	3	2	-	-	-	-	-	-	-	-	1	3	2	1
AE19B16.3	3	3	2	-	-	-	-	-	-	-	-	1	3	2	1
AE19B16.4	3	3	2	-	-	-	-	-	-	-	-	1	2	1	1
AE19B16.5	3	3	2	-	-	-	-	-	-	-	-	1	2	2	1
Average	3	2.6	2	-	-	-	-	-	-	-	-	1	2.4	1.6	1

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19B17	**NUMERICAL HEAT TRANSFER**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To impart knowledge to students in the fundamental principles of various numerical methods which are useful to obtain numerical solutions to heat transfer problems
- To make the students learn numerical methods to obtain solution to 1-D, 2-D and 3-D conductive heat transfer problems.
- To introduce both implicit and explicit methods for numerical solution of transient heat conduction problems to students
- To make the students familiarize with the numerical treatment of convective heat transfer problems to compute velocity and temperature profiles in boundary problems.
- To acquaint students with the use of finite volume method in radiative heat transfer problems

UNIT-I NTRODUCTION **9**

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

UNIT-II CONDUCTIVE HEAT TRANSFER **9**

General 3D-heat conduction equation in Cartesian, cylindrical and spherical coordinates. Computation (FDM) of One –dimensional steady state heat conduction with Heat generationwithout Heat generation- 2D-heat conduction problem with different boundary conditionsNumerical treatment for extended surfaces. Numerical treatment for 3D- Heat conduction. Numerical treatment to 1D-steady heat conduction using FEM.

UNIT-III TRANSIENT HEAT CONDUCTION **9**

Introduction to Implicit, explicit Schemes and crank-Nicolson Schemes Computation(FDM) of One – dimensional un-steady heat conduction –with heat Generation-without Heat generation - 2D-transient heat conduction problem with different boundary conditions using Implicit, explicit Schemes. Importance of Courant number. Analysis for I-D,2-D transient heat Conduction problems

UNIT-IV CONVECTIVE HEAT TRANSFER **9**

Convection- Numerical treatment (FDM) of steady and unsteady 1 -D and 2-d heat convectiondiffusion steady-unsteady problems- Computation of thermal and Velocity boundary layer flows. Upwind scheme. Stream function-vorticity approach-Creeping flow.

UNIT-V RADIATIVE HEAT TRANSFER **9**

Radiation fundamentals-Shape factor calculation-Radiosity method- Absorption Method – Montacalro method-Introduction to Finite Volume Method- Numerical treatment of radiation enclosures using finite Volume method. Developing a numerical code for 1D, 2D heat transfer problems.

Total Contact Hours: 45

Course Outcomes: Upon completion of this course, Students will be able to

- Acquire knowledge on the basic concepts on the applications of numerical methods for the heat transfer problem solutions
- Appreciate the role of boundary conditions in defining the complexities and the methodology for numerical solutions of heat transfer problems
- Use both implicit and explicit schemes for transient heat conduction problems
- Compute the temperature profiles in thermal boundary layer.
- Apply finite volume methods for radiative heat transfer problems and the role of Montecarlo methods in radiative heat transfer.

SUGGESTED ACTIVITIES (if any

- Problem solving sessions
- Flipped classroom - Comparing SOA with Client-Server and Distributed architectures
- Survey on various storage technologies
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS (if Any)

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

Textbook(s):

1. Sachdeva, S.C., Fundamentals of Engineering Heat and Mass Transfer, NEW AGE publishers,2010
2. Yunus A. Cengel, Heat Transfer – A Practical Approach Tata McGraw Hill 4thEdition, 2009

Reference Books(s) / Web links:

- Necati Ozisik, Finite Difference Method in Heat Transfer, CRC Press, 2nd edition, 2017.
- Pradip Majumdar, Computational Methods for Heat & Mass Transfer, CRC Press, 2005.
- Yogesh Jaluria, Kenneth E Torrence, Computational Heat transfer, CRC Press, 3rd Edition, 2017

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19B17.1	3	2	2	-	-	3	3	-	-	-	-	1	2	2	-
AE19B17.2	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1
AE19B17.3	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1
AE19B17.4	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1
AE19B17.5	3	2	2	-	-	3	3	-	-	-	-	1	2	2	-
Average	3	2	2	-	-	3	3	-	-	-	-	1	2	2	1

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19B18	**HIGH-TEMPERATURE GAS DYNAMICS**		3	0	0	3

Objectives:

- To gain basic knowledge of thermo-physical properties of gases
- To give conceptual understanding of equilibrium and non-equilibrium processes in a gas
- To understand behaviour of gases in equilibrium
- To know the basic gas dynamics like isentropic flow and shocks
- To know the basics of frictional flow and the flow with heating

UNIT-I INTRODUCTION 9

Review of equilibrium gas properties, non-equilibrium and non-equilibrium kinetic theory.

UNIT-II EQUILLIBRIUM OF GASES 9

Equilibrium flow (Steady shocks, nozzle flow, Prandtl-Meyer flow, Frozen flow), Vibrational and Chemical rate processes (Vibrational rate equation, chemical rate equation, local relaxation times, small departures from equilibrium)

UNIT-III PROPERTIES OF GASES 9

Flow with Vibrational and chemical non-equilibrium (Equilibrium and frozen flow, non- linear equations, acoustic equations, speed of sound, sound propagation, small departures from uniform flow, linearised normal shock wave, dispersed shock wave, nozzle flow, MOC)

UNIT-IV GAS FLOWS 9

Flow with translational non-equilibrium (transport properties, Bulk viscosity, structure of shock wave, linearised Couette flow)

UNIT-V RADIATION CHARACTERISTICS 9

Radiative transfer in gases (Equation of radiative transfer, radiative equilibrium, radiation-solid surface interaction, Emission and absorption of radiation), Flow with radiative non-equilibrium (Basic non-linear equations, grey-gas, 1D equations, normal shock wave) .

Total Contact Hours: 45

Course Outcomes:

- Abel to analyse the thermo-physical properties of gases
- Able to understand the equilibrium and non-equilibrium processes in a gas
- Able to understand behaviour of gases in equilibrium
- Able to understand the basic gas dynamics like isentropic flow and shocks
- Able to understand the basics of frictional flow and the flow with heating

SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic

- Problem solving sessions
- Flipped classroom - Comparing SOA with Client-Server and Distributed architectures
- Survey on various storage technologies
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS (if Any) (UNIT/ Module Wise) – could suggest topic

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

Textbook(s):

1. W G Vincenti and C H Kruger,Jr., Introduction to Physical Gas Dynamics, Kreiger Publishing Co., Malabar, Florida, USA (1986).
2. J.D. Anderson Jr., Hypersonic and High Temperature gas dynamics, McGraw Hill (1989)
3. T.K. Bose, High Temperature Gas Dynamics: an Introduction for Physicists and Engineers, Springer (2004).

Reference Books(s) / Web links:

- J.O. Hirschfelder, C.F. Curtiss, and R.B. Bird, Molecular theory of gases and liquids, Wiley-Inter science; Rev Ed edition (1964)

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19B18.1	2	1	1	-	-	-	1	-	-	-	-	1	3	1	-
AE19B18.2	3	3	1	-	-	-	1	-	-	-	-	1	3	3	-
AE19B18.3	3	3	1	-	-	-	1	-	-	-	-	1	3	3	-
AE19B18.4	3	2	1	-	-	-	1	-	-	-	-	1	3	2	-
AE19B18.5	3	2	1	-	-	-	1	-	-	-	-	1	3	2	-
Average	2.8	2.2	1	-	-	-	1	-	-	-	-	1	3	2.2	-

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19B19	**REFRIGERATION AND CRYOGENICS**		**3**	**0**	**0**	**3**

Objectives:

- To provide the students with a foundation of refrigeration.
- To provide the students details of the refrigerants
- To make the students aware of the capabilities and limitations of cryogenics.
- To study advanced features of the cryogenic engineering.
- To study the industrial practices in cryogenic engineering.

UNIT-I BASICS OF REFEREGIRATION 9

Brief history of refrigeration, refrigerants and environmental issues. Reverse Carnot cycle and standard vapor compression refrigeration cycle - analysis, comparison and Ewing's construction. Compressors - reciprocating, centrifugal and screw type, volumetric efficiency and performance. Performance of single stage refrigeration cycle and its limitations. Multistage, multi evaporator and cascade systems.

UNIT-II PROPERTIES OF REFRIGERANTS 9

Properties of refrigerants -primary, secondary and mixtures. Ozone friendly refrigerants, ozone depletion and global warming. lubricants. Absorption refrigeration system - LiBr- water and aqua-ammonia systems, calculations by h-x diagrams, Platen-Munter's system and solar energy applications. Steam jet refrigeration, vortex tube, Pulse tube, thermoelectric refrigeration and gas cycle refrigeration.

UNIT-III BASICS OF CRYOGENICS 9

Air liquefaction cycles. Condensers and evaporators: classifications, condensation and boiling heat transfer correlations, design and performance. Expansion values - capillary tube, AEV, TEV and float value. Refrigeration system simulation: balancing of condensing unit and evaporator

UNIT-IV THERMODYNAMICS OF CRYOGENIC ENGINEERING 9

Thermodynamics of gas liquefaction- liquefaction cycles- cryogenic refrigeration systems down to milli Kelvin range. Properties of cryogenic liquids, superfluidity, properties of solids at cryogenic temperatures: mechanical, thermal, electrical and magnetic properties, superconductivity. Storage and transfer of cryogenic liquids, liquid level.

