NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

(Deemed to be University Under Section 3 of the UGC Act, 1956)
Kumaracoil, Thuckalay

DEPARTMENT OF AEROSPACE ENGINEERING

B.E. AEROSPACE ENGINEERING

CURRICULUM AND SYLLABI

REGULATION 2021

NOORUL ISLAM CENTRE FOR HIGHER EDUCATION, Kumaracoil
Regulation: 2021

Curriculum and Syllabi

DEPARTMENT OF AEROSPACE ENGINEERING

B.E. AEROSPACE ENGINEERING

Vision of the University

To be recognized by the Government and society at large as an institution able to deliver excellence with relevance in the field of higher education and research focusing on the needs of the nation in tune with the technological revolution to cope with the knowledge explosion and global competence.

Mission of the University

To develop the institution as a Centre of Excellence, keeping pace with the advances in the field, so as to provide quality higher education to the students and instill in them high standards of discipline and ethics so that they become enlightened individuals in the service of humanity and to carry out focused research in the frontier areas of science and technology.

Vision of Department:

Impart quality education to create world class technocrats and entrepreneurs with new ideas and innovations to meet industry expectations through advanced research.

Mission of Department:

To Develop and deliver Quality academic programmes in Emerging and innovative field of Engineering to empower the students to meet Industry Standards. To build student community with high ethical standards to undertake R&D in thrust areas of national and international needs. To create Centre of Excellence by establishing the incubation centers to meet global research challenges.

Programme Educational Objectives - PEO	
PEO-01	To strengthen the fundamental knowledge and practical skills of the aerospace Students for meeting the requirements industries and educational institutions.
PEO-02	To give quality and facilitate the students with latest technology in the industries of aerospace and to bring a problem-solving technique.

PEO-03	To provide student a exposure to the aerospace to learn the new and modern technology and make the students fit for industry.
PEO-04	To make the students fit for the social needs and provide them a good exposure to working environment for ethical Aerospace engineers.
PEO-05	To mould graduates for good team work and to make them to face the challenging work environment to build up the leadership skills of the future engineers.

	Graduate Attributes
GA -1	**Innovative Engineering Solutions:** Develop creative and innovative solutions to complex engineering problems, incorporating the latest technologies and approaches to address current and future challenges.
GA-2	**Global Perspective in Engineering:** Understand and apply engineering solutions in a global context, recognizing the diversity of global issues, standards, and the impact of engineering decisions on different cultures and
GA-3	**Sustainable Development and Green Engineering:** Design and implement engineering solutions that prioritize sustainability, resource efficiency, and environmental protection, contributing to a sustainable future.
GA-4	**Social Responsibility and Community Engagement:** Demonstrate a commitment to social responsibility by engaging with and contributing to local communities, understanding societal needs, and addressing social challenges through engineering practices
GA-5	**Adaptability and Lifelong Learning:** Exhibit a proactive approach to continuous learning and adaptability, keeping pace with technological advancements and industry changes, and engaging in professional development activities
GA-6	**Entrepreneurship and Innovation:** Foster an entrepreneurial mindset, identifying opportunities for innovation and creating value through new technologies, products, and processes that meet market needs.
GA-7	**Interdisciplinary Collaboration:** Work effectively in interdisciplinary teams, integrating knowledge from various fields to develop comprehensive solutions to complex engineering problems.
GA-8	**Ethical Leadership and Integrity:** Lead with integrity and ethical principles, ensuring transparency, fairness, and respect in all professional and personal interactions

GA-9	**Digital and Data Literacy:** Utilize advanced digital tools and data analytics techniques to solve engineering problems, optimize processes, and make informed decisions based on data-driven insights.
GA-10	**Safety, Health, and Risk Management:** Prioritize safety, health, and risk management in engineering practices, ensuring the well-being of individuals and communities while minimizing potential risks and hazards.
GA-11	**Effective Communication and Negotiation Skills:** Communicate ideas, solutions, and technical information effectively to a variety of audiences, and engage in negotiation to resolve conflicts and reach consensus.
GA-12	**Impact Assessment and Policy Making:** Assess the impact of engineering projects on society and the environment, and contribute to policy-making processes that promote sustainable and responsible engineering practices.

Programme Outcome - PO	
PO-A	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO-B	**Problem Analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO-C	**Design/development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet t h e specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
P0-D	**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.
PO-E	**Modern Tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO-F	**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.
PO-G	**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.
PO-H	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO-I	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.

PO-J	**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.
PO-K	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO-L	**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.

Mapping of Graduate Attributes and Program Educational Objectives (PEO)

GAs / PEOs	G A-01	GA-02	GA-03	GA-04	GA-05	GA-06	GA-07	GA-08	GA-09	GA-10	GA-11	GA-12
PEO-01	H	A	A	Not	A	Not	A	Not	A	Not	A	A
PEO-02	A	A	Not	H	A	A	Not	Not	Not	Not	A	A
PEO-03	Not	Not	Not	Not	Not	H	A	A	Not	Not	H	A
PE0-04	Not	Not	A	H	Not	A	Not	Not	Not	H	Not	A
PEO-05	Not	A	Not	A	Not	A	Not	H	Not	Not	Not	Not

H-Highly Associated A-Associated Not – Not Associated

Mapping of Graduate Attributes and Program Outcomes (PO)

GAs / PEOs	GA-01	GA-02	GA-03	GA-04	GA-05	GA-06	GA-07	GA-08	GA-09	GA-10	GA-11	GA-12
PO-A	Not	A	Not	A	Not	Not	Not	Not	Not	Not	Not	Not
PO-B	H	A	Not	Not	A	Not	H	Not	H	Not	Not	Not
PO-C	A	H	A	Not	Not	Not	Not	Not	A	Not	Not	Not
P0-D	H	A	A	Not	Not	Not	A	Not	H	Not	Not	A
PO-E	H	A	A	Not	Not	Not	A	Not	A	Not	Not	Not
PO-F	A	A	A	Not	Not	Not	A	Not	H	A	A	A
PO-G	Not	Not	Not	H	Not	A	Not	A	Not	Not	H	Not
PO-H	Not	A	A	H	Not	A	Not	A	Not	A	A	A
PO-I	Not	A	A	H	Not	A	Not	A	Not	A	A	A
PO-J	Not	A	A	H	Not	A	Not	H	Not	H	A	A
PO-K	Not	A	A	H	Not	A	Not	A	Not	A	A	A
PO-L	Not	A	A	H	Not	A	Not	H	Not	H	A	A

H-Highly Associated A-Associated Not – Not Associated

Mapping of Programme Educational Objective (PEOs) and Programme Outcomes (POs)

PEO / PO	PEO-01	PEO-02	PEO-03	PEO-04	PEO-05
PO-A	A	A	Not	Not	Not
PO-B	A	A	Not	Not	Not
PO-C	H	A	Not	Not	Not
P0-D	A	A	Not	Not	Not
PO-E	A	A	Not	A	Not
PO-F	A	A	Not	Not	Not
PO-G	A	Not	H	A	H
PO-H	Not	Not	A	A	A
PO-I	Not	Not	Not	A	Not
PO-J	Not	Not	Not	H	Not
PO-K	A	Not	H	A	H
PO-L	Not	Not	A	A	A

H-Highly Associated A-Associated Not – Not Associated

Total Credits: 163

SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	EG3101	Technical English	3	1	0	4
2.	MA3101	Engineering Mathematics – I	3	1	0	4
3.	BS3101	Engineering Physics	3	0	0	3
4.	BS3102	Engineering Chemistry	3	0	0	3
5.	CS3101	Fundamentals of Computing and Python Programming	3	0	0	3
PRACTICALS						
6.	CS3171	Fundamentals of Computing and Python Programming Laboratory	0	0	4	2
7.	BS3171	Physics and Chemistry Laboratory	0	0	4	2
TOTAL			**15**	**2**	**8**	**21**

SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	EG3102	Communicative English	3	0	0	3
2.	MA3102	Engineering Mathematics – II	3	1	0	4
3.	BE3101	Basic Electrical and Electronics Engineering	3	0	0	3
4.	ME3201	Engineering Mechanics	3	0	0	3
5.	AS3101	Basic Aerospace Engineering	3	0	0	3
6.	ME3101	Engineering Graphics	3	0	2	4
PRACTICALS						
7.	BE3171	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1
8.	BE3173	Manufacturing Practices Laboratory	0	0	2	1
9.	AS3171	Basic Aerospace Engineering Lab	0	0	2	1
TOTAL			**18**	**1**	**8**	**23**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA3201	Engineering Mathematics - III	3	1	0	4
2.	AS3201	Aero Thermodynamics	3	0	0	3
3.	AS3202	Flight Systems and Instrumentation	3	0	0	3
4.	AS3203	Structural Mechanics	3	0	0	3
5.	ME3202	Engineering Materials and Metallurgy	3	0	0	3
6.	ME3204	Fluid Mechanics and Machinery	3	0	0	3
PRACTICAL						
7.	AS3271	Structural Mechanics Lab	0	0	2	1
8.	AS3272	Thermal and Heat transfer Laboratory	0	0	2	1
9.	ME3272	Fluid Mechanics and Machinery Laboratory	0	0	2	1
TOTAL			**18**	**1**	**6**	**22**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	BS3201	Environmental Science	2	0	0	2
2.	MA3203	Numerical Methods	3	1	0	4
3.	AS3204	Aerodynamics I	3	0	0	3
4.	AS3205	Aerospace Structures	3	0	0	3
5.	AS3206	Wind Tunnel Testing	3	0	0	3
6.	AE3208	Mechanics of Machines	3	0	0	3
PRACTICAL						
7.	AS3273	Aerospace Structures Lab	0	0	2	1
8.	AS3274	Flight Systems Laboratory	0	0	2	1
9.	AS3275	Low Speed Wind Tunnel Testing Laboratory	0	0	2	1
10.	AS32P1	Summer Internship-I	0	0	0	2
TOTAL			**17**	**1**	**6**	**23**

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MS3201	Professional and Business Ethics	3	0	0	3
2.	AS3209	Aerospace Production Techniques	3	0	0	3
3.	AS3210	Aerodynamics II	3	0	0	3
4.	AS3211	Aerospace Propulsion I	3	0	0	3
5.	AS3212	Aircraft Performance, Stability and control	3	0	0	3
6.	AS32A1	UAV Design (Department Elective-I)	3	0	0	3
PRACTICAL						
7.	AS3276	CAD modeling and analysis	0	0	3	1
8.	AS3277	Aerospace Design Project I	0	0	3	1
TOTAL			**18**	**0**	**6**	**20**

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	AS3213	Finite Element Analysis	3	0	0	3
2.	AS3214	Aerospace propulsion II	3	0	0	3
3.	AS32A5	Avionics (Department Elective-II)	3	0	0	3
4.	AS32A6	Cryogenics (Department Elective-III)	3	0	0	3
5.	AI32D1	Fundamentals of Artificial Intelligence (Open Elective I)	3	0	0	3
PRACTICAL						
6.	AS3278	Aerospace Propulsion Laboratory	0	0	3	1
7.	AS3279	Aerospace Design Project II	0	0	3	1
8.	AS3280	Navigation and Guidance Laboratory	0	0	3	1
9.	AS32P2	Summer Internship II	0	0	0	2
TOTAL			**15**	**0**	**9**	**20**