UNIT-V INDUSTRIAL APPLICATIONS OF CRYOGENIC ENGINEERING 9

Thermocouples, platinum resistance and semiconductor thermometry. Cool down of cryogenic transfer lines, frost phenomena, cryogenic insulation. Applications of cryogenics in engineering, space technology, liquid fuel rockets, space simulation chambers.

Total Contact Hours: 45

Course Outcomes:

- Able to understand the details of the working principle of refrigeration cycle
- Able to analyse the properties of different types of refrigerants
- Able to understand different types of cryogenic processes
- Able to understand different types of cryogenic engineering
- Able to understand the application of cryogenic engineering in the industries

SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic

- Problem solving sessions
- Flipped classroom - Comparing SOA with Client-Server and Distributed architectures
- Survey on various storage technologies
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS (if Any) (UNIT/ Module Wise) – could suggest topic

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

Textbook(s):

4. Gosney W.B. "Principles of refrigeration" Cambridge University Press(1982)
5. Dossat R. J., Principles of Refrigeration" 4th Edition 2002.-Pearson Education, India.
6. Haselden C.J. (Ed) Cryogenic Fundamentals, Academic Press (1975)

Reference Books(s) / Web links:

- ASHRAE guide and Data Books Fundamentals (1977), Transactions (1978), Equipment, (1979), Systems (1980)
- Transactions of ASHRAE. 2008
- Baily C.A. Advanced cryogenics. Plenum Press (1971)

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19B19.1	3	1	1	-	-	1	1	-	-	-	-	1	2	1	1
AE19B19.2	3	3	2	-	-	2	2	-	-	-	-	1	3	2	1
AE19B19.3	3	3	2	-	-	2	2	-	-	-	-	1	3	2	1
AE19B19.4	3	3	2	-	-	1	1	-	-	-	-	1	2	1	1
AE19B19.5	3	3	2	-	-	2	2	-	-	-	-	1	2	2	1
Average	3	2.6	2	-	-	1.6	1.6	-	-	-	-	1	2.4	1.6	1

AE19C11	FATIGUE AND FRACTURE	L	T	P	C
		3	0	0	3

OBJECTIVE

- To understand the basic concepts involved in fatigue analysis and to study the importance of fracture mechanics in aerospace applications.

UNIT I FATIGUE OF STRUCTURES 7

Kinds of Failure - S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors - Plastic stress concentration factors - Notched S.N. curves

UNIT II STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR 8

Low cycle and high cycle fatigue - Coffin - Manson's relation - Transition life - cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques -Cumulative damage - Miner's theory - Other theories.

UNIT III PHYSICAL ASPECTS OF FATIGUE 7

Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces.

UNIT IV FRACTURE MECHANICS 13

Strength of cracked bodies - Potential energy and surface energy - Griffith's theory – Energy Release Rate - Importance of R-curve in fracture mechanics – Critical Energy Release Rate – Stress Intensity Factor – Westergaard Approach – Relation between G_I and K_I - Irwin - Orwin extension of Griffith's theory to ductile materials -– Effective Crack Length - Effect of thickness on fracture toughness. Elastic – Plastic analysis through J-integral – CTOD.

UNIT V FATIGUE DESIGN, TESTING AND NUMERICAL ANALYSIS OF FRACTURE 10

Safe life and Fail-safe design philosophies –Test Methods-FEM- Direct and indirect method to determine fracture parameters-Importance of Fracture Mechanics in aerospace structures.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Prasanth Kumar, "Elements of fracture mechanics", Wheeter publication, 1999.
2. Barrois W, Ripely, E.L., "Fatigue of aircraft structure," Pergamon press. Oxford, 1983.

REFERENCES:

1. Sih C.G., "Mechanics of fracture." Vol - I, Sijthoff and w Noordhoff International Publishing Co., Netherlands, 1989.
2. Knott, J.F., "Fundamentals of Fracture Mechanics," - Buterworth & Co., Ltd., London, 1983.
3. Kare Hellan ,'Introduction to Fracture Mechanics', McGraw Hill, Singapore,1985
4. D.Brock, "Elementary Engineering Fracture Mechanics", Noordhoff International PublishingCo., London, 1994.

After successful completion of the course students will demonstrate the following outcomes:

1.

AE19C11.1 Apply mathematical knowledge to define fatigue behaviour
AE19C11.2 Apply concept of various theories to define fatigue behavior.
AE19C11.3 Compute the physical aspects of fatigue.
AE19C11.4 Analyze fracture due to fatigue
AE19C11.5 Perform fatigue design and testing

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19C11.1	3	2	2	2	-	-	-	-	-	-	-	2	3	-	2
AE19C11.2	3	3	2	3	-	-	-	-	-	-	-	2	3	-	2
AE19C11.3	3	3	3	3	-	-	-	-	-	-	-	2	3	-	2
AE19C11.4	3	3	3	2	-	-	-	-	-	-	-	2	3	3	3
AE19C11.5	3	2	3	2	-	-	-	-	-	-	-	2	3	-	3
Average	3	2.6	2.6	2.4	-	-	-	-	-	-	-	2	3	3	2.4

Subject Code	Subject Name	Category	L	T	P	C
AE19C12	THEORY OF ELASTICITY	PE	3	0	0	3

OBJECTIVES

- To make the student understand the elastic behavior of different structural components under various loadings and boundary conditions.

UNIT I BASIC EQUATIONS OF ELASTICITY 9

Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant‟s principle - Principal Stresses, Stress Ellipsoid - Stress invariants.

UNIT II PLANE STRESS AND PLANE STRAIN PROBLEMS 9

Airy‟s stress function, Bi-harmonic equations, Polynomial solutions, Simple two-dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams.

UNIT III POLAR COORDINATES 9

Equations of equilibrium, Strain - displacement relations, Stress – strain relations, Airy‟s stress function, Axi – symmetric problems, Introduction to Dunder‟s table, Curved beam analysis, Lame‟s, Kirsch, Michell‟s and Boussinesque problems – Rotating discs.

UNIT IV TORSION 9

Navier‟s theory, St. Venant‟s theory, Prandtl‟s theory on torsion, semi- inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections. Membrane Analogy.

UNIT V INTRODUCTION TO THEORY OF PLATES AND SHELLS 9

Classical plate theory – Assumptions – Governing equations – Boundary conditions – Navier‟s method of solution for simply supported rectangular plates – Levy‟s method of solution for rectangular plates under different boundary conditions.

TOTAL: 45 PERIODS

OUTCOMES

- Ability to use mathematical knowledge to solve problem related to structural elasticity.

TEXT BOOKS

1. Timoshenko, S., and Goodier, T.N., "Theory of Elasticity", McGraw – Hill Ltd., Tokyo, 1990.
2. Ansel C Ugural and Saul K Fenster, "Advanced Strength and Applied Elasticity", 4th Edition, Prentice Hall, New Jersey, 2003.
3. Bhaskar, K., and Varadan, T. K., "Theory of Isotropic/Orthotropic Elasticity", CRC Press USA, 2009.

REFERENCES

1. Wang, C. T., "Applied Elasticity", McGraw – Hill Co., New York, 1993.
2. Sokolnikoff, I. S., "Mathematical Theory of Elasticity", McGraw – Hill, New York, 1978.
3. Volterra & J.H. Caines, "Advanced Strength of Materials", Prentice Hall, New Jersey, 1991
4. Barber, J. R., "Elasticity", Kluwer Academic Publishers, 2004

After successful completion of the course students will demonstrate the following outcomes:

AE19C12.1 Students will able to solve problems on equations of elasticity with different boundary conditions.

AE19C12.2 Students will able able to determine bi harmonic equations and its application to two dimensional problems like bending of cantilever and simply supported beams

AE19C12.3 Students will resolve the stress strain and displacements problems in polar coordinates for axi-symmetric sections.

AE19C12.4 Students will able to determine Navier's theory, St. Venant's theory, Prandtl's theory on torsion and its application to various shafts.

AE19C12.5 Students can interprete the results obtained from governing equation and give solutions for different plates and shells using Navier's and Levy's method.

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19C12.1	3	3	2	1	-	-	-	-	1	1	-	1	3	1	-
AE19C12.2	3	3	2	2	-	-	-	-	1	1	-	1	3	1	-
AE19C12.3	3	3	2	2	-	-	-	-	1	1	-	1	3	1	-
AE19C12.4	3	2	2	1	-	-	-	-	1	1	-	1	3	1	-
AE19C12.5	3	3	3	2	-	-	-	-	1	1	-	1	3	1	-
Average	3	2.8	2.2	1.6	0	0	0	0	1	1	0	1	3	1	0

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19C13	**NON-DESTRUCTIVE EVALUATION**		**3**	**0**	**0**	**3**

Objectives:

- To impart knowledge on the fundamentals of nondestructive testing methods and techniques, aircraft inspection methodology using NDT methods
- To get insights into the basic aspects of electron microscopy
- To learn modern NDT techniques like acoustic emission, ultrasonic and thermographic testing methods.
- To inspect the aircraft structures using NDT techniques
- To get basic knowledge on the structural health monitoring of aerospace structures.

UNIT-I INTRODUCTION 9

Need for non-destructive evaluation (NDT) – NDT Versus Mechanical testing, Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation – Structural deterioration due to corrosion and fatigue –Relative merits and limitations, Various physical characteristics of materials and their applications in NDT - Visual inspection – Unaided and aided - Aircraft wing and fuselage inspection using various NDT techniques

UNIT-II ELECTRON MICROSCOPY 9

Fundamentals of optics – Optical microscope and its instrumental details – Variants in the optical microscopes and image formation – Polarization light effect – Sample preparation and applications of optical microscopes – Introduction to Scanning electron microscopy (SEM) – Instrumental details and image formation of SEM – Introduction to transmission electron microscopy (TEM) – Imaging techniques and spectroscopy – Sample preparation for SEM and TEM

UNIT-III ACOUSTIC EMISSION AND ULTRASONICS 9

Sources of acoustic emission – Physical principals involving acoustic emission and ultrasonics – Configuration of ultrasonic sensors – Phased array ultrasonics – Instrument parts and features for acoustic emission and ultrasonics – Defect characterization – Inspection of cracks and other flaws in metals and composites – Interpretation of data – Image processing – Concepts and application

UNIT-IV AIRCRAFT INSPECTION 9

Inspection Levels – General Visual Inspection – During pre, or post flight – Detailed Visual Inspection (DET) – Periodic inspection – Special Detailed Inspection (SDET) – Uses of NDT Methods - Comparison of different methods of NDT – Visual – Radiography – Eddy Current Testing – Liquid Penetrant Testing – Remote Testing - Landing Gear Inspection

UNIT-V STRUCTURAL HEALTH MONITORING 9

An Overview of Structural Health Monitoring – Structural Health Monitoring and Role of Smart Materials – Structural Health Monitoring versus Non-Destructive Evaluation – A Broad Overview of Smart Materials Applications – Notable Applications of SHM in Aerospace Engineering – Structural health monitoring of composites – Repair investigation using SHM – Current limits and future trends.

Total Contact Hours: 45

Course Outcomes:

- To realize the importance of various NDT techniques
- To identify suitable NDT technique for a particular application.
- To demonstrate the physical principles involved in acoustic emission and ultrasonics.
- To have knowledge on the physical principles involved in the various other techniques of NDT.
- To realise the state-of-the-art in NDT testing and structural health monitoring.

SUGGESTED ACTIVITIES (if any)

- Flipped classroom
- Activity Based Learning

SUGGESTED EVALUATION METHODS (if Any)

- Class Presentation/Discussion

Text Book(s):

1. J Prasad, C G K Nair, "Non-Destructive Testing and Evaluation of Materials", Tata McGraw Hill Education Private Limited
2. Baldev Raj, T.Jayakumar, M.Thavasimuthu Practical Non-Destructive Testing, Narosa Publishing House, 2014.
3. Douglas B. Murphy, "Fundamentals of light microscopy and electronic imaging", Wiley-Liss, Inc. USA, 2001.

Reference Books(s) / Web links:

- ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", Volume-17 American Society of Metals, Metals Park, Ohio, USA, 2000
- Handbook of Non-Destructive evaluation Charles, J. Hellier McGraw Hill, New York 2001
- Douglas E Adams, "Health Monitoring of Structural Materials and Components-Methods with Applications", John Wiley and Sons, 2007.

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19C13.1	3	3	2	1	-	-	-	-	1	1	-	1	3	1	-
AE19C13.2	3	3	2	2	-	-	-	-	1	1	-	1	3	1	-
AE19C13.3	3	3	2	2	-	-	-	-	1	1	-	1	3	1	-
AE19C13.4	3	2	2	1	-	-	-	-	1	1	-	1	3	1	-
AE19C13.5	3	3	3	2	-	-	-	-	1	1	-	1	3	1	-
Average	3	2.8	2.2	1.6	0	0	0	0	1	1	0	1	3	1	0

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19C14	**INTRODUCTION TO VIBRATIONS**		**3**	**0**	**0**	**3**

Objectives:

- To study the effect of time dependent forces on mechanical systems and to get the natural characteristics of system with single degree of freedom systems.
- Determine the natural frequencies of the system subjected to forced excitation with single degrees of freedom
- Understand the modal analysis for the multi-degree of freedom systems
- Obtain the natural frequencies for all the continuous systems through wave equations
- Use of approximate and numerical methods to solve for the natural frequencies in multi-degrees of freedom

UNIT-I SINGLE DEGREE OF FREEDOM SYSTEMS – FREE VIBRATIONS 9

Introduction to simple harmonic motion, Single degree of freedom systems – free vibrations – damped vibrations.

UNIT-II SINGLE DEGREE OF FREEDOM SYSTEMS - FORCED VIBRATIONS 9

Forced vibrations, with and without damping – Logarithmic decrement - Support excitation – Transmissibility.

UNIT-III DYNAMICS OF MULTI DEGREES OF FREEDOM SYSTEMS 9

Two degrees of freedom systems - Eigen value problems – Modal Analysis - Static and dynamic couplings – Hamilton's principle - Lagrangian equations and application.

UNIT-IV DYNAMICS OF CONTINUOUS SYSTEMS 9

Vibration of string – Longitudinal, Lateral and Torsional vibrations

UNIT-V APPROXIMATE METHODS 9

Influence Co-efficient method – Rayleigh's method – Rayleigh-Ritz method - Dunkerley's method – Matrix iteration method.

Total Contact Hours: 45

Course Outcomes:

- Apply knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free response
- Formulate and analyse the forced vibration
- Construct the governing differential equation and solve vibration problems that contain multiple degrees of freedom
- Calculate the modes of simple structural elements and explain the utility of modal analysis in structural dynamics
- Demonstrate a basic understanding of modern numerical methods in structural dynamics

SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic

- Problem solving sessions
- Flipped classroom - Comparing SOA with Client-Server and Distributed architectures
- Survey on various storage technologies
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS (if Any) (UNIT/ Module Wise) – could suggest topic

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

Textbook(s):

1. Singiresu S. Rao, 'Mechanical Vibrations', Fifth Edition, Prentice Hall, 2011.
2. Thomson W T, „Theory of Vibration with Application" - CBS Publishers, 1990.

Reference Books(s) / Web links:

- Grover. G.K., "Mechanical Vibrations", 7th Edition, Nem Chand Brothers, Roorkee, India, 2003
- TSE. F.S., Morse, I.F., Hinkle, R.T., "Mechanical Vibrations" – Prentice Hall, New York, 1984.
- V. P. Singh, 'Mechanical Vibrations', Fourth Edition, Dhanpat Rai and Co., 2014.

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19C14.1	3	2	2	2	-	-	-	-	-	-	-	2	3	-	2
AE19C14.2	3	3	2	3	-	-	-	-	-	-	-	2	3	-	2
AE19C14.3	3	3	3	3	-	-	-	-	-	-	-	2	3	-	2
AE19C14.4	3	3	3	2	-	-	-	-	-	-	-	2	3	3	3
AE19C14.5	3	2	3	2	-	-	-	-	-	-	-	2	3	-	3
Average	3	2.6	2.6	2.4	-	-	-	-	-	-	-	2	3	3	2.4

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19C15	**AEROELASTICITY**		**3**	**0**	**0**	**3**

Objectives:

- Explain structural concepts such as elastic stiffness, inertia, influence coefficients, elastic axis, and shear center.
- Describe structural dynamics of wings, including bending and torsion modes of vibration and theirassociated natural frequencies.
- Apply aeroelastic concepts of divergence, flutter, lift and roll effectiveness, aileron reversal,and mode coalescence.
- Knowledge to formulate and derive static and dynamic aeroelastic equations of motion.
- To Apply Rayleigh-Ritz Method for Approximate continuous aeroelastic systems able to Interpret velocity-damping and velocity-frequency flutter diagrams.

UNIT-I AERO ELASTICITY PHENOMENA 9

Vibration of beams due to coupling between bending and torsion - The aero-elastic triangle of forces -Stability versus response problems — Aeroelasticity in Aircraft Design — Vortex induced vibration — Introduction to aero servo elasticity.

UNIT-II DIVERGENCE OF A LIFTING SURFACE 9

Simple two dimensional idealizations – Strip theory – Fredholm integral equation of the second kind – Exact solutions for simple rectangular wings – Semi rigid assumption and approximate solutions –Generalized coordinates – Successive approximations – Numerical approximations using matrix equations.

UNIT-III STEADY STATE AEROELASTIC PROBLEMS 9

Loss and reversal of aileron control – Critical aileron reversal speed – Aileron efficiency – Semi rigidtheory and successive approximations – Lift distributions – Rigid and elastic wings.

UNIT-IV FLUTTER ANALYSIS 9

Non-dimensional parameters – Stiffness criteria Dynamic mass balancing – Model experiments – Dimensional similarity – Flutter analysis – Two dimensional thin airfoils in steady incompressible flow Quasi steady aerodynamic derivatives – Galerkin's method for critical speed – Stability of distributedmotion – Torsion flexure flutter – Solution of the flutter determinant – Methods of determining the critical flutter speeds – Flutter prevention and control.