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	AS3215	Computational Fluid Dynamic Techniques	3	0	0	3
2.	AS32B9	Space Propulsion Systems (Department Elective-IV)	3	0	0	3
3.	AS32C5	Rockets and missiles (Department Elective-V)	3	0	0	3
4.	MS3202	Principles of Management	2	0	0	2
5.	IT32D2	Fundamentals of Data Science (Open Elective-II)	3	0	0	3
PRACTICAL						
6.	AS3281	Aerospace Computational Laboratory	0	0	2	1
7.	AS3282	Composite Materials Laboratory	0	0	2	1
8.	AS32P3	Mini Project	0	0	6	3
TOTAL			**14**	**0**	**10**	**19**

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	AS32**	Department Elective-VI	3	0	0	3
2.	AS32**	Department Elective-VII	3	0	0	3
PRACTICAL						
3.	AS32P5	Project Work Phase –II	0	0	20	10
TOTAL			**6**	**0**	**20**	**16**

PCC – Department Core Paper
PEC – Department Elective Paper
OEC- Open Elective paper

SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	EG3101	Technical English	3	1	0	4
2.	MA3101	Engineering Mathematics – I	3	1	0	4
3.	BS3101	Engineering Physics	3	0	0	3
4.	BS3102	Engineering Chemistry	3	0	0	3
5.	CS3101	Fundamentals of Computing and Python Programming	3	0	0	3
PRACTICAL						
7.	CS3171	Fundamentals of Computing and Python Programming Laboratory	0	0	4	2
8.	BS3171	Physics and Chemistry Laboratory	0	0	4	2
TOTAL			**15**	**2**	**8**	**21**

EG3101	Technical English	L	T	P	C
		3	1	0	4

OBJECTIVES

Upon completing Technical English, students will communicate technical information effectively through clear writing and presentations, applying standard conventions, vocabulary, and visual aids to produce readable reports and documentation for various audiences.

Course Outcome		Cognitive Skill
CO-01	To develop the linguistic, communicative and critical thinking competencies of First Year Engineering students	A
CO-02	To enhance the understanding of the complex grammatical structures of the English language to students	U

CO-03	To improve the language proficiency of students in English with emphasis on Vocabulary, Grammar, Listening, Speaking, Reading, and Writing skills	A
CO-04	To introduce the students to the basic phonetics of English and make them grasp the various sounds of the English language to improve their pronunciation	U
CO-05	Edit documents to achieve 99% error-free grammar and punctuation.	

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	M	S	M	S	S	S	S	M	S	S	M
CO-02	S	M	M	M	S	S	M	S	M	M	M	M
CO-03	S	M	M	M	S	S	M	M	M	S	S	M
CO-04	S	M	S	M	S	M	S	S	M	S	S	M
CO-05	S	M	S	M	S	M	S	S	M	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: **9**

Word formation with prefixes and suffixes -Articles – Conjunctions – Prepositions - Expansion of Abbreviations and Acronyms - Writing Checklists -Writing Instructions.

Unit II: **9**

Tense -Voice –Punctuation Expansion of Compound Nouns –Writing Recommendations – Paragraph Writing –Types, Structures and Features of a Paragraph –Creating Coherence -– Organizing Principles of Paragraphs in Documents.

Unit III: **9**

Discourse Markers **–** Gerunds and Present Participles – Relative Pronouns – Conditional Clauses – Definitions of Technical Terms –Transcoding: Bar Chart – Flow Chart – Pie Chart –Tree Diagram – Tabular Column.

Unit IV: **9**

Concord – Clauses – Phrases – Numerical Adjectives – CV/Resume Writing – Virtual Communication**:** E-Mail Writing – Essay Writing : Basic Format of an Essay – Types – Examples.

Unit V: **9**

Basic Phonetics**:** Phonemes – Vowels, Diphthongs and Consonants – Classification**:** Pure Vowels/Monophthongs – Vowel Glides /Diphthongs.

L: 45 + T: 15, TOTAL: 60 HOURS

TEXT BOOKS

Shiv Khera, *You Can Win*, Milan, Delhi, 2004

NOTE:

The book given under Extensive Reading is meant for inculcating the reading habit of the students. They need not be used for testing purposes.

MA3101	ENGINEERING MATHEMATICS - I	L	T	P	C
		3	1	0	4

OBJECTIVES

The course objective is to develop the required skill of the students in the area of Engineering Mathematics with special emphasis on the characteristic equation of matrices, differential calculus, Beta and Gamma functions and to develop basic knowledge to the students in double and triple integration.

Course Outcome		Cognitive Skill
CO-01	Understand the characteristic equation and find eigen values and Eigen vector of a real matrix. Compute the eigen value and eigen vector using properties. Verify Cayley Hamilton theorem and its applications. Apply orthogonal transformation of a symmetric matrix.	U, A ,E. R
CO-02	Define the definitions and formula for curvature, radius of curvature, circle of curvature. Apply the formula and solve problems using the required formulas also find the evolute of the curves.	U, A ,E, An
CO-03	Know about the differentiation formulae and apply on partial derivatives, total derivatives and Jacobians. Verify the functions be maximum or minimum and Lagrange's multiplier method. Express the Taylor's expansion for two variables.	U, A ,E. R
CO-04	Know the Fundamental concepts of improper integrals, Beta and gamma function and their properties. Develop the skill in the relation between Beta and Gamma Functions. Calculate definite integral values using Beta and Gamma Functions.	U, A , An,E
CO-05	Evaluate the double and multiple integrals and can apply these concepts to find areas of regions on a plane or in space. Graph Cartesian and polar equations. Convert Cartesian coordinates into polar coordinates.	U, A , An,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	M	S	M	S	S	S	S	M	S	S	M
CO-02	S	M	M	M	S	S	M	S	M	M	M	M
CO-03	S	M	M	M	S	S	M	M	M	S	S	M
CO-04	S	M	S	M	S	M	S	S	M	S	S	M
CO-05	S	M	S	M	S	M	S	S	M	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: MATRICES **9**

Characteristic equation - Eigen values and Eigen vectors of a real matrix - Properties of eigen values and eigen vectors(without proof)- Cayley Hamilton theorem (statement only), verification and its applications - Orthogonal and Symmetric matrices and their properties(excluding proof)- Orthogonal transformation of a symmetric matrix to diagonal form.

Unit II: DIFFERENTIAL CALCULUS **9**

Curvature - Cartesian co-ordinates and parametric form -Centre and radius of cur- vature, Circle of curvature - Evolutes.

Unit III: FUNCTIONS OF SEVERAL VARIABLES **9**

Partial derivatives - Total derivatives - Jacobians - Properties - Maxima and minima for functions of two variables - Lagrange Multiplier method- Taylor's expansion.

Unit IV: IMPROPER INTEGRALS **9**

Evaluation of improper integrals- Beta and Gamma functions - Properties - Relation between Beta and Gamma functions - Evaluation of integrals using Beta and Gamma functions.

Unit V: MULTIPLE INTEGRALS **9**

Evaluation of double and triple integrals - Area enclosed by plane curves as double integral in cartesian and polar co-ordinates - Change of order of integration- Transformation of Cartesian coordinates into polar coordinates.

L: 45 + T: 15, TOTAL: 60 HOURS

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics"- 40th Edition , Khanna Pub- lishers, Delhi 2007

REFERENCES:

1. M.Immaculate Mary , K.Uma Samundesvari," Engineering Mathematics - I" Revised Edition, R.K Publishers, 2016.
2. Veerarajan T, " Engineering Mathematics (for first year)", Fourth Edition, Tata McGraw- Hill Publishing Company Ltd.,New Delhi , 2007.

3. Erwin Kreyszig,"Advanced Engineering Mathematics", Seventh Edition, Wi- ley India, 2007.
4. P.Kandasamy , K.Thilagavathy , K.Gunavathy" Engineering Mathematics" Vol,1 ,S.Chand & Company Ltd.2002.
5. B.V. Ramana,"Higher Engineering Mathematics" Second Edition Tata McGraw- Hill, Publishing Company Ltd.,New Delhi, 2006 .

BS3101	ENGINEERING PHYSICS	L	T	P	C
		3	1	0	4

OBJECTIVES

The course objective is to provide basic ideas about the principles of physics related to properties of matter, wave optics, heat, quantum concepts and materials. engineering problems.

Course Outcome		Cognitive Skill
CO-01	Students will be able to understand and apply knowledge about the properties of materials.	R,U,A
CO-02	Students will be able to understand the types of oscillations and the wave nature of light in interference, diffraction and polarization phenomenon.	R,U,A,E
CO-03	Students will be able to state and explain the various laws of thermodynamics, understand entropy and its application.	R,U,A,An, ,E
CO-04	Students gain basic knowledge about quantum mechanics and will be able to solve time dependent and time independent Schrodinger equation for simple potentials.	R,U,A,E,S
CO-05	Students will be able to know the different types of crystal structures and also gain basic knowledge about nanomaterials and biomaterials.	R,U,A,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	M	S	M	S	S	S	S	M	S	S	M
CO-02	S	M	M	M	S	S	M	S	M	M	M	M
CO-03	S	M	M	M	S	S	M	M	M	S	S	M

CO-04	S	M	S	M	S	M	S	S	M	S	S	M
CO-05	S	M	S	M	S	M	S	S	M	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Properties of Matter **9**

Elasticity – Poisson's ratio – Stress-strain diagram – factors affecting elasticity – bending of beams – cantilever depression – Young's Modulus- theory and experiment of Young's modulus determination (uniform and non-uniform bending) –Shear Modulus – twisting couple – hollow cylinder – torsion pendulum – determination of rigidity modulus - Bulk Modulus - applications of elastic behaviours of materials.

Unit II: Oscillations and Wave optics **9**

Oscillations - Rectilinear motion - Oscillations or Vibrations - Simple Harmonic Motion - Damped Harmonic motion - Real oscillatory system - Forced or Driven oscillation.Wave optics - Interference of light – Photons - Young's Double Slit Experiment - Huygens's Principle - Diffraction - Diffraction Grating - Polarization.

Unit III: Thermal Physics **9**

Transfer of heat energy (conduction, convection and radiation) - thermal expansion of solids and liquids – expansion joints – bimetallic strips-Thermal conductivity- Forbe's and Lee's disc methods (theory and experiment)- thermal insulation in buildings -Laws of thermodynamics- heat exchanger -solar power- applications of solar power (solar water heater, photo voltaic cell).

Unit IV: Quantum Physics **9**

Matter waves- de-Broglie wavelength - Schrodinger's wave equation-time independent and time dependent equations- physical significance of wave function- uncertainty principle and its application- energy and momentum operators-particle in a one dimensional box- scanning electron microscope- transmission electron microscope-scanning tunnelling microscope.