UNIT-V EXAMPLES OF AEROELASTIC PROBLEMS 9

Galloping of transmission lines and flow induced vibrations of tall slender structures and suspension bridges – Aircraft wing flutter- Vibrational problems in Helicopters.

Total Contact Hours: 45

Course Outcomes:

- Formulate and perform classical solutions of aeroelastic problems.
- Calculate divergence of a lifting surface in the aerospace vehicles.
- Formulate aeroelastic equations of motion and use them to derive fundamental relations foraeroelastic analysis.
- Analyze the static aeroelastic instabilities such as divergence, control surface reversal and flutter
- Analyze the aeroelastic problems in civil and mechanical engineering.

SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic

- Problem solving sessions
- Flipped classroom - Comparing SOA with Client-Server and Distributed architectures
- Survey on various storage technologies
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS (if Any) (UNIT/ Module Wise) – could suggest topic

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

Textbook(s):

1. Fung, Y.C. An Introduction to the theory of Aeroelasticity, Dover Publications Inc., 2008.

2. Bisplinghoff., R.L. Ashley, H., and Halfman, R.L, "Aeroelasticity" Addison Wesley Publishing Co., Inc. II ed. 1996.

Reference Books(s) / Web links:

- Broadbent, E.G., Elementary Theory of Aeroelasticity, Bunhill Publications Ltd, 1986.
- Blevins R.D, "Flow induced vibrations", Krieger Pub Co; 2 Reprint editions, 2001.
- Scanlan, R.H. and Rosenbaum, R., Introduction to the Study of Aircraft Vibration and Flutter, Macmillan Co., N.Y., 1991.

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19C15.1	3	2	2	2	-	-	-	-	-	-	-	2	3	-	2
AE19C15.2	3	3	2	3	-	-	-	-	-	-	-	2	3	-	2
AE19C15.3	3	3	3	3	-	-	-	-	-	-	-	2	3	-	2
AE19C15.4	3	3	3	2	-	-	-	-	-	-	-	2	3	3	3
AE19C15.5	3	2	3	2	-	-	-	-	-	-	-	2	3	-	3
Average	3	2.6	2.6	2.4	-	-	-	-	-	-	-	2	3	3	2.4

AE19C16	COMPOSITE MATERIALS AND STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVES

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

UNIT I MICROMECHANICS 9

Introduction - Advantages and application of composite materials - reinforcements and matrices – Introduction to Nano composite -Micro mechanics – Mechanics of materials approach, elasticity approach-Effect of voids - hygro thermal effects on a lamina.

UNIT II MACROMECHANICS 9

Macro mechanics - Generalized Hooke's Law - Elastic constants for anisotropic, orthotropic and isotropic materials - Macro Mechanics – Stress-strain relations with respect to natural axis, arbitrary axis – Determination of material properties - Experimental characterization of lamina.

UNIT III LAMINATED PLATE 9

Governing differential equation for a unidirectional lamina and general laminate, angle ply and cross ply laminate, Failure criteria for composites.

UNIT IV FABRICATION PROCESS AND REPAIR METHODS 9

Various open and closed mould processes, Manufacture of fibers, Types of resins, properties and applications, Netting analysis. importance of repair and different types of repair techniques in composites

UNIT V SANDWICH CONSTRUCTIONS 9

Basic design concepts of sandwich construction - Materials used for sandwich construction - Failure modes of sandwich panels - Bending stress and shear flow in composite beams.

TOTAL: 45 PERIODS

OUTCOMES

- Understanding the mechanics of composite materials
- Ability to analyse the laminated composites for various loading eases
- Knowledge gained in manufacture of composites

TEXT BOOKS

1. Jones, R.M., "Mechanics of Composite Materials," Taylor & Francis, II Edition, 2000.
2. Madhuji Mukhapadhyay, Mechanics of Composite Materials and Structures, University Press, 2004

REFERENCES

1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites," John Wiley and sons. Inc., New York, 1995.
2. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989.
3. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Nostrand Reinhold Company, New York 1998.
4. Allen Baker, "Composite Materials for Aircraft Structures", AIAA Series, II Edition, 1999.
5. Autar K Kaw, „Mechanics of Composite Materials", CRC Press, 1997.

After successful completion of the course students will demonstrate the following outcomes:

AE19C16.1 Students will able to illustrate the application and micromechanics approach of composites.

AE19C16.2 Students will able to determine stress strain relations and elastic constants for different materials.

AE19C16.3 Students will able to resolve the governing differential equation for different ply laminates.

AE19C16.4 Students will able to understand the manufacturing process and repair methods of composites.

AE19C16.5 Students can design basic sandwich construction and calculate bending stress and shear flow in composite beams.

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19C16.1	3	3	2	2	1	1	1	1	1	1	-	1	3	1	-
AE19C16.2	3	3	3	2	1	1	1	1	1	1	-	1	3	1	-
AE19C16.3	3	3	3	2	1	1	1	1	1	1	-	1	3	2	-
AE19C16.4	3	2	2	1	1	1	1	1	1	1	-	1	3	2	-
AE19C16.5	3	3	2	2	1	1	1	1	1	1	-	1	3	2	-
Average	3	2.8	2.4	1.8	1	1	1	1	1	1	0	1	3	1.6	0

AE19C17	EXPERIMENTAL STRESS ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES

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

UNIT I EXTENSOMETERS AND DISPLACEMENT SENSORS 8

Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical, Acoustical and Electrical extensometers and their uses, Advantages and disadvantages**,** Capacitance gauges, Laser displacement sensors.

UNIT II ELECTRICAL RESISTANCE STRAIN GAUGES 12

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

UNIT III PHOTOELASTICITY 11

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

UNIT IV BRITTLE COATING AND MOIRE TECHNIQUES 7

Introduction to Brittle Coating - Relation between stresses in coating and specimen, use of failure theories in brittle coating, Moire method of strain analysis.

UNIT V NON – DESTRUCTIVE TESTING 7

Fundamentals of NDT, Acoustic Emission Technique, Radiography, Thermography, Ultrasonics, Eddy Current testing, Fluorescent Penetrant Testing,

TOTAL: 45 PERIODS

TEXTBOOKS

1. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw Hill Inc., New York 1998.
2. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., "Experimental Stress Analysis", Tata McGraw Hill, New Delhi, 1984.
3. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 1996.

REFERENCES

1. Hetenyi, M., "Hand book of Experimental Stress Analysis", John Wiley and Sons Inc., New York, 1972.
2. Pollock A.A., Acoustic Emission in Acoustics and Vibration Progress, Ed. Stephens R.W.B., Chapman and Hall,1993.
3. Max Mark Frocht, "Photo Elasticity", John Wiley and Sons Inc., New York, 1968
4. Durelli. A.J., "Applied Stress Analysis", Prentice Hall of India Pvt Ltd., New Delhi, 1970
5. Ramesh, K., Digital Photoelasticity, Springer, New York, 2000.

After successful completion of the course students will demonstrate the following outcomes:

AE19C17.1 Able to distinguish various types of principles in strain and stress measurement.
AE19C17.2 Able to analyze various electrical resistance strain gauges and its applications
AE19C17.3 Able to acquire knowledge on photoelastic techniques
AE19C17.4 Able to use brittle coating and moire fringe methods
AE19C17.5 Familiarized to various techniques on non-destructive testing

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19C17.1	1	1	1	1	-	1	-	1	1	1	-	1	2	3	-
AE19C17.2	2	2	1	1	-	1	-	1	1	1	-	1	2	3	-
AE19C17.3	2	1	1	1	-	1	-	1	1	1	-	1	2	2	-
AE19C17.4	1	1	1	1	-	1	-	1	1	1	-	1	2	3	-
AE19C17.5	1	1	1	1	-	1	-	1	1	1	-	2	1	3	-
Average	1.4	1.2	1	1	0	1	0	1	1	1	0	1.2	1.8	2.8	0

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19C18	**THEORY OF PLATES AND SHELLS**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- Achieve fundamental understanding of the classical theory of elastic plates and shells
- Use analytical methods for the solution of thin plates
- Understand the dynamic behaviour of the plates
- Apply the numerical techniques for the complex problems in thin plates
- Use analytical methods for the solution of thin shells

UNIT-I INTRODUCTION TO PLATE THEORY 9

Classical Plate Theory – Assumptions – Differential Equation – Boundary Conditions – Kirchoff's Plate Theory

UNIT-II PLATES OF VARIOUS SHADES 9

Navier's Method of Solution for Simply Supported Rectangular Plates – Leavy's Method of Solution for Rectangular Plates under Different Boundary Conditions. Governing Equation – Solution for Axi-symmetric loading – Annular Plates – Plates of other shapes.

UNIT-III EIGEN VALUE ANALYSIS 9

Stability and free Vibration Analysis of Rectangular Plates.

UNIT-IV APPROXIMATE METHODS 9

Rayleigh – Ritz, Galerkin Methods– Finite Difference Method – Application to Rectangular Plates for Static, Free Vibration and Stability Analysis.

UNIT-V SHELLS 9

Basic Concepts of Shell Type of Structures – Membrane and Bending theories for Circular Cylindrical Shells.

Total Contact Hours: 45

Course Outcomes:

- Describe the governing equation for a rectangular plate
- Analyze under axi-symmetric loading, governing differential equation in polar co-ordinates.
- Demonstrate the vibrations of the plates and analyze the behaviour.
- Approximate methods of analysis- Rayleigh-Ritz approach for simple cases in rectangular plates.
- Understand the membrane theory of cylindrical shells

SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic

- Problem solving sessions
- Flipped classroom - Comparing SOA with Client-Server and Distributed architectures
- Survey on various storage technologies
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS (if Any) (UNIT/ Module Wise) – could suggest topic

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

Textbook(s):

1. Timoshenko, S.P. Winowsky. S., and Kreger, "Theory of Plates and Shells", McGraw-Hill Book Co. 1990.
2. Varadan. T. K. and Bhaskar. K., "Theory of Plates and Shells", 1999, Narosa.

Reference Books(s) / Web links:

- Timoshenko, S.P. and Gere, J.M., "Theory of Elastic Stability", McGraw-Hill Book Co. 1986
- Ugural, A. C. Stresses in Plates and Shells. 2nd ed. New York, NY: McGraw-Hill, 1998.
- J. N. Reddy, "Theory and Analysis of Elastic Plates and Shells", CRC Press, 2006.

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19C18.1	1	1	1	1	-	1	-	1	1	1	-	1	2	3	-
AE19C18.2	2	2	1	1	-	1	-	1	1	1	-	1	2	3	-
AE19C18.3	2	1	1	1	-	1	-	1	1	1	-	1	2	2	-
AE19C18.4	1	1	1	1	-	1	-	1	1	1	-	1	2	3	-
AE19C18.5	1	1	1	1	-	1	-	1	1	1	-	2	1	3	-
Average	1.4	1.2	1	1	-	1	-	1	1	1	-	1.2	1.8	2.8	-

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19C19	**MATERIALS TESTING AND CHARACTERIZATION TECHNIQUES**	**PE**	**3**	**0**	**0**	**3**

OBJECTIVE:

(1) Make them acquainted with microscopic techniques to analyse crystal structures
(2) Acquire an understanding on the electron microscopic techniques for characterization
(3) Gain a fundamental on chemical and thermal analysis
(4) Provide the knowledge on various static methods to characterize materials
(5) Study the failure of materials under stress

UNIT I MICRO AND CRYSTAL STRUCTURE ANALYSIS 9

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size

numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

UNIT II ELECTRON MICROSCOPY 9

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications. Atomic Force Microscopy- Construction & working of AFM - Applications.

UNIT III CHEMICAL AND THERMAL ANALYSIS 9

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra-Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo-Gravitymetric Analysis (TGA)

UNIT IV MECHANICAL TESTING – STATIC TESTS 9

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

UNIT V MECHANICAL TESTING – DYNAMIC TESTS 9

Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests.

TOTAL: 45 PERIODS

OUTCOMES:

1) At the end of this course the students are expected
2) to be knowledgeable in microstructure evaluation, crystal structure analysis,
3) to take images in electron microscopy and process those images,
4) to do Chemical Thermal Analysis,
5) Analyse the results of static and dynamic mechanical testing.

TEXTBOOK(S)

1. ASM Hand book-Materials characterization, Vol – 10, 2004.
2. Culity B.D., Stock S.R& Stock S., Elements of X ray Diffraction, (3rd Edition). Prentice Hall, 2001.

REFERENCES:

1. Davis J. R., Tensile Testing, 2nd Edition, ASM International, 2004.
2. Davis, H.E., Hauck G. & Troxell G.E., The Testing of engineering Materials, (4th Edition), McGraw Hill, College Divn., 1982.
3. Dieter G.E., Mechanical Metallurgy, (3rd Edition), ISBN: 0070168938, McGraw Hill, 1988.
4. Goldsten,I.J., Dale.E., Echin.N.P.& Joy D.C., Scanning Electron Microscopy & X ray- Micro Analysis, (2nd Edition), ISBN – 0306441756, Plenum Publishing Corp., 2000.
5. Grundy P.J. and Jones G.A., Electron Microscopy in the Study of Materials, Edward Arnold Limited, 1976.

6. Morita.S, Wiesendanger.R, and Meyer.E, "Non-contact Atomic Force Microscopy" Springer, 2002
7. Newby J., Metals Hand Book- Metallography & Micro Structures, (9th Edition), ASM International, 1989.
8. Suryanarayana A. V. K., Testing of metallic materials, (2nd Edition), BS publications, 2007

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19C19.1	1	1	1	1	-	1	-	1	1	1	-	1	2	3	-
AE19C19.2	2	2	1	1	-	1	-	1	1	1	-	1	2	3	-
AE19C19.3	2	1	1	1	-	1	-	1	1	1	-	1	2	2	-
AE19C19.4	1	1	1	1	-	1	-	1	1	1	-	1	2	3	-
AE19C19.5	1	1	1	1	-	1	-	1	1	1	-	2	1	3	-
Average	1.4	1.2	1	1	-	1	-	1	1	1	-	1.2	1.8	2.8	-

AE19D11 INTRODUCTION TO UAV SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES

- To make the students understand the basic concepts of UAV systems design.

UNIT I INTRODUCTION TO UAV 9

History of UAV –classification – Introduction to Unmanned Aircraft Systems--models and prototypes – System Composition-applications

UNIT II UAV SYSTEM SELECTION CRTERIA 9

Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations-Characteristics of Aircraft Types- Design Standards and Regulatory Aspects-UK, USA and Europe-Design for Stealth--control surfaces-specifications.

UNIT III AVIONICS HARDWARE 9

Autopilot – AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply-processor, integration, installation, configuration, and testing

UNIT IV COMMUNICATION PAYLOADS AND CONTROLS 9

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range – modems-memory system-simulation-ground test-analysis-trouble shooting

UNIT V THE DEVELOPMENT OF UAV SYSTEMS 9

Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing-Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.

TOTAL: 45 PERIODS

REFERENCES

1. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.
2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

3. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007.
4. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998.
5. Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 2001.

After successful completion of the course students will demonstrate the following outcomes:

AE19D11.1 Discuss the configuration, performance parameters, and design aspects of unmanned aerial vehicle (UAV).
AE19D11.2 Compare the sensors, payloads and actuators suitable for various UAVs.
AE19D11.3 Explain the working of UAV propulsion systems.
AE19D11.4 Discuss the communication and navigation systems in UAV.
AE19D11.5 Explain the practical limitations in the design and development of an UAV.

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19D11.1	3	1	1	2			3	2	2	1			1		2
AE19D11.2	2	-	-		1	1	1	2			1		3		1
AE19D11.3	2	3	1			1		1	2		1	2	2		1
AE19D11.4	3	2	-	-		1	2	2	1	1	2			1	
AE19D11.5	2	-	1	1	1				1		1	2		2	
Average	2.4	1.2	0.6	0.6	0.4	0.6	1.2	1.4	1.2	0.4	1	0.8	1.2	0.6	0.8

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19D12	**SPACE MECHANICS**		**3**	**0**	**0**	**3**

OBJECTIVES

- To introduce concepts of satellite injection and satellite perturbations, trajectory computation for interplanetary travel and flight of ballistic missiles based on the fundamental concepts of orbital mechanics.

UNIT I SPACE ENVIRONMENT 8

Peculiarities of space environment and its description– effect of space environment on materials of spacecraft structure and astronauts- manned space missions – effect on satellite lifetime

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

The solar system – reference frames and coordinate systems – terminology related to the celestial sphere and its associated concepts – Kepler's laws of planetary motion and proof of the laws –Newton's universal law of gravitation - the many body problem - Lagrange-Jacobi identity – the circular restricted three body problem libration points – the general N-body problem – two body problem – relations between position and time.

UNIT III SATELLITE INJECTION AND SATELLITE PERTURBATIONS 10

General aspects of satellite injection – satellite orbit transfer – various cases – orbit deviations due to injection errors – special and general perturbations – Cowell's method and Encke's method – method of variations of orbital elements – general perturbations approach.

UNIT IV INTERPLANETARY TRAJECTORIES 8

Two-dimensional interplanetary trajectories – fast interplanetary trajectories – three dimensional interplanetary trajectories – launch of interplanetary spacecraft – trajectory estimation about the target planet – concept of sphere of influence – Lambert's theorem

UNIT V BALLISTIC MISSILE TRAJECTORIES 9

Introduction to ballistic missile trajectories – boost phase – the ballistic phase – trajectory geometry –optimal flights – time of flight – re-entry phase – the position of impact point – influence coefficients.

TOTAL: 45 PERIODS

TEXTBOOKS

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co.,Ltd, London,1982
2. Parker, E.R., "Materials for Missiles and Spacecraft", Mc.Graw Hill Book Co. Inc., 1982.

REFERENCES

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition,1993.

After successful completion of the course students will demonstrate the following outcomes:

- To understand the space environment and its effect on spacecrafts and satellites
- To understand the concepts of the general *n*-body problem using the fundamental concepts of orbital mechanics.
- To understand various methods employed for satellite injection
- To perform calculations related to trajectory computation for interplanetary travel
- To perform calculations related to trajectory computation for flight of ballistic missiles.