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Unit V: Material Physics **9**

Single crystalline, polycrystalline and amorphous materials- Single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, miller indices – inter planar distances. Introduction and applications of Metallic glasses, Shape Memory Alloys (SMA), Nanomaterials, Biomaterials.

L: 45 + T: 15, TOTAL: 60 HOURS

TEXT BOOKS:

1. Engineering Physics I by Bindhu B, Sagi Rani C, Meenadevi V N, Ganapathi Raman R, RK Publishers 2015.
2. Engineering Physics II by Bindhu B, GeethaKumari R, SugirthaSuni N Y, RK Publishers 2016.
3. Engineering Physics by R K Gaur And S L Gupta, Dhanpat Rai Publications 2011.
4. A Text Book Oscillations, Waves & Acoustics by Dr. M. Gosh, Dr. D. Battacharya, S. Chand, Revised Edition.

REFERENCES:

1. Engineering Physics by Rajendran V, McGraw-Hill, New Delhi, 2013
2. Engineering Physics by Arumugam M, Anuradha Publications, 2014.
3. Principles of Physics by Halliday D, Resnick R and Walker J, Wiley 2015.

4. Physics for scientist and Engineers by Serway R A and Jewett J W, Cengage Learning 2010.
5. Engineering Physics by Bhattacharya D K and Poonam T, Oxford University Press 2015.
6. Engineering Physics by Pandey B K and Chaturvedi,Cengage Learning India 201

BS3102	ENGINEERING CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES

To make the students conversant with the principles of the following topics:(i) Use of free energy in chemical equilibria (ii) Water chemistry (iii) Periodic properties (iv) Spectroscopic techniques and applications and (v) Organic reactions and synthesis of a drug molecule.

Course Outcome		Cognitive Skill
CO-01	Investigate advanced materials and nanotechnology.	R,U,A
CO-02	Evaluate environmental and sustainability aspects of chemical processes.	R,U,A,E
CO-03	Apply computational tools for chemical modeling and simulation.	R,U,A,An, ,E
CO-04	Collaborate in multidisciplinary teams to solve engineering chemistry problems.	R,U,A,E,S
CO-05	Develop programming skills in chemical engineering software.	R,U,A,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	M	S	M	S	S	S	S	M	S	S	M
CO-02	S	M	M	M	S	S	M	S	M	M	M	M
CO-03	S	M	M	M	S	S	M	M	M	S	S	M
CO-04	S	M	S	M	S	M	S	S	M	S	S	M
CO-05	S	M	S	M	S	M	S	S	M	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: USE OF FREE ENERGY IN CHEMICAL EQUILIBRIA 9

Thermodynamic functions: energy, entropy and free energy –Estimations of entropy and free energies – Free energy and emf – Cell potentials, the Nernst equation and applications – Acid base, oxidation reduction and solubility equilibria – Corrosion –Use of free energy considerations in metallurgy through Ellingham diagrams.

Unit II: WATER CHEMISTRY 9

Water as a universal solvent – hard and soft water – reasons for hardness – disadvantages of hard water in washing and industrial purposes - estimation of hardness by EDTA method, problems; boiler feed water – characteristics- softening methods - external conditioning – demineralization (ion exchange) process, desalination by reverse osmosis method- internal conditioning (phosphate, calgon and carbonate conditioning methods); stages in domestic water treatment – disinfection by chlorination, ozone and UV treatments.

Unit III: PERIODIC PROPERTIES 9

Effective nuclear charge – penetration of orbitals – variations of s, p, d and f orbital energies of atoms in the periodic table – electronic configurations – atomic and ionic sizes – ionization energies – electron affinity and electronegativity – polarizability – oxidation states – coordination numbers and geometries – hard soft acids and bases – molecular geometries.

Unit IV: SPECTROSCOPIC TECHNIQUES AND APPLICATIONS 9

Principles of spectroscopy and selection rules – Electronic spectroscopy – Fluorescence and its applications in medicine –Vibrational and rotational spectroscopy of diatomic molecules – Applications –Nuclear magnetic resonance and magnetic resonance imaging –surface characterization techniques – Diffraction and scattering.

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Unit V: ORGANIC REACTIONS AND SYNTHESIS OF A DRUG MOLECULE 9

Introduction to reactions involving substitution, addition, elimination – oxidation, reduction, cyclization and ring openings – Synthesis of a commonly used drug molecule.

TOTAL: 45 HOURS

Suggested Text Books

1. University chemistry, by B. H. Mahan
2. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
3. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
4. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
5. Physical Chemistry, by P. W. Atkins
6. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition.

CS3101	FUNDAMENTALS OF COMPUTING AND PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To know the basics of algorithmic problem solving
- To read and write simple Python programs.

- To develop Python programs with conditionals and loops.
- To define Python functions and callthem.
- To use Python data structures –- lists, tuples, dictionaries.
- To do input/output with files in Python.

Course Outcome		Cognitive Skill
CO-01	Investigate advanced Python topics (e.g., decorators, generators).	R,U,A
CO-02	Evaluate web development frameworks (e.g., Flask, Django).	R,U,A,E
CO-03	Apply machine learning concepts using Python libraries (e.g., scikit-learn, TensorFlow).	R,U,A,An, ,E
CO-04	Collaborate in multidisciplinary teams to solve computing problems.	R,U,A,E,S
CO-05	Develop programming skills in other languages (e.g., Java, C++).	R,U,A,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	M	S	M	S	S	S	S	M	S	S	M
CO-02	S	M	M	M	S	S	M	S	M	M	M	M
CO-03	S	M	M	M	S	S	M	M	M	S	S	M
CO-04	S	M	S	M	S	M	S	S	M	S	S	M
CO-05	S	M	S	M	S	M	S	S	M	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: ALGORITHMIC PROBLEM SOLVING 9

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

Unit II: DATA, EXPRESSIONS, STATEMENTS **9**

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

Unit III: CONTROLFLOW, FUNCTIONS **9**

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

Unit IV: LISTS, TUPLES, DICTIONARIES **9**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tupleasre turn value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

Unit V: FILES, MODULES, PACKAGES **9**

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

TOTAL: 45 HOURS

TEXT BOOKS:

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist‘‘, 2nd edition, Updated for Python 3, Shroff /O‘Reilly Publishers, 2016
2. (http://greenteapress.com/wp/thinkpython/)
3. Guido van Rossum and Fred L. Drake Jr, ―An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd.,2011.

REFERENCES:

1. John V Guttag, ―Introduction to Computation and Programming Using Python‘‘, Revisedand Revised and expanded Edition, MIT Press ,2013
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, ―Introduction to Programming in Python: 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. KennethA.Lambert,―FundamentalsofPython:FirstPrograms‖,CENGAGELearning,2012. Charles Dierbach, ―Introduction to Computer Science using Python: A Computational Problem Solving Focus, Wiley India Edition,2013.
5. Paul Gries, Jennifer Campbell and Jason Montojo, ―Practical Programming: An Introduction to Computer Science using Python 3‖, Second edition, Pragmatic Programmers, LLC,2013.

BS3171	PHYSICS & CHEMISTRY LABORATORY	L	T	P	C
		0	0	4	2

Objective:

The course objective is to teach students, the importance of physics through involvement in experiments and to have knowledge of the world due to constant interplay between observations and hypothesis.

Subject Code: **BS3171** Subject Name: **PHYSICS & CHEMISTRY LABORATORY**		
Course Outcome – Cos		**Cognitive Skill**
CO-01	The students will be able to analyse the physical principle involved in various instruments and also relate the principle to new applications.	R,U,A,An, E
CO-02	Various experiments in the areas of optics, properties of matter and ultrasonics will nurture the students in all branches of engineering.	R ,U,A, An,E
CO-03	The students will be able to think innovatively and also improve the creative skills that are essential for engineering.	R,U,A,An, E
CO-04	The students will be able to gain knowledge of new concept in the solution of practical oriented problems and theoretical problems.	R,U,A,An, E
CO-05	The students will be able to understand measurement technology ,usage of new instruments and real time applications in engineering studies.	R,U,A,An, E

R- Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S- Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	S	S	S	S	S	S	S	S	M	S	S	M
CO-02	S	S	S	M	S	S	M	S	M	M	M	M
CO-03	S	S	S	S	S	S	M	M	M	S	S	M
CO-04	S	M	S	S	S	M	S	S	M	S	S	M
CO-05	S	S	M	M	S	M	S	S	M	S	S	M

S- Strong, M- Medium, L-Low, N- Not Relevant

List of experiments: Physics Laboratory (Any Five Experiments)

1. Determination of velocity of ultrasonic waves and compressibility of the given liquid by Ultrasonic interferometer.(Real and Virtual Lab)
2. Determination of rigidity modulus by Torsional pendulum. (Real and Virtual Lab)
3. Determination of coefficient of viscosity by Poiseulli'smethod.
4. Determination of Youngs modulus by non-uniform bending method.(Real and Virtual Lab)
5. Determination of LASER parameters using LASER diode. (Real and Virtual Lab)
6. Determination of band gap of the semi-conductor.(Real and Virtual Lab)
7. Determination of wavelength of mercury spectrum by diffraction grating.(Real and virtual lab)
8. Determination of wavelength of light by Newton's rings.(Real and Virtual Lab)
9. Determination of angle of the prism using spectrometer. (Real and Virtual Lab)

CHEMISTRY LAB
(Any FIVE experiments)

OBJECTIVE:

The objective of the course is to develop the interest among the students regarding chemistry and their applications in engineering.

Course Outcomes

The student at the end of the course will

CO1 learn and apply basic techniques used in chemistry laboratory for small/large scale water analyses/purification.

CO2 be able estimate the ions/metal ions present in domestic/industry waste water.

CO3 utilize the fundamental laboratory techniques for analyses such as titrations, separation/purification and spectroscopy.

CO4 able to analyze and gain experimental skill.

CO5 Suggest improvements to experimental design and procedures to increase precision by 10%.

List of Experiments

1. Determination of conductance of solutions
2. Potentiometry - determination of redox potentials and emfs
3. Synthesis of drug
4. Determination of Chloride content
5. Determination of hardness of water sample
6. Determination of Alkalinity of water sample
7. Virtual lab experiments

CS3171	FUNDAMENTALS OF COMPUTING AND PYTHON PROGRAMMING LAB	L	T	P	C
		0	0	4	2

OBJECTIVES:

- ✓ To write, test, and debug simple Python programs.
- ✓ To implement Python programs with conditionals and loops.
- ✓ Use functions for structuring Python programs.
- ✓ Represent compound data using Python lists, tuples, dictionaries.
- ✓ Read and write data from/to files in Python.