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19D12.1	1	1	1	1	-	1	-	1	1	1	-	1	2	3	-
AE19D12.2	2	2	1	1	-	1	-	1	1	1	-	1	2	3	-
AE19D12.3	2	1	1	1	-	1	-	1	1	1	-	1	2	2	-
AE19D12.4	1	1	1	1	-	1	-	1	1	1	-	1	2	3	-
AE19D12.5	1	1	1	1	-	1	-	1	1	1	-	2	1	3	-
Average	1.4	1.2	1	1	-	1	-	1	1	1	-	1.2	1.8	2.8	-

Subject Code	Subject Name	Category	L	T	P	C
AE19D13	CIVIL AVIATION REQUIREMENTS	PE	3	0	0	3

Objectives

1. Enhance the knowledge of aircraft act1934, and aircraft rules.
2. Understand the responsibility of owner/operator of a/c.
3. Understand the procedure for the preparation.
4. Enhance the knowledge on the different types of maintenance programme their approval.
5. Understand the procedure for getting the approvals of organizations in different categories.

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UNIT I INDIAN AIRCRAFT RULES 1937 AND RELATED PUBLICATIONS 4

Knowledge of aircraft act, 1934, aircraft rules, 1937 as far as they related to airworthiness and safety of aircraft. Knowledge of civil airworthiness requirements, aeronautical information circulars, aeronautical information publications- (relating to airworthiness), advisory circulars & A.M.E. notices (NOTAMS) by DGCA.

UNIT II C.A.R. SERIES "A" &"B " 8

C.A.R. series A - procedure for issue of civil airworthiness requirements and responsibility of operators vis-à-vis air worthiness directorate:

Responsibilities of operators/owners; procedure of CAR issue, amendments etc; objectives and targets of airworthiness directorate; airworthiness regulations and safety oversight of engineering activities of operations C.A.R. series "B" - issue approval of cockpit check list, MEL, CDL:
Deficiency list (MEL & CDL); preparation and use of cockpit check list and emergency check list.

UNIT III C.A.R. SERIES "C" 8

C.A.R. series 'C' - defect recording, monitoring, investigation and reporting: Defect recording, reporting, investigation, rectification and analysis; flight report, recording of in-flight instrument, reading and reporting of flight defects and rectification of defects observed on aircraft.

UNIT IV C.A.R. SERIES "E" 10

C.A.R. Series E - approval of organizations:

Approval of organizations in categories A, B, C, D, E, F, & G; requirements of infrastructure at stations other than parent base.

UNIT V C.A.R. SERIES "F " 15

C.A.R. Series "F" airworthiness and continued airworthiness:
Procedure relating to registration of aircraft; procedure for issue / revalidation of type certification of aircraft and its engines / propellers; issue /revalidation and renewal of certificate of airworthiness; require for renewal of certificate of airworthiness. Suspensions of certificate of airworthiness and its subsequent revalidation; rebuilding of aircraft, continuous airworthiness maintenance programme; airworthiness of ageing aircraft; control system-duplicate inspection, Inspection of wooden aircraft; airworthiness requirements of gliders, requirements of manufacture , registration & airworthiness control of hot air balloons; approval of flight manuals and their amendments ; pooling of aircraft parts by national airlines of India with foreign airlines construction, certification and operation of experimental / amateur built aircraft; manufacture of aircraft and accessories and airworthiness certification thereof; age of aircraft to be imported for charter hire " air taxi and other operations", import/export of aircraft, item of equipment etc . For use on aircraft; load and trim sheet - requirements thereof.

TOTAL 45 hours

References

1. Aircraft manual (India) volume - latest edition, the English book store, 17-l, Connaught circus, New

Delhi.

2. Civil aviation requirements with latest amendment (section 2 airworthiness) - published by DGCA, the English book store, 17-l, Connaught circus, New Delhi.
3. Aeronautical information circulars (relating to airworthiness) from DGCA. Advisory circulars from DGCA.

Course Outcomes

1. Describe the Indian aircraft rules and the related publications.
2. Know the procedure for keeping the aircraft in airworthiness conditions.
3. Describe the use of MEL, and the procedure for releasing the a/c under MEL.
4. Describe the different types of maintenance programme.
5. Understand the procedure for getting the approvals of organizations in different categories

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19D13.1	3	1	1		3	-	-	2	-	-	-	-	2	2	-
AE19D13.2	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D13.3	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D13.4	2	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D13.5	1	2	2		1	-	-	2	-	2	-	2	1	1	-
Average	2.4	1,8	1.8	-	2.6	-	-	2	-	2	-	1.25	1.8	1.8	-

AE19D14 AERO ENGINE MAINTENANCE AND REPAIR

L	T	P	C
3	0	0	3

OBJECTIVES

- Apply maintenance procedure to piston engines
- Understand the propeller theory
- Identify the jet engine components and faults
- Apply non destructive testing procedures
- Apply overhauling procedure to engines
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UNIT I PISTON ENGINES 9

Engine operating conditions at various altitudes–Engine power measurements– Classification of engine lubricants and fuels – Induction, Exhaust and coolingsystem-Maintenanceandinspectionchecktobecarriedout-inspectionandmaintenanceandtroubleshooting-Inspection of all engine components-Daily and routine checks-Overhaul procedures-Compression testing of cylinders-Special inspection schedules.

UNIT II PROPELLERS 9

Propeller theory-operation, construction assembly and installation-Pitch change mechanism- Propeller axially system-Damage and repair criteria-General Inspection procedures-Checks on constant speed propellers - Pitch setting, Propeller Balancing, Blade cuffs, Governor/Propeller operating conditions–Damage and repair criteria.

UNIT III JET ENGINES 9

Types of jet engines – Fundamental principles – Inspection and Maintenance- permissible limits of damage and repair criteria of engine components- internal inspection of engines- compressor washing- field balancing of compressor fans- Component maintenance procedures - Systems maintenance procedures - use of

instruments for online maintenance - Special inspection procedures-Foreign Object Damage - Blade damage.

UNIT IV TESTING AND INSPECTION 9

Symptoms of failure - Fault diagnostics -Rectification during testing equipment for overhaul: Tools and equipments requirements for various checks and alignment during overhauling - Tools for inspection - Tools for safety and for visual inspection - Methods and instruments for non-destructive testing techniques -Engine testing: Engine testing procedures and schedule preparation - Online maintenance.

UNITV OVERHAULING 9

Engine Overhaul - Overhaul procedures - Inspections and cleaning of components - Repairs schedules for overhaul - Balancing of Gas turbine components. Trouble Shooting: Procedures for trouble shooting - Condition monitoring of the engine on ground and at altitude - engine health monitoring and corrective methods.

TOTAL: 45 PERIODS

TEXT BOOK

1. Kroes & Wild, “Aircraft Powerplants", McGraw Hill, New York, 7th Edition

REFERENCES

1. Irving E Treager , “Aircraft Gas Turbine Engine”, Technology” McGraw Hill, New York, 3rd Edition

After successful completion of the course students will demonstrate the following outcomes:

1.

AE19D14.1 Knowledge gaining sheet metal repair
AE19D14.2 Evaluate different methods plastic repair
AE19D14.3 Understand jacking and rigging procedure
AE19D14.4 Analysis of trouble shooting in aircraft
AE19D14.5 Understand safety procedures in aircraft

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19D14.1	3	1	1		3	-	-	2	-	-	-	-	2	2	-
AE19D14.2	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D14.3	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D14.4	2	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D14.5	1	2	2		1	-	-	2	-	2	-	2	1	1	-
Average	2.4	1,8	1.8	-	2.6	-	-	2	-	2	-	1.25	1.8	1.8	-

AE19D15	AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study ground handling and support equipment
- To understand aircraft logbooks and documentation
- To acquire knowledge of different agencies and documents
- To understand aircraft inspection
- To understand aircraft hardware materials

UNIT I AIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENTS 10

Mooring, jacking, leveling and towing operations – Preparation – Equipment – precautions – engine starting procedures – Piston engine, turboprops and turbojets – Ground power units.

UNIT II AIRCRAFT MATERIALS TESTING 7

Knowledge of various types of corrosion, its cause and protection- detailed knowledge of the hot oil and chalk, dye penetrant and fluorescent and magnetic particle techniques and the subsequent inspection of the parts, knowledge of the X-ray, ultrasonic and eddy current inspections.

UNIT III AIRCRAFT DOCUMENTATION 8

Roll of DGCA in Indian aviation-Categories of AME Licenses'-civil airworthiness requirements-various aircraft-logbooks- logbook maintenance and making entry-Advisory circulars-certificate of registration and certificate of airworthiness- modification, concession

UNIT IV INSPECTION 10

Process – Purpose – Types – Inspection intervals – Techniques – Checklist – Special inspection –Publications, bulletins, various manuals – FAR Air worthiness directives – Type certificate Data sheets– ATA Specifications

UNIT V AIRCRAFT HARDWARE, MATERIALS, SYSTEM PROCESSES 10

Precision instruments – special tools and equipment in an airplane maintenance shop– specification and correct use of various aircraft hardware (i.e., nuts, bolts, rivets) – threads, gears, bearings-Identification of all types of fluid line fittings, materials, metallic and non-metallic plumbing connectors – cables – swaging procedures, tests, advantages of swaging over splicing.

TOTAL: 45 PERIODS

TEXT BOOK

1. Airframe &Plant Mechanics," General Hand Book", Shroff publishers, 2007

REFERENCES

1. Kroes, Watkins and Delp, "Aircraft Maintenance and Repair", Tata McGraw Hill, 2010

OUTCOMES:

After successful completion of the course students will demonstrate the following outcomes:

AE19D15.1	Knowledge gaining on ground handling equipments and starting procedure of aircraft
AE19D15.2	Evaluate different methods of non-destructive test methods
AE19D15.3	Understand role of DGCA and its structure
AE19D15.4	Understand inspection procedures and documentation
AE19D15.5	Understand hardware and repair of swaging in aircraft maintenance

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19D15.1	3	1	1		3	-	-	2	-	-	-	-	2	2	-
AE19D15.2	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D15.3	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D15.4	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D15.5	1	2	2		1	-	-	2	-	2	-	2	1	1	-
Average	2.6	1,8	1.8	-	2.6	-	-	2	-	2	-	1.25	1.8	1.8	-

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
AE19D16	**DRONE SAFETY RULES AND REGULATIONS**	**PE**	**3**	**0**	**0**	**3**

Objectives: To make the students to understand the national and international drone safety rules and regulations

- To create awareness on drone safety rules and regulations in India
- To study the process of RPAS certifications
- To analyse the drone safety regulation and traffic management
- To study about the Drone rules in DGCA, India
- To understand the importance of international drone safety and regulations

UNIT-I REMOTELY PILOTED AIRCRAFT SYSTEM RULES 9

DGCA- Digital sky – DGCA RPAS- Acquisition of RPAS - Unique Identification Number - Unmanned Aircraft Operator Permit - RPAS Operation - Remote Pilot & Training - Manufacturing of RPAS - NPNT Specifications - Procedure for acceptance of RPAS model for Digital Sky - Authorisation procedures for operations of RPAS- SOP Approval Procedure for RPAS.

UNIT-II REMOTELY PILOTED AIRCRAFT SYSTEM CERTIFICATION 9

Certification criteria for RPAS – objective and scope- competence requirement – General – Performance – Powerplant – Structure- Material and Construction - Data Link - Digital Sky NPNT- instruments - Qualification Testing - Documentation

UNIT-III DGCA SAFTY REGULATION & TRAFFIC MANAGEMENT 9

Establishment of a Safety Management System – APPLICABILITY- ALoSP - SMS framework - safety policy and objectives - Safety Accountabilities and Responsibilities - Appointment of Key Safety Personnel - Coordination of Emergency Response Planning – Documentation- UAS TRAFFIC Management - UTM services - UTM participation - real-time identification and tracking - UTM data communication, security and privacy - integration of UTM - UTM deployment plan.

UNIT-IV DRONE RULES DGCA 9

Drone rules 2021- Possible Modes of Impact Damage on Failure- Limits - guidelines for flight testing - flight test schedule and checklist – stages -flight module compliance levels - certification process - requirements for certification bodies - resource requirements – process requirement – document requirements - rules for use of certification mark- provisional approval system for certification bodies

UNIT-V INTERNATIOAL DRONE REGULATIONS 9

Remote Identification of Unmanned Aircraft - Moored Balloons, Kites, Amateur Rockets, and Unmanned Free Balloons - Ultralight Vehicles - Parachute Operations- Small Unmanned Aircraft Systems.

Total Contact Hours:45

- **Course Outcomes:** Students will be able to
- understand the drone safety rules and regulations in India
- Familiarise the process of RPAS certifications
- Understand the drone safety regulation and traffic management
- study about the Drone rules in DGCA, India
- understand the importance of international drone safety and regulations

SUGGESTED ACTIVITIES

- Flipped classroom

SUGGESTED EVALUATION METHODS

- Quizzes
- Class Presentation/Discussion

Textbook(s):

1. "DGCA RPAS Guidance manual", DGCA, CAR Section 3 SERIES X, PART 1, 2020. & CAR Section 1 , Series C Part 1, 2017
2. DGCA "Drone rule 2021", Part II , Section 3, 2021
3. Code of federal regulation title 14 **chapter 1, su**bchapter F, part 89,91,101,103,105,107

Reference Books(s) / Web links:

- "Unmanned Aircraft Systems (UAS)", cir 328, AN/190International Civil Aviation Organization, Canada, 2021
- John Baichtal "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs" Que Publishing, second edition 2016

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19D16.1	3	1	1		3	-	-	2	-	-	-	-	2	2	-
AE19D16.2	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D16.3	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D16.4	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D16.5	1	2	2		1	-	-	2	-	2	-	2	1	1	-
Average	2.6	1,8	1.8	-	2.6	-	-	2	-	2	-	1.25	1.8	1.8	-

AE19D17	ENTREPRENEURSHIP DEVELOPMENT FOR ENGINEERS	L	T	P	C
		3	0	0	3

OBJECTIVE

- To develop and strengthen entrepreneurial quality and motivation in students.
- To impart basic entrepreneurial skills and understandings to run a business efficiently and effectively.

UNIT I ENTREPRENEURAL COMPETENCE 6

Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality -Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur.

UNIT II ENTREPRENEURAL ENVIRONMENT 12

Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organisational Services - Central and State Government Industrial Policies and Regulations - International Business.

UNIT III BUSINESS PLAN PREPARATION 12

Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product -Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

UNIT IV LAUNCHING OF SMALL BUSINESS 10

Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection -Growth Strategies - Product Launching – Incubation, Venture capital, IT start-ups.

UNIT V MANAGEMENT OF SMALL BUSINESS 5

Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business.

TOTAL: 45 PERIODS

TEXTBOOKS

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001.
2. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 2001.

REFERENCES

1. Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis,Biztrantra ,2nd Edition ,2005
2. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews,Tata McGraw-Hill, 1996.
3. P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai - 1997.Arya Kumar. Entrepreneurship. Pearson. 2012
4. Donald F Kuratko, T.V Rao. Entrepreneurship: A South Asian perspective. Cengage Learning.2012

OUTCOMES:

After successful completion of the course students will demonstrate the following outcomes:

AE19D17.1 Knowledge gaining on motivational theory
AE19D17.2 Understand small business and market survey
AE19D17.3 Understand project report and appraisal
AE19D17.4 Analysis finance and accounting
AE19D17.5 Understand business incubators

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19D17.1	3	1	1		3	-	-	2	-	-	-	-	2	2	-
AE19D17.2	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D17.3	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D17.4	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D17.5	3	2	2		1	-	-	2	-	2	-	2	1	1	-
Average	3	1,8	1.8	-	2.6	-	-	2	-	2	-	1.25	1.8	1.8	-

AE19D18 AIR TRAFFIC CONTROL AND PLANNING

L	T	P	C
3	0	0	3

OBJECTIVES

- To study the procedure of the formation of aerodrome and its design and air traffic control.

UNIT I BASIC CONCEPTS 9

Objectives of air traffic control systems - Parts of ATC services – Scope and Provision of ATCs – VFR& IFR operations – Classification of ATS air spaces – Various kinds of separation – Altimeter setting procedures – Establishment, designation and identification of units providing ATS – Division of responsibility of control.

UNIT II AIR TRAFFIC SYSTEMS 9

Area control service, assignment of cruising levels - minimum flight altitude - ATS routes and significant points – RNAV and RNP – Vertical, lateral and longitudinal separations based on time /distance –ATC clearances – Flight plans – position report. Automatic Dependent Surveillance Broadcast (ADS-B).

UNIT III FLIGHT INFORMATION SYSTEMS 10

Radar service, Basic radar terminology – Identification procedures using primary / secondary radar – performance checks – use of radar in area and approach control services – assurance control and coordination between radar / non radar control – emergencies – Flight information and advisory service – Alerting service – Co-ordination and emergency procedures – Rules of the air.

UNIT IV AERODROME DATA 9

Aerodrome data - Basic terminology – Aerodrome reference code – Aerodrome reference point –Aerodrome elevation – Aerodrome reference temperature – Instrument runway, physical Characteristics; length of primary / secondary runway – Width of runways – Minimum distance between parallel runways etc. – obstacles restriction.

UNIT V NAVIGATION AND OTHER SERVICES 8

Visual aids for navigation Wind direction indicator – Landing direction indicator – Location and characteristics of signal area – Markings, general requirements – Various markings – Lights, general requirements – Aerodrome beacon, identification beacon – Simple approach lighting system and various lighting systems – VASI & PAPI - Visual aids for denoting obstacles; object to be marked and lighter – Emergency and other services.

TOTAL : 45 PERIODS

TEXTBOOK

1. AIP (India) Vol. I & II, “The English Book Store”, 17-1, Connaught Circus, New Delhi.

After successful completion of the course students will demonstrate the following outcomes:

AE19D18.1 Understanding the Objective and requirement of air traffic control systems
AE19D18.2 Knowledge about types of air traffic control system.
AE19D18.3 Knowledge in flight information systems and rules of air traffic systems.
AE19D18.4 Knowledge about aerodrome related data's
AE19D18.5 Knowledge indirection indicator systems for air navigation.

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19D18.1	3	2	2	1	1	-	-	-	1	1	1	1	3	2	1
AE19D18.2	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19D18.3	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19D18.4	3	2	2	1	2	-	-	-	1	1	1	1	3	2	1
AE19D18.5	3	2	2	-	2	2	2	1	1	1	1	1	3	2	1
Average	3	2	2	1	1.8	2	2	1	1	1	1	1	3	2	1

		L	T	P	C
AE19D19	**TOTAL QUALITY MANAGEMENT FOR ENGINEERS**	**3**	**0**	**0**	**3**

OBJECTIVES

- To facilitate the understanding of Quality Management principles and process.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Costs of quality.