LIST OF PROGRAMS:

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

PLATFORM NEEDED: Python 3 interpreter for Windows/Linux

TOTAL: 45 HOURS

SEMESTER II

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	EG3102	Communicative English	3	0	0	3
2.	MA3102	Engineering Mathematics – II	3	1	0	4
3.	BE3101	Basic Electrical and Electronics Engineering	3	0	0	3
4.	ME3201	Engineering Mechanics	3	0	0	3
5.	AS3101	Basic Aerospace Engineering	3	0	0	3
6.	ME3101	Engineering Graphics	3	0	2	4
PRACTICAL						
7.	BE3171	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1
8.	BE3173	Manufacturing Practices Laboratory	0	0	2	1
9.	AS3171	Basic Aerospace Engineering Lab	0	0	2	1
TOTAL			**18**	**1**	**8**	**23**

EG3102	Communicative English	L	T	P	C
		3	0	0	3

OBJECTIVES

- To widen and expand students' knowledge of English vocabulary
- To develop skills of students in the areas of vocabulary, grammar, listening, speaking, reading, and writing
- To develop the knowledge, skills and strategies the student must possess to become proficient readers
- To make the students learn the importance and purpose of communication skills and overcome the communication barriers by gaining confidence
- To make the students understand how to apply technical information and knowledge in practical documents

Course Outcome		Cognitive Skill
CO-01	Use English Language effectively in spoken and written forms.	R
CO-02	Comprehend the given texts and respond appropriately.	U
CO-03	Communicate confidently in various contexts and different cultures.	A
CO-04	Acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.	A
CO-05	Demonstrate active listening and critical thinking skills.	A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	M	S	M	S	S	N	M	M	S	S	M	M
CO-02	S	M	L	N	L	M	S	L	L	S	M	M
CO-03	S	L	S	S	L	L	S	S	M	M	S	S
CO-04	S	L	M	S	N	L	S	S	M	S	S	M
CO-05	S	L	M	M	M	L	N	S	M	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: VOCABULARY AND GRAMMAR 9

Parts of Speech – Sentence Structures – Technical Vocabulary – Synonyms – Antonyms – Homonyms – Homophones – Misspelled Words – One word Substitutes – Odd Words Out – Changing words from one form to another – Common Errors in English – Correction of Errors in Sentences.

Unit II: LISTENING and READING 9

Reading Comprehension – Skimming – Scanning – Predicting the Content – Comprehension Questions – Inductive Reading – Close Reading – Note Making – Précis Writing.

Unit III: SPEAKING **9**

Introducing Oneself **–** Exchanging Personal Information **–** Small Talk: Family, Friends, Studies, Profession **–** Speaking**:** Greeting, Taking Leave **–** Product Description **–** Completing information **–** Gap Exercises **–** Presentation / Public Speaking Skills – Group Discussion – Debate – Role Play.

Unit IV: TECHNICAL WRITING **9**

Report Writing – Characteristics of a Report – Categories of Reports – Letter Writing (Formal Letters)**:** Job Application Letter with Resume – Letter Seeking Permission – Letter of Invitation – Letter Declining an Invitation – Letter of Complaint – Letter of Requisition.

Unit V: TECHNICAL COMMUNICATION **9**

The Theory of Communication – Definition and Scope – Nature, Importance and Types – Different Communication Models – Barriers to Communication – Effective Communication (Verbal / Non-verbal).

TOTAL: 45 HOURS

EXTENSIVE READING:

Canfield Jack, *Chicken Soup for the Soul*, Westland, Chennai, 1999.

NOTE:

The book given under Extensive Reading is meant for inculcating the reading habit of the students. They need not be used for testing purposes.

REFERENCE BOOKS:

1. Communication Skills. Oxford University Press.
2. Wood, F. T. (2007). Remedial English Grammar. Macmillan.
3. Zinsser, William. (2001). On Writing Well. Harper Resource Book.
4. The Four Skills for Communication – Josh Sreedharan – Foundation Books
5. Communicative English – E. Sureshkumar and P. Sreehari – Orient Blackswan

MA3102	ENGINEERING MATHEMATICS – II	L	T	P	C
		3	1	0	4

OBJECTIVES

To develop basic knowledge to the students in differential equations and vector calculus. This subject is further broadened to the functions of complex variables and complex integration. A thorough knowledge about Laplace transforms is also covered to aid the students solve the differential equations.

Course Outcome		Cognitive Skill
CO-01	The Students will be able to solve ordinary differential equations	An , E , S
CO-02	The Students will be able to solve complex variables	E

CO-03	The students will be able to synthesize complex integration	S
CO-04	The students will be able to solve Vector Calculus	E , S
CO-05	The students will be able to Synthesize Laplace transforms	S

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	M	S	M	S	S	N	M	M	S	S	M	M
CO-02	S	M	L	N	L	M	S	L	L	S	M	M
CO-03	S	L	S	S	L	L	S	S	M	M	S	S
CO-04	S	L	M	S	N	L	S	S	M	S	S	M
CO-05	S	L	M	M	M	L	N	S	M	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: ORDINARY DIFFERENTIAL EQUATIONS 9

Linear differential equations of second order with constant and variable coefficients- Cauchy's and Legendre's linear equations – Method of variation of parameters.

Unit II: COMPLEX VARIABLES 9

Functions of a complex variable – Analytic function – Necessary conditions- Cauchy- Riemann equations in cartesian and polar co-ordinates - Sufficient conditions(excluding proof) –Properties of analytic function – Harmonic and its conjugate – Construction of analytic function by Milne Thomson method – Conformal mappings $w = z + c$, cz , $1/z$ and Bilinear transformation.

Unit III: COMPLEX INTEGRATION 9

Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Laurent's expansion – Singular points – Residues – Cauchy's Residue theorem – Evaluation of

real definite integral using contour integration (excluding poles on the real axis) - $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$ and $\int_{-\infty}^{\infty} \frac{f(x)}{g(x)}dx$

Unit IV: VECTOR CALCULUS **9**

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 V: LAPLACE TRANSFORMS **9**

Laplace transform –Existence condition– Transforms of elementary functions – Basic properties – Transforms of derivatives and integrals – Transform of Periodic functions. Inverse Laplace transform – Convolution, Initial and Final value theorems (statement only) – Solutions of linear ordinary differential equation of second order with constant coefficients using Laplace transform techniques.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics"- 40th Edition, Khanna Publishers, Delhi 2007.

REFERENCES:

2. M.Immaculate Mary, K.Uma Samundesvari, Engineering Mathematics – II" First Edition, Anuradha Publications, ,2013.
3. Erwin Kreyszig, "Advanced engineering Mathematics", Seventh Edition, Wiley India, 2007.
4. Veerarajan T, "Engineering Mathematics (for first year)", Tata McGraw- Hill Publishing Company Ltd.,New Delhi,2007.
5. P.Kandasamy , K.Thilagavathy , K.Gunavathy" Engineering Mathematics" S.Chand & Company Ltd.2002.
6. B.V. Ramana,"Higher Engineering Mathematics" Second Edition Tata McGraw- Hill, Publishing Company Ltd.,New Delhi, 2006.

BE3101	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the basic solutions of AC and DC circuits.
- To study the basic principle and operation of AC and DC machines.
- To study the fundamental operations of measuring instruments.
- To study the layout of power system
- To understand the fundamental operation and characteristics of Electron devices
- To understand the implementation of Boolean expression using logic gates.
- To become familiar with basic concepts of Communication system.

Course Outcome		Cognitive Skill
CO-01	Investigate advanced electrical and electronics topics (e.g., microcontrollers, power electronics).	R,U,A,An, E
CO-02	Evaluate renewable energy systems and energy efficiency.	R ,U,A, An,E
CO-03	Apply electrical and electronics principles to biomedical engineering.	R,U,A,An, E
CO-04	Collaborate in multidisciplinary teams to solve electrical and electronics engineering problems.	R,U,A,An, E
CO-05	Develop programming skills in electrical and electronics engineering software.	R,U,A,An, E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: ELECTRICAL CIRCUITS 9

Ohms Law – Kirchhoff's laws – Mesh and Nodal Analysis for DC Circuits – Introduction to AC Circuits, Faraday's Law of Electromagnetic Induction – Lenz law – Inductor – Capacitor – Power factor – Waveforms and RMS value – Average Value – Peak factor and Form factor – Single phase circuits – Series and Parallel – Three phase balanced circuits – Fundamentals of wiring and earthing.

Unit II: ELECTRICAL MEASUREMENTS, MACHINES AND POWER SYSTEM 9

Operating principles of Moving coil and Moving iron instruments (Ammeter and voltmeter) – Dynamometer type watt meter and Energy meter – Errors in Measurements –Construction –

Principle of operation and Applications of DC Generators – DC Motors – Single phase transformers – Structure of power system.

Unit III: SEMICONDUCTOR DEVICES **9**

Introduction to Semiconductors – PN Junction diode-Zener diode and its characteristics – Half wave and Full wave Rectifiers – Bipolar Junction transistor – CB,CE,CC Configuration and characteristics – JFET and MOSFET construction – operation – characteristics (CS only) and uses.

Unit IV: Digital Electronics **9**

Number systems – binary arithmetic – Boolean algebra – laws and theorems – Simplification of Boolean expression – logic gates –Implementation of Boolean expression using logic gates – standard forms of Boolean expression.

Unit V: Communication Systems **9**

Block diagram of basic communication system – need for modulation – Types of modulation – Principles of Amplitude and Frequency modulation – pulse analog and digital modulation – AM and FM transmitter and receiver (Block diagram description only) –Satellite Communication Radar Systems – Data transmission and MODEM.

TOTAL: 45 HOURS

REFERENCES:

1. Muthusubramanian R, Salivahanan S and Muraleedharan K A, "Basic Electrical, Electronics and Computer Engineering", Tata McGraw Hill, Second Edition, (2006).
2. V.N. Mittle "Basic Electrical Engineering", Tata McGraw Hill Edition, New Delhi, 1990.
3. V.K.Mehta "Principles of Power System", S.Chand & Company Ltd, New Delhi, 2001.
4. R.S.Sedha,"Applied electronics"S.Chand&Co.,2006.

ME3201	ENGINEERING MECHANICS	L	T	P	C
		3	0	0	3

OBJECTIVES

This is a basic engineering course common to all branches to inculcate in the students, problem solving abilities and to enhance their analytical abilities.

Course Outcome		Cognitive Skill
CO-01	Investigate advanced topics in engineering mechanics (e.g., fracture mechanics, computational mechanics).	R,U,A,An, E
CO-02	Evaluate biomechanics and medical device applications.	R ,U,A, An,E
CO-03	Apply mechanics principles to aerospace, civil, or mechanical engineering.	R,U,A,An, E

CO-04	Collaborate in multidisciplinary teams to solve complex mechanics problems.	R,U,A,An, E
CO-05	Develop programming skills in mechanics software.	R,U,A,An, E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Statics of Particles **9**

Statics –Basics Concepts, Fundamental principles & concepts: Vector algebra, Newton‟s laws, gravitation, force (external and internal, transmissibility), couple, moment (about point and about axis), Varignon's theorem, resultant of concurrent and non-concurrent coplanar forces, static equilibrium, free body diagram, reactions. Problem formulation concept; 2-D statics, two and three force members, alternate equilibrium equations, constraints and static determinacy; 3-D statics

Unit II: Application of Statics & Friction **9**

Analysis of Structures- Trusses: Assumptions, rigid and non-rigid trusses; Simple truss (plane and space), analysis by method of joints. Analysis of simple truss by method of sections; **FRICTION:** Friction- Coulomb dry friction laws, simple surface contact problems, friction angles, types of problems, wedges. Sliding friction and rolling resistance

Unit III: - Centroid, Centre of Gravity and Moment of Inertia **9**

Moment of Inertia- First moment of mass and center of mass, centroids of lines, areas, volumes, composite bodies. Area moments- and products- of inertia, radius of gyration, transfer of axes, composite areas. Rotation of axes, principal area-moments-of-inertia,. Second moment of mass, Mass moments- and products- of inertia, radius of gyration, transfer of axes, flat plates (relation between area- and mass- moments- and products- of inertia), composite bodies. Rotation of axes, principal mass-moments-of-inertia.

Unit IV: Particle Dynamics **9**

Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique).

Unit V: Kinematics & Kinetics of Rigid Bodies **9**

Plane kinematics of rigid bodies- Rotation; Parametric motion. Relative velocity, instantaneous center of rotation. Relative acceleration, rotating reference frames. Rotating reference frames, 3-part velocity and 5-part acceleration relations, Coriolis acceleration.

Plane kinetics of rigid bodies- Kinetics of system of particles and derivation of moment equation. Translation. Fixed axis rotation; General planar motion.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Beer F P and Johnson E R, "Vector Mechanics for Engineers, Statics and Dynamics", Tata Mc-Graw Hill Publishing Co. Ltd., New Delhi, 2006.
2. Tayal A K, "*Engineering Mechanics- Statics and Dynamics*" , Umesh Publications, Delhi,2004
3. Irving H. Shames, Engineering Mechanics, Prentice Hall, New Delhi 1997.

REFERENCES:

1. Bansal R K, "Engineering Mechanics", Laxmi Publications Pvt. Ltd., New Delhi, 2006.
2. Bhavikatti S S, "Engineering Mechanics", New Age International Pvt. Ltd., New Delhi, 2003.
3. Young D H and Timashenko S, "Engineering Mechanics", Tata Mcgraw-Hill, Fourth Edition, 2006.
4. JivanKhachane, RuchiShrivastava, "Engineering Mechanics: Statics and Dynamics", ANE Books, 2006.
5. Rajasekaran S and Sankarasubramanian G, "Engineering Mechanics-Statics and Dynamics", Vikas Publishing House Pvt. Ltd., New Delhi, 2006.
6. NPTEL courses: *http://nptel.iitm.ac.in/courses.php*, web and video resources on *Engineering Mechanics*.

AS3101	BASIC AEROSPACE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

1) Learn from the history about the evaluation of aerospace vehicles
2) Get an introduction on aircraft systems and its functions.
3) Understand the basic principles of aerospace propulsion systems.
4) Get an introduction on aerospace structures and construction.
5) Study about various aircraft instruments and navigation systems.

Course Outcome		Cognitive Skill
CO-01	Learn the history of aircraft & development over the years	R,U,A,An, E
CO-02	Understand the types and classifications of components and configurations.	R ,U,A, An,E
CO-03	Understand the basic concepts of propulsion and power plants.	R,U,A,An, E
CO-04	Understand the aerospace structure and construction.	R,U,A,An, E
CO-05	Understand the aerospace navigation and instrumentation.	R,U,A,An, E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	L	M	M	S	M	N	N	M	M	L	M	M
CO-02	M	S	L	N	L	M	S	L	L	S	S	M
CO-03	S	M	S	S	L	N	L	M	M	M	S	S
CO-04	M	L	S	M	N	L	S	S	S	S	M	M
CO-05	M	L	M	M	M	S	S	S	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: HISTORICAL EVALUATION **9**

History of aviation, early development of airplanes, biplanes and monoplanes, history of space flight, development of space vehicle, classification of duct jet propulsion, rocket propulsion, advance propulsion and applications.

Unit II: CONFIGURATIONS **9**

Anatomy of flight vehicles, components of an airplanes and their function, configuration of space vehicle, earth's atmosphere and gravitational field, bluff bodies v/s streamlined body, airfoil, lift generation, significance of L/D ratio, aerodynamic forces.

Unit III: - PROPULSION **9**

Classification and essential features of propulsion, jet propulsion, general characteristics of rocket engines, theory of propulsion, elementary gas dynamics, spacecrafts and aircraft performance.

Unit IV: AEROSPACE STRUCTURES AND MATERIALS **9**

General types of construction and structural layout, flight envelope and V-n diagrams, Monocoque, semimonocoque, corrugated, sandwich structure, reinforced and honeycomb structures, geodesic construction, aerospace materials, metallic and non metallic materials, use of aluminum alloy, titanium, stainless steel, composite and ceramic materials.

Unit V: INSTRUMENTS AND NAVIGATION **9**

Basic instrumentation electronics (dc electronics, ac electronics, semiconductors, electro-optics and digital electronics), sensing devices, bridge circuits, optical devices ,introduction to computer based data acquisition, measurements in aerodynamics, flight structures and flight control, principles of navigation, celestial, radio and inertial navigation schemes, navigational and guidance requirements for orbital, planetary and atmospheric entry missions.

TEXT BOOKS:

1. Shevel, "Fundamentals of Flight", Prentice Hall, 1989.
2. Merrill G., "Principle of Guided Missile Design", D. Van Nostrand Co., INC., 1977

REFERENCES:

1. Anderson. David, Wand Scott Eberhardt. "Understanding Flight". 2nd ed. McGraw-Hill Professional, 2009.
2. Anderson .J.D." Introduction to flight". 6th ed. McGraw Hill, 2009.
3. Zebehely.V.G and Mark.H. "Adventures in celestial mechanics". 4th ed. WILEY-VCH Verlag GmbH Co, 2004.
4. Turner.M.J. "Rocket and Spacecraft Propulsion". 3rd ed. Springer, 2009.
5. Newman Dava. "Interactive Aerospace Engineering and Design". McGraw Hill, 2002.
6. Sutton G.P., Rocket Propulsion Elements, Eight Edition, John Wiley & Sons Inc., New Jersey, 2010
7. E. Irwin Treager, Aircraft Gas Turbine Engine Technology, 3rd Edition .

ME3101	ENGINEERING GRAPHICS	L	T	P	C
		3	0	2	4

OBJECTIVES

- To develop skills for communication of concepts, ideas and design of Engineering Products.
- To expose them to existing national standards related to technical drawings

Course Outcome		Cognitive Skill
CO-01	To know and understand the conventions and the methods of engineering drawing.	R,U,A,An, E
CO-02	Interpret Engineering drawings using fundamental technical mathematics.	R ,U,A, An,E
CO-03	Construct basic and intermediate geometry.	R,U,A,An, E
CO-04	To improve their visualization skills so that they can apply these skills in developing new products.	R,U,A,An, E
CO-05	To improve their technical communication skill in the form of communicative drawings and comprehend the theory of projection.	R,U,A,An, E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	L	M	M	S	M	N	N	M	M	L	M	M
CO-02	M	S	L	N	L	M	S	L	L	S	S	M
CO-03	S	M	S	S	L	N	L	M	M	M	S	S
CO-04	M	L	S	M	N	L	S	S	S	S	M	M
CO-05	M	L	M	M	M	S	S	S	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Introduction **9**

Concepts and conventions: Use of drafting instruments, BIS conventions and specifications – Size, layout and folding of drawing sheets, Lettering and dimensioning. General principles of orthographic projection, First angle projection – Layout of views. **(Not for examination)**

General Plane Curves

Conic sections including the Rectangular Hyperbola (General method); Cycloid, Epicycloid, Hypocycloid and Involute.

Unit II: Projection of Points, Lines & Planes **9**

Projection of points, Projection of straight lines located in the first quadrant. Determination of true lengths and true inclinations. Projection of planes- parallel to any one reference plane, perpendicular to any one reference plane, Inclined to any one reference plane and inclined to both reference planes

Unit III: - Projection of Solids & Section of Solids **9**

Prisms, pyramids, cylinder and cone, axis perpendicular to any one reference plane. Axis parallel to both the planes. Axis inclined to any one reference plane.

Sectioning of solids- Prisms, pyramids, cylinder and cone in simple vertical position by cutting planes inclined to one reference plane. Obtaining the true shape of section

Unit IV: Development of Surfaces & Isometric Projection **9**

Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone, Isometric view, Isometric scale to draw Isometric projection, Non-Isometric lines, construction of Isometric view from given orthographic views and to construct Isometric view of a Pyramid, Cone, Sphere.

Unit V: Orthographic Projection & Perspective Projection **9**

Fundamental of projection along with classification, Projections from the pictorial view of the object on the principal planes for view from front, top and sides using first angle projection method and third angle projection method, full sectional view. Perspective Projection of Solids (Any one Method).

TEXT BOOKS:

1. Venugopal K and Prabhu Raja V, "*Engineering Graphics*", New Age International Publishers, 2007.
2. Luzadder W J, "*Fundamentals of Engineering Drawing*", Prentice Hall Book Co., New York, 1998
3. Bhat, N.D.& M. Panchal , *Engineering Drawing*, Charotar Publishing House,2008

REFERENCES:

1. Kumar M S, "*Engineering Graphics*", Ninth Edition, DD Publications, Chennai, 2007.
2. Bureau of Indian Standards, "*Engineering Drawing Practices for Schools and Colleges* SP 46-2003", BIS, New Delhi, 2003.
3. Shah, M.B. & B.C. Rana , *Engineering Drawing and Computer Graphics*, Pearson *Education,2008*

BE3171	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY	L	T	P	C
		0	0	2	1

AIM:

To understand the electric circuit connection, measurement of electrical parameters, Characteristics of electron devices and its applications.

OBJECTIVES:

- To make basic electrical connection
- To measure the electrical parameters
- To obtain the characteristics of Electron devices
- To verify the operation of logic gates.

Course Outcome		Cognitive Skill
CO-01	Understand and Apply Basic Electrical Circuits Concepts	R,U,A,An, E
CO-02	Design, Build, and Test Electronic Circuits	R ,U,A, An,E
CO-03	Understand and Measure Electrical Signals	R,U,A,An, E
CO-04	Apply Digital Electronics Fundamentals	R,U,A,An, E
CO-05	Develop Experimental and Troubleshooting Skills	R,U,A,An, E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	L	M	M	S	M	N	N	M	M	L	M	M
CO-02	M	S	L	N	L	M	S	L	L	S	S	M
CO-03	S	M	S	S	L	N	L	M	M	M	S	S
CO-04	M	L	S	M	N	L	S	S	S	S	M	M
CO-05	M	L	M	M	M	S	S	S	S	S	M	S

- S-Strong, M-Medium,L-Low,N-Not relevant

I. Electrical Engineering Lab

1 Study of Symbols, Cables and Earthing.
2 Residential house wiring using switches, fuse, indicator, lamp and energy meter.
3 Fluorescent lamp wiring.

4 Stair case wiring / Lamp control from three different places/ Doctor Room control/ Go down control
5 Measurement of electrical quantities – voltage, current, power & computation of power factor in RLC circuit.
6 Measurement of energy using single phase energy meter.
7 Fan Wiring.

II. Electronics Engineering Lab

1. Study of Electronic components and equipments – Resistor, colour coding, Measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
2. Characteristics of PN Junction diode
3. Characteristics of Zener diode
4. Voltage Regulator using Zener diode
5. Measurement of ripple factor of HWR and FWR.
6. Study of logic gates AND, OR, EX-OR and NOT, NAND and NOR.
7. Generation of Clock Signal.
8. Soldering practice – Components, Devices and Circuits – Using general purpose PCB.

TOTAL: 30 HOURS

BE3173	MANUFACTURING PRACTICES LABORATORY	L	T	P	C
		0	0	2	1

Objective:

To provide hands-on experience in various manufacturing processes, techniques, and technologies, enabling students to understand and apply theoretical knowledge in a practical setting.

Course Outcome		Cognitive Skill
CO-01	Demonstrate Safety and Shop Practices	R,U,A,An, E
CO-02	Apply Manufacturing Processes and Techniques	R ,U,A, An,E
CO-03	Design and Fabricate Simple Parts	R,U,A,An, E
CO-04	Analyze and Optimize Manufacturing Processes	R,U,A,An, E
CO-05	Document and Communicate Manufacturing Projects	R,U,A,An, E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	L	M	M	S	M	N	N	M	M	L	M	M
CO-02	M	S	L	N	L	M	S	L	L	S	S	M
CO-03	S	M	S	S	L	N	L	M	M	M	S	S
CO-04	M	L	S	M	N	L	S	S	S	S	M	M
CO-05	M	L	M	M	M	S	S	S	S	S	M	S

S-Strong, M-Medium, L-Low, N-Not relevant

List of experiments:

1. Preparation of the mould using single piece pattern
2. Preparation of the mould using split pattern
3. Prepare at least two jobs using gas cutting and gas welding. This includes cutting of raw material and preparation of pre -weld parts.
4. Exercises in Arc Welding with use of appropriate fixtures for welding
5. Preparation of Square / Hexagonal Head Bolt in forging
6. Visit a nearby Rolling mill/Hot - Cold material processes, allied manufacturing processes industry and prepare a two-page report comprises of details (type, material, process, etc.) of items produced, quantities, different sections, equipment used with specification, process parameters being used and consumables
7. Plane turning, taper turning, drilling and thread cutting and knurling

TOTAL HOURS: 30

AS3171	**BASIC AEROSPACE ENGINEERING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

OBJECTIVE

To enable the students, understand the fundamentals and basics of various elements of aerospace.

Course Outcome		Cognitive Skill
CO-01	demonstrate Understanding of Aerospace Materials and Properties	R,U,A,An, E
CO-02	Apply Aerodynamics and Fluid Dynamics Principles	R ,U,A, An,E
CO-03	Design and Test Aerospace Structures	R,U,A,An, E
CO-04	Understand Propulsion Systems and Performance	R,U,A,An, E
CO-05	Develop Experimental and Analytical Skills in Aerospace Engineering.	R,U,A,An, E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	L	M	M	S	M	N	N	M	M	L	M	M
CO-02	M	S	L	N	L	M	S	L	L	S	S	M
CO-03	S	M	S	S	L	N	L	M	M	M	S	S
CO-04	M	L	S	M	N	L	S	S	S	S	M	M
CO-05	M	L	M	M	M	S	S	S	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS

1. Practical on flight controls and components.
2. Maintenance of Aircraft structures. p
3. Servicing aircraft piston engine.
4. Servicing aircraft gas turbine engine.
5. Calibration and maintenance of air data system of an aircraft.
6. Practical of navigation and guidance system of an aircraft.
7. Integration of Nano Satellite (NIUSAT).
8. Study of satellite ground station (NIUSAT).
9. Study of various facilities required for development of nano satellite. (NIUSAT).

TOTAL: 30 HOURS

LIST OF EQUIPMENTS

(for a batch of 30 students)

SI.No.	Items	Quantity	Experiment No.
1.	Serviceable aircraft with all above systems	1	1,2,5,6
2.	Piston engines	2	3
3.	Jet engine / engine model	1	4
4.	Air data system model	2	5
5.	Radio navigation system model	2	6
6.	Nano satellite model	1	7,8,9

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA3201	Engineering Mathematics - III	3	1	0	4
2.	AS3201	Aero Thermodynamics	3	0	0	3
3.	AS3202	Flight Systems and Instrumentation	3	0	0	3
4.	AS3203	Structural Mechanics	3	0	0	3
5.	ME3202	Engineering Materials and Metallurgy	3	0	0	3
6.	ME3204	Fluid Mechanics and Machinery	3	0	0	3
PRACTICAL						
7.	AS3271	Structural Mechanics Lab	0	0	2	1
8.	AS3272	Thermal and Heat transfer Laboratory	0	0	2	1
9.	ME3272	Fluid Mechanics and Machinery Laboratory	0	0	2	1
TOTAL			**18**	**1**	**6**	**22**

MA3201	ENGINEERING MATHEMATICS III	L	T	P	C
		3	**1**	**0**	**4**

OBJECTIVES

To develop the skill of the students in the areas of boundary value problems and Transform techniques. This will be necessary for their effective studies in a large number of Engineering subjects like heat conduction, communication systems, electro-optics and electromagnetic theory. This course will also serve as a prerequisite for post graduate and specialized studies and research.

Course Outcome		Cognitive Skill
CO-01	Recognize a Partial Differential Equation and formulate a Partial Differential Equation from a given equation. Solve linear Partial Differential Equation of both first and second order using various methods.	U,A
CO-02	Derive a Fourier series expansion for a given periodic function by evaluating Fourier coefficient and expand Fourier cosine and Sine series for given function. Also find the Fourier series expansion for a given set of numerical values by applying harmonic analysis.	A,An
CO-03	Classify the second order Partial Differential Equation and solve second order Partial Differential Equations such as wave equation, heat equation and Laplace equation with boundary and initial conditions applying Fourier series expansion.	R,U
CO-04	Know fundamental and mathematical properties of Fourier transform. Calculate the Fourier transform of a given function and inverse Fourier transform of function. Know the applications of Parseval's and convolution theorem.	E, S
CO-05	Understand the characteristics and properties of Z-transform. Compute Z-transform of simple functions and inverse z transform of given functions and apply Z-transform for solving difference equations.	A,An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

(Increase or reduce the columns based on the program Outcome of the department)*

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	L	M	M	S	M	N	N	M	M	L	M	M
CO-02	M	S	L	N	L	M	S	L	L	S	S	M
CO-03	S	M	S	S	L	N	L	M	M	M	S	S
CO-04	M	L	S	M	N	L	S	S	S	S	M	M
CO-05	M	L	M	M	M	S	S	S	S	S	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Partial Differential Equations **12**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of Clairaut's equations – Lagrange's linear equation –Homogeneous linear partial differential equations of second order with constant coefficients.

Unit II: Fourier Series **12**

Dirichlet's conditions – Fourier series – Change of interval - Odd and Even functions – Half range sine and cosine series – Parseval's identity – Harmonic Analysis.

Unit III: Boundary Value Problems **12**

Classification of second order linear partial differential equations – One dimensional wave and heat equations – Assumptions – Fourier series solution – Steady state solution of two dimensional heat equation (insulated edges excluded) – Fourier series solution in Cartesian co-ordinates.

Unit IV: Fourier Transforms **12**

Statement and meaning of Fourier integral theorem – Fourier transform — Properties - Inverse Fourier transform – Fourier Sine and Cosine transforms – Inverse sine and cosine transforms – Properties -Transforms of simple functions – Convolution theorem – Parseval's identity.

.

Unit V: Z-Transforms **12**

Z- transform – Elementary properties – convolution theorem-Inverse Z-transform –Partial fraction Method, Inversion integral method and Convolution – Initial and Final value theorems – Formation of difference equations – Solution of difference equations using Z-transform.

TOTAL: 60 HOURS

TEXT BOOKS

5. Grewal B.S., "Higher Engineering Mathematics" – 40th Edition , Khanna Publishers, Delhi 2011.

REFERENCES:

1. ErwinKreyszig, "Advanced Engineering Mathematics",10th Edition, John Wiley & Sons, Inc., USA, 2011
2. Kandasamy P, Thilagavathy K, and Gunavathy K., "Engineering Mathematics Volume III", First Edition, S.Chand& Company Ltd., New Delhi.
3. Veerarajan T., "Engineering Mathematics(for Semester III), Third Edition, Tata McGraw – Hill Publishing Company Limited, New Delhi 2007.
4. Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Seventh Edition, Lakshmi Publications Pvt. Ltd., New Delhi, 2009

AS3201	AERO THERMODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES

To give a brief background of application of various laws of thermodynamics and its application in heat transfer, refrigeration and air conditioning, jet propulsion system.

Course Outcome		Cognitive Skill
CO-01	Remembering the basic laws of thermodynamics	R
CO-02	Understanding the Air cycles phenomena	U
CO-03	Synthesize of kinetic theory of gases and chemical kinetics	S
CO-04	Understanding the working principles of Refrigeration and Air conditioning	U
CO-05	Understanding thermodynamics of Air compressors	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

(Increase or reduce the columns based on the program Outcome of the department)*

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	S	S	M	N	N	M	M	L	M	M
CO-02	M	S	L	N	L	M	S	L	L	S	S	M
CO-03	M	L	S	S	L	N	S	M	M	M	S	S
CO-04	M	L	M	M	N	L	S	S	M	S	M	M
CO-05	M	L	M	M	M	L	N	S	M	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Basic Thermodynamics **9**

Systems, Zeroth Law, First Law - Heat and work transfer in flow and non-flow processes, Second law, Kelvin- Planck statement - Clausius statement - concept of entropy - Clausius inequality - entropy change in non-flow processes.

Unit II: Air Cycles **9**

Otto, Diesel, Dual combustion and Brayton combustion cycles – Air standard efficiency - Mean effective pressure – Actual and theoretical PV diagrams of four stroke and two stroke IC Engines.

Unit III: Thermodynamics Of One Dimensional Fluid Flow **9**

Application of continuity and energy equations- Properties of steam – steam tables - Isentropic flow of ideal gases through nozzles - Simple jet propulsion system - Thrust rocket motor – Specific impulse.

Unit IV: Refrigeration And Air Conditioning **9**

Principles of refrigeration, Air conditioning - Heat pumps - Vapor compression - Vapor absorption types - Coefficient of performance, Properties of refrigerants.

.

Unit V: Air Compressors **9**

Classification and working principle, work of compression with and without clearance, Isothermal and Isentropic efficiency of reciprocating air compressors, multistage compression and inter cooling. Various types of compressors (Descriptive treatment only).

TOTAL: 45 HOURS

TEXT BOOKS

1. Rathakrishnan, E, "Fundamentals of Engineering Thermodynamics", Prentice – Hall, India, 2000
2. Nag. P.K., "Engineering Thermodynamics", Tata McGraw-Hills Co., Ltd., Seventh Edn., 1993.
3. YunusA.Cengal. "Thermodynamics and Engineering Approach", Tata McGraw-Hill Co. Ltd., 3rd Edition, 2002.

REFERENCES

1. Mayhew, A. and Rogers, B., "Engineering Thermodynamics", Longman Green & Co. Ltd., London, E.L.B.S. Edition, 1990.
2. Van Wylen, G.J. and Sonntag, R.E., "Fundamentals of Classical Thermodynamics (S.I.Version)", Second Edition, 1986.
3. Bacon, D.H., "Engineering Thermodynamics", Butterworth & Co., London, 1989.
4. Saad, M.A., "Thermodynamics for Engineers", Prentice-Hall of India Pvt. Ltd., 1989.
5. Reynolds, "Thermodynamics", Int. Student Edn., McGraw-Hill Book Co., Ltd., 1990

AS3202	FLIGHT SYSTEMS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES

To describe the principle and working of flight systems and instruments

Course Outcome		Cognitive Skill
CO-01	Understand the basic concepts of aircraft control systems.	U

CO-02	Ability to analyze the different systems used in aircraft operations.	An
CO-03	To apply the knowledge of different systems used in aircraft engines.	A
CO-04	Understand the different auxiliary systems used in the effective operations of aircrafts.	U
CO-05	To understand the different instruments used in different kind of operations.	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	L	M	M	M	L	S	M	N	L	S	M
CO-02	M	L	L	M	M	M	L	S	L	M	N	M
CO-03	S	L	L	M	L	L	M	N	S	L	M	M
CO-04	M	M	M	L	L	L	M	N	L	L	M	L
CO-05	M	L	L	L	M	M	L	S	L	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Flight Control Systems **9**

Conventional Systems - Power assisted and fully powered flight controls - Power actuated systems – Engine control systems - Push pull rod system, flexible push full rod system - Components - Modern control systems - Digital fly by wire systems - Auto pilot system active control Technology, Communication and Navigation systems Instrument landing systems.

Unit II: Flight Systems **9**

Hydraulic systems - components - Hydraulic system controllers - Modes of operation - Pneumatic systems - Working principles - Typical Air pressure system – Brake system - Typical Pneumatic power system - Components, Landing Gear systems - Classification – Shock absorbers - Retractive mechanism- Rocket Separation mechanism.

Unit III: Engine Systems **9**

Fuel systems for Piston and jet engines, - Components of multi engines. Lubricating systems for piston and jet engines - Starting and Ignition systems - Typical examples for piston and jet engines.

Unit IV: Auxilliary System **9**

Basic Air cycle systems - Vapour Cycle systems, Boost-Strap air cycle system - Evaporative vapour cycle systems - Evaporative air cycle systems - Oxygen systems - Fire protection systems, Deicing and anti icing systems.

Unit V: Flight Instruments **9**

Flight Instruments and Navigation Instruments – Gyroscope - Accelerometers, Air speed Indicators – TAS, EAS- Mach Meters - Altimeters - Principles and operation - Study of various types of engine instruments - Tachometers - Temperature gauges - Pressure gauges - Operation and Principles.

TOTAL: 45 HOURS

TEXT BOOKS

1. McKinley, J.L., and Bent, R.D., "Aircraft Maintenance & Repair", McGraw-Hill, 1993.
2. "General Hand Books of Airframe and Powerplant Mechanics", U.S. Dept. of Transportation, Federal Aviation Administation, The English Book Store, New Delhi1995.
3. David harris, " Flight Instruments and Automatic Flight Control" Blackwell, Sixth Edition 2004.

REFERENCES

1. Mekinley, J.L. and Bent, R.D., "Aircraft Power Plants", McGraw-Hill, 1993.
2. Pallet, E.H.J., "Aircraft Instruments & Principles", Pitman & Co., 1993.
3. Treager, S., "Gas Turbine Technology", McGraw-Hill, 1997.

AS3203	STRUCTURAL MECHANICS	L	T	P	C
		3	0	0	3

OBJECTIVES

To give brief descriptions on the behaviour of materials due to axial, bending and torsional and combined loads.

Course Outcome		Cognitive Skill
CO-01	Understand the basics in Axial Loading	U
CO-02	Evaluate the stresses thereby deflection of beams	E
CO-03	Synthesize torsion behavior in columns	S

CO-04	Evaluate Bi-Axial Stresses in cylinder and Spherical	E
CO-05	Analysis the application of Energy Methods to various bodies	An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	S	S	M	N	N	M	M	L	M	M
CO-02	L	M	L	N	L	M	S	L	L	S	S	M
CO-03	L	L	S	S	L	N	S	M	M	L	S	S
CO-04	M	L	M	M	N	L	S	S	M	S	M	M
CO-05	M	L	M	M	M	L	N	N	M	M	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Basics And Axial Loading **9**

Stress and Strain – Hooke's Law – Elastic constants and their relationship– Statically determinate cases - bar with uniform and varying section statically indeterminate cases – composite bar. Thermal Stresses – stresses due to freely falling weight.

Unit II: Stresses And Deflection Of Beams **9**

Shear force and bending moment diagrams for simply supported and cantilever beams – Bending stresses in straight beams – Shear Stresses in bending of beams with various cross sections – beams of uniform strength. Double integration method – McCauley's method - Area moment method – Conjugate beam method.

Unit III: Torsion And Columns **9**

Torsion of circular shafts - shear stresses and twist in solid and hollow circular shafts – closely coiled helical springs. Columns with various end conditions – Euler's Column curve – Rankine's formula - Column with initial curvature - Eccentric loading – South well plot – Beam column.

Unit IV: Bi Axial Stresses **9**

Stresses in thin circular cylinder and spherical shell under internal pressure – volumetric Strain. Combined loading – Principal Stresses and maximum Shear Stresses - Analytical and Graphical methods.

Unit V: Energy Methods **9**

Strain Energy due to axial, bending and Torsional loads - Castigliano's theorem - Maxwell's Reciprocal theorem, Unit load method - application to beams, trusses, frames, rings, etc.

TOTAL: 45 HOURS

TEXT BOOKS

1. Nash William – "Strength of Materials", TMH, 1998
2. Timoshenko.S. and Young D.H. – "Elements of strength materials Vol. I and Vol. II"., T. Van Nostrand Co-Inc Princeton-N.J. 1990.

REFERENCES

1. Dym C.L. and Shames I.H. – "Solid Mechanics", 1990.

ME3202	ENGINEERING MATERIALS AND METALLURGY	L	T	P	C
		3	0	0	3

OBJECTIVES

To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.

Course Outcome		Cognitive Skill
CO-01	Students gain the knowledge about Iron – Carbon system, various ferrous and non ferrous alloys .	U
CO-02	Study about different heat treatment process and its applications.	A,R
CO-03	Gain the knowledge about different types of non-metallic materials.	U
CO-04	Learn about different types of nano materials and its applications.	A
CO-05	Study and implements the different types of destructive and non destructive testing methods for different materials.	E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	M	L	L	L	M	N	M	L	M	L	N
CO-02	S	M	L	L	L	M	N	L	L	M	L	N
CO-03	S	M	M	L	L	L	N	L	L	L	M	N
CO-04	S	M	L	M	L	L	N	L	L	M	M	N
CO-05	S	M	L	M	M	L	N	L	L	M	M	N

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Steels& Alloys **9**

Allotropy, Iron - Iron carbide equilibrium diagram, critical temperatures. cooling curve and volume changes of pure iron. Effect of alloying additions on steel (Mn, Si, Cr, Mo, V Ti & W) - stainless and tool steels – HSLA. Gray, White malleable, spheroidal -Graphite - alloy cast-iron. Microstructures of slowly cooled steels, Estimation of carbon from Microstructures, non-equilibrium cooling of steels. Widmanstatten structures, Structures - property relationship.

Copper and Copper alloys, Aluminium and Aluminium alloys, Titatanium alloys, Magnesium alloys, Standards, precipitation strengthening treatment – Bearing alloys.

Unit II: Heat Treatment of Metals **9**

Heat treatment of steels, Transformation products of austenite, Time temperature Transformation diagrams(TTT), Critical cooling rate(CCR), continuous cooling transformation diagrams. Cooling media. Types - Annealing, normalizing, hardening. Tempering, Carburising, nitriding, carbonitriding,Flame and Induction hardening. Commercial heat treatment practice of gears of different sizes, tools, lathe beds, springs, etc.

Unit III: Polymers, Ceramics And Nano Materials **9**

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI,PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)- Engineering Ceramics –Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON.

Nano structured materials, Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots, Nano clusters & Nano crystals. Electronic and optical properties of nano crystallites, Metallic and semiconducting super lattices. Synthesis of nanostructured materials, Fabrication and characterization of nano electronic devices. Basics of synthesis and characterization of nano-multi-component systems for sensors (magnetic, electronic and optical) and electrodes.

Unit IV: Powder Metallurgy And Composites **9**

Powder metallurgy, Manufacturing Process, Compacting, Sintering, Vacuum processing. Properties of Powder processed materials, high energy compaction. Metal matrix composites, properties, Applications of Composites-Synthesis and fabrication of carbon nano structures for fuel cell and energy storage applications.

Unit V: Mechanical Properties And Testing **9**

Mechanical Properties And Testing**:** Mechanism of plastic deformation, slip and twinning. Types of fracture – Testing of materials under tension, compression and shear loads Hardness tests (Brinell, Vickers and Rockwell) Impact test, Izod and charpy, fatigue and creep test

Non Destructive Testing**:** basic principles and testing method for Radiographic testing, Ultrasonic testing, Magnetic particle inspection and Liquid penetrant inspections, Eddy current testing.

TOTAL: 45 HOURS

TEXT BOOK:

1. Kenneth G.Budinski and Michael K. Buinski, "*Engineering Materials*", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002
2. Sydney H.Avner "*Introduction to Physical Metallurgy*" McGraw Hill Book Company, 2007

REFERENCES:

1. O.P. Khanna ,A text book of Materials Science and Metallurgy, Khanna Publishers, 2003
2. William D Callister, "Material Science and Engineering", John Wiley and Sons, 1997.
3. Raghavan V, "Materials Science and Engineering", Prentice Hall of India Pvt. Ltd., 1999.
4. Dieter G. E., Mechanical Metallurgy, McGraw Hill Book Company, 1988
5. NPTEL courses, http://www.nptel.iitm.ac.in/courses.php?disciplineId=112: related web and video resources under Mechanical Engineering &Metallurgy and Material Science categorie.

ME3204	FLUID MECHANICS AND MACHINERY	L	T	P	C
		3	0	0	3

OBJECTIVES

The applications of the conservation laws to flow through pipes and hydraulic machines are studied. To understand the importance of dimensional analysis. To understand the importance of various types of flow in pumps and turbines

Course Outcome		Cognitive Skill
CO-01	To understand fluid properties and flow characteristics	U,R

CO-02	To understand ideal flow & boundary layer theory	U,R
CO-03	To understand flow through circular pipes and dimensional analysis	U,R
CO-04	To understand hydraulic turbines and their classification	U,R
CO-05	To understand the working principle of various pumps	

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	M	M	M	S	S	M	S	S	S	M
CO-02	S	S	M	M	M	S	S	M	S	S	S	M
CO-03	S	S	M	M	M	S	S	M	S	S	S	M
CO-04	S	S	M	M	M	S	S	M	S	S	S	M
CO-05	S	S	M	M	M	S	S	M	S	S	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Fluid Properties And Flow Characteristics 9

Units and dimensions- Properties of fluids. Pressure-height relation for incompressible fluid – Manometers. Bernoulli's equation, applications - Venturi meter, Orifice meter, Pitot tube. Statement of Navier Stokes equation, derivation of Euler's equation.

Unit II: Ideal Flow& Boundary Layer Theory 9

Types of flow - laminar, turbulent, unsteady, steady, non-uniform and uniform flows. Stream line, streak line and path line. Ideal Flow: Ir-rotational and rotational, stream function, potential function, continuity equation, derivation of three dimensional equation, applications to one dimensional flows steady flow, differential momentum equation. Boundary Layer Theory- D-Alembert paradox, Development of boundary layer, Prandtl’s boundary layer equations, Blasius solution.

Unit III: Flow Through Circular Pipes And Dimensional Analysis 9

Reynolds number, Darcy-Weisbach equation, use of Moody diagram, minor losses-sudden expansion, sudden contraction and losses in pipe fittings, Introduction to CFD: Necessity, limitations, philosophy behind CFD, applications**.** Dimensional analysis - Buckingham's Pi

theorem- applications - similarity laws and models.

Unit IV: Hydraulic Turbine: **9**

Hydraulic Turbines- Fluid machines definition and classification. Hydro turbines – definition, classification and flow, specific speed, performance characteristics, study of impulse and reaction turbines. Components of energy transfer- degree of reaction compounding of turbine, governing of turbine.

Unit V: Pumps **9**

Hydraulic Pumps- Classification of pumps and principle of working, Centrifugal pump classifications, working principles, velocity triangles, specific speed, efficiency and performance curves. Reciprocating pump classification, working principles, indicator diagram, work saved by Air vessels and performance curves - working principles of gear and vane pumps-Selection of pumps**.** Cavitation in pumps.

TOTAL: 45 HOURS

TEXT BOOK:

1. Kumar D S, "Fluid Mechanics and Fluid Power Engineering ", Kataria S K and Sons, New Delhi, 6th edition, 2008.
2. Robert W Fox, "Introduction to Fluid Mechanics", 10th Edition, John Wiley and sons, Singapore, 2020.

REFERENCES:

1. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 9th edition 2017
2. NPTEL courses: http://nptel.iitm.ac.in/courses.php - web and video resources on Fluid Mechanics.
3. Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, “Fluid Mechanics and Machinery”, 2011.
4. Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
5. John D Anderson, “Computational Fluid Dynamics – The Basics with Applications”, McGraw Hill, New Delhi, 1995.

AS3271	STRUCTURAL MECHANICS LAB	L	T	P	C
		0	0	2	1

OBJECTIVES

To develop the knowledge in testing the materials for hardness, fatigue, impact, tension and torsion.

Course Outcome		Cognitive Skill
CO-01	Carrying Out hardness Test	S
CO-02	Carrying out Fatigue Test	S
CO-03	Verification of Maxwell's Reciprocal theorem & principle of superposition	An
CO-04	Evaluation of young's modulus using extensometers	E
CO-05	Stress Strain curve for various engineering materials.	An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	S	S	M	N	N	M	M	L	S	M
CO-02	M	S	L	M	L	M	S	L	L	S	S	M
CO-03	N	L	S	S	L	N	S	S	M	M	S	S
CO-04	M	L	L	M	N	L	S	S	M	S	N	M
CO-05	M	L	M	M	M	L	N	S	M	M	L	S

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS

1. Hardness test - a)Vickers b)Brinell c) Rockwell d) Shore
2. Impact test – a) Izod b) Charpy
3. Fatigue test - a) Reverse plate bending b) Rotating Beam
4. Testing of springs
5. Deflection of beams with various end conditions.
6. Verification of Maxwell's Reciprocal theorem & principle of superposition
7. Block Compression Test
8. Determination of Young's modulus of steel using mechanical extensometers.
9. Determination of Young's modulus of aluminum using electrical extensometers
10. Determination of fracture strength and fracture pattern of ductile materials

11. Determination of fracture strength and fracture pattern of brittle materials
12. Stress Strain curve for various engineering materials.
13. Determination of Young's modulus for composite materials.

TOTAL: 45 HOURS

LIST OF EQUIPMENTS
(for a batch of 30 students)

Sl.No	Details of Equipments	Qty Required	For Experiments
1.	Vickers Hardness Testing Machine	1	1
2.	Brinell Hardness Testing Machine	1	1
3.	Rockwell Hardness Testing Machine	1	1
4.	Shore Hardness Testing Machine	1	1
5.	Universal Testing Machine	1	2,3
6.	Izod Impact Testing Machine	1	4
7.	Charpy Impact Testing Machine	1	4
8.	Fatigue tester- Rotating Beam	1	5
9.	Fatigue tester –Reverse plate bending	1	5
10.	Dial Gauges	2	8
11	Beam Test set up with various end conditions	1	7
12.	Weight 1 Kg	5	7
13.	Weight 2 Kg	5	7

AS3272	THERMAL AND HEAT TRANSFER LAB	L	T	P	C
		0	0	2	1

OBJECTIVES

To enhance the basic knowledge in applied thermodynamics & Heat Transfer

Course Outcome		Cognitive Skill
CO-01	COP test on a vapour compression.	S
CO-02	Determination of Transfer Coefficient in convection process.	S
CO-03	Determination of Thermal Resistance of a Composite wall.	An

CO-04	Determination of the viscosity of a given liquid.	An
CO-05	Determination of effectiveness of various heat exchanger.	E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	M	S	S	S	N	N	M	S	L	M	M
CO-02	M	S	L	N	L	M	S	L	L	S	S	M
CO-03	M	L	S	S	L	L	S	S	M	M	S	S
CO-04	M	L	M	M	N	L	S	S	M	S	M	M
CO-05	M	L	M	L	M	L	N	S	L	M	M	M

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS

1. Performance test on a 4-stroke engine
2. Valve timing of a 4 – stroke engine and port timing of a 2 stroke engine
3. Determination of effectiveness of a parallel flow heat exchanger
4. Determination of effectiveness of a counter flow heat exchanger
5. Determination of the viscosity coefficient of a given liquid
6. COP test on a vapor compression refrigeration test rig
7. COP test on a vapor compression air-conditioning test rig
8. Study of a Gas Turbine Engine.
9. Determination of Conductive Heat Transfer Coefficient.
10. Determination of Thermal Resistance of a Composite wall.

TOTAL: 45 HOURS

LIST OF EQUIPMENTS

(for a batch of 30 students)

Sl.No	Details of Equipment	Quantity required	Experiment No.
1.	4 stroke twin cylinder diesel engine	1	1
2.	Cut section model of 4 stroke Kirloskar diesel engine and cut section model of 2 stroke petrol	1	2

	engine		
3.	Parallel and counter flow heat exchanger test rig	1	3,4
4.	Red wood viscometer	1	5
5.	Vapour compression refrigeration test rig	1	6
6.	Vapour compression air-conditioning test rig	1	7
7.	Gas Turbine Engine	1	8
8.	Conductive Heat Transfer set up	1	9
9.	Composite wall	1	10

ME3271	FLUID MECHANICS AND MACHINERY LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES

To impart the fundamental knowledge of fluid mechanics and machinery lab to the students in order to achieve a well-founded knowledge about the principles of fluid mechanics and machinery lab.

Course Outcome		Cognitive Skill
CO-01	To determine coefficient of discharge of orifice meter and venturi meter	U, An
CO-02	To calculate rate of flow using rotameter	U, An
CO-03	To determine friction factor for a given set of pipes	U, An
CO-04	To conduct experiments in centrifugal pump and reciprocating pump	U, An
CO-05	To conduct experiments in gear pump, Pelton wheel, Francis turbine and Kaplan turbine	U, An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	M	L	L	M	S	M	S	S	S	L
CO-02	S	S	S	M	L	M	S	M	S	S	S	L
CO-03	S	S	S	L	L	M	S	M	S	S	S	L
CO-04	S	S	S	L	L	M	S	M	S	S	S	L
CO-05	S	S	S	L	L	M	S	M	S	S	S	L

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given venturi meter.
3. Calculation of the rate of flow using Rota meter/Mass flowmeter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal pump/submergible pump
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.
7. Conducting experiments and drawing the characteristic curves of Gear pump.
8. Conducting experiments and drawing the characteristic curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristic curves of Kaplan turbine.
11. Model study in wind tunnel.

TOTAL: 30 HOURS

LIST OF EQUIPMENTS

(for a batch of 30 students)

Sl.No	Details of Equipment	Quantity required	Experiment No.
1.	Orifice Meter	1	1
2.	Venturi meter	1	2
3.	Rota meter/Mass flow meter	1	3
4.	Centrifugal pump/submergible pump	1	5
5.	Reciprocating pump	1	6

6.	Gear pump	1	7
7.	Pelton wheel	1	8
8.	Francis turbine	1	9
9.	Kaplan turbine	1	10
10.	wind tunnel	1	11

SEMESTER IV

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MA3203	Numerical Methods	3	1	0	4
2.	BS3201	Environmental Science	2	0	0	2
3.	AS3204	Aerodynamics I	3	0	0	3
4.	AS3205	Aerospace Structures	3	0	0	3
5.	AS3206	Wind Tunnel Testing	3	0	0	3
6.	AE3208	Mechanics of Machines	3	0	0	3
PRACTICAL						
7.	AS3273	Aerospace Structures Lab	0	0	2	1
8.	AS3274	Flight Systems Laboratory	0	0	2	1
9.	AS3275	Low Speed Wind Tunnel Testing Laboratory	0	0	2	1
10.	AS32P1	Summer Internship-I	0	0	0	2
TOTAL			**17**	**1**	**6**	**23**

MA3203	NUMERICAL METHODS	L	T	P	C
		2	**1**	**0**	**3**

OBJECTIVES

To have the basic concepts in numerical methods and find the solutions of large system of linear equations where analytical methods fail to give solution. To gain the ability to solve engineering problems characterized in the form of non- linear ordinary differential equation