UNIT II TQM PRINCIPLES 9

Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal- Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUE I 9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process -FMEA - Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES II 9

Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing -QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors.

TOTAL: 45 PERIODS

TEXTBOOK

1. Dale H. Besterfiled, et at., "Total quality Management", Pearson Education Asia, Third Edition, Indian Reprint (2006).

REFERENCES

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition,
1. First Indian Edition, Cengage Learning, 2012.
2. Suganthi L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

After successful completion of the course students will demonstrate the following outcomes:

AE19D19.1 Knowledge gaining on basic concepts of TQM
AE19D19.2 Evaluate six sigma and bench marking
AE19D19.3 Understand motivation and Kaizen
AE19D19.4 Understand control chart and process capability
AE19D19.5 Understand ISO 9001-2008 quality system

CO	PO												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
AE19D19.1	2	1	1		3	-	-	2	-	-	-	-	2	2	-
AE19D19.2	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D19.3	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D19.4	3	2	2	-	3	-	-	-	-	-	-	1	2	2	-
AE19D19.5	1	2	2		1	-	-	2	-	2	-	2	1	1	-
Average	2.4	1,8	1.8	-	2.6	-	-	2	-	2	-	1.25	1.8	1.8	-

OPEN ELECTIVE - I

OAE1901	INTRODUCTION TO AERONAUTICAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To introduce history and classification of aircraft
- To understand properties of atmosphere
- To study basic aerodynamics
- To introduce basic concepts of aircraft structure
- To introduce piston and jet engines

UNIT I AIRCRAFT CONFIGURATIONS 8

History of Flight-Wright Brothers-Different types of flight vehicles, classification, components and functions of typical transport aircraft, Helicopter and UAV parts and functions,

UNIT II PROPERTIES OF ATMOSHPHERE 7

Physical properties and structure of the atmosphere, ISA, lapse rate –different layer of atmosphere-different types of altitudes-temperature, pressure and altitude relationships-calculations.

UNIT III BASICS OF AERODYNAMICS 12

Newton's law of motions applied to aeronautics - aerofoil and wing geometry, NACA series airfoils, generation of lift, Mach number and ranges, aerodynamic center, pressure coefs, aspect ratio, types of drag, induced drag, lift and drag curves, sweepback on wing, shock waves in supersonic flight-basics of Pitot tube.

UNIT IV AIRPLANE STRUCTURES AND MATERIALS 9

General types of construction, monocoque and semi-monocoque, typical wing and fuselage structure, metallic and non-metallic materials, use of aluminium alloy, titanium, stainless steel , plastics, composite materials and applications.

UNIT V POWER PLANTS 9

Basics about piston, turbojet, turboprop and turbofan - concept of propeller and jets for thrust production, principles of operation of rocket, types of rockets and typical applications, exploration into space- India

TOTAL: 45 PERIODS

OUTCOMES

- Identify the types and component of aircraft
- Understand properties of atmosphere
- Performs basic calculation on lift, drag and moment.
- Identifies suitable materials for aircraft structure
- Identifies types of jet and rocket engines

TEXT BOOKS

1. Anderson, J.D., "Introduction to Flight", Tata McGraw-Hill, 2010.

REFERENCES

1. Kermode, A.C., "Mechanics of Flight", Pearson Education; 11th edition.
2. Kermode, A.C., "Flight without Formula", Pearson Education; 5th edition .

OAE1902	FUNDAMENTALS OF JET PROPULSION	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the principles of operation of jet and rocket propulsion.
- Also to understand about the types, operation and performance of various parts of the gas turbine engines.

UNIT I FUNDAMENTALS OF GAS TURBINE ENGINES 8

Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust – Effect of pressure, velocity and temperature changes of air entering compressor – Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet – Performance characteristics.

UNIT II BASICS OF GAS TURBINE ENGINE COMPONENTS 9

Subsonic and supersonic inlets for gas turbine engines – inlet performance – axial flow and centrifugal flow compressors and their efficiencies & principle of operation – gas turbine combustion chambers & types – axial flow turbines and their performance – jet engine nozzles and their efficiency

UNIT III RAMJET PROPULSION 8

Operating principle of ramjet engine – various components of ramjet engines and their efficiencies – Combustion in ramjet engine – critical, subcritical and supercritical modes of operation -ramjet engine and its performance characteristics – sample ramjet design calculations – flame stability problems in ramjet combustors –integral ram rockets.

UNIT IV HYPERSONIC AIRBREATHING PROPULSION 9

Introduction to hypersonic air breathing propulsion, hypersonic vehicles and supersonic combustion- need for supersonic combustion for hypersonic propulsion – salient features of scramjet engine and its applications for hypersonic vehicles – problems associated with supersonic combustion – engine/airframe integration aspects of hypersonic vehicles

UNIT V ROCKET PROPULSION 10

Operating principle – specific impulse of a rocket – internal ballistics –solid propellant rockets – selection criteria of solid propellants –liquid propellant rockets – selection of liquid propellants – various feed systems for liquid rockets -thrust control in liquid rockets – cooling in liquid rockets and the associated heat transfer problems – advantages of liquid rockets over solid rockets - introduction to hybrid propulsion – advantages and limitations of hybrid propulsion -.Electrical propulsion – Arcjet, resistojet – MPD thrusters, nuclear propulsion.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Pearson education (2009).

REFERENCES

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. “Gas Turbine Theory”, Pearson Education Canada; 6th edition, 2008.
2. Oates, G.C., “Aero thermodynamics of Aircraft Engine Components”, AIAA Education Series, New York, 1985.
3. “Rolls Royce Jet Engine”, Rolls Royce; 4th revised edition, 986.
4. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 2nd edition,2014.

OAE1903	INTRODUCTION TO SPACE FLIGHT	L	T	P	C
		3	0	0	3

UNIT I HISTORY OF INTERNATIONAL SPACE FLIGHT **8**

Manned space flight – Mercury, Gemini, Apollo, Skylab, Apollo-Soyuz, Space shuttle, Soviet manned spaceflights and International manned space flight. Unmanned space flight – Earth observation, space environment, planetary exploration, space exploration, commercial satellites, military satellites.

UNIT II INDIAN SPACE RESEARCH ORGANIZATION **8**

Organisation structure, Test facilities, Launch facilities, tracking and control facilities, Launch vehicles – SLV, ASLV, PSLV, GSLV, GSLV III and future launch vehicles. Satellite programmes, human space flight programme. Chandrayaan, Mangalyaan

UNIT III SKY COORDINATES AND MOTIONS **8**

Sky coordinates and motions - Earth Rotation - Sky coordinates - seasons - phases of the Moon - the Moon's orbit and eclipses - timekeeping (side real vs synodic period)

UNIT IV ORBITAL PRINCIPLES **12**

Kepler’s laws, Newton's laws - angular momentum, total energy, orbital velocities, orbital properties – field of view, ground track, maximum time in view, number of revolutions per day, and revisit time. Useful orbits – low earth orbits, polar orbits, geostationary orbits, sun-synchronous orbit. Orbit establishment, orbital maneuvers – simple impulse maneuver, Hoffmann transfer, simple plane changes

UNIT V SATELLITE DESIGN **9**

Mission, payload, launch vehicle and site selection, subsystems - attitude reference and control, power, thermal, orbital maintenance, data handling, TT&C, onboard computer, structure. Ground support systems.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Bruce A. Campbell and Samuel Walter McCandless, Jr., Introduction to Space Sciences and Spacecraft Applications, Gulf Professional Publishing (1996)

REFERENCES

1. 2. Brown, C. D., Spacecraft Mission Design , 2nd ed., AIAA Edu. Series (1998).

2. Escobal, P. R., Methods of Orbit Determination, 2nd ed., Krieger Pub. Co. (1976).

3. Web link: https://www.isro.gov.in/

OAE1904	INDUSTRIAL AERODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To familiarize the learner with non-aeronautical uses of aerodynamics such as road vehicle, building aerodynamics and problems of flow induced vibrations.

UNIT I ATMOSPHERE 9

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows

UNIT II WIND ENERGY COLLECTORS 9

Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory

UNIT III VEHICLE AERODYNAMICS 9

Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of racing car, trains and Hovercraft

UNIT IV BUILDING AERODYNAMICS 9

Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, building codes, Building ventilation and architectural aerodynamics

UNIT V FLOW INDUCED VIBRATIONS 9

Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.

TOTAL: 45 PERIODS

OUTCOMES

- Use of aerodynamics for non- aerodynamics such as vehicle, building.
- Solve the problems and able to analyse vibrations during flow

TEXT BOOKS

1. M.Sovran (Ed), “Aerodynamics and drag mechanisms of bluff bodies and Road vehicles”, Plenum press, New York, 1978.
2. Sachs. P., “Winds forces in Engineering”, Pergamum Press, 1978.

REFERENCES

1. Blevins. R.D., “Flow Induced Vibrations”, Van Nostrand, 1990.
2. Calvent. N.G., “Wind Power Principles”, Charles Griffin & Co., London, 1979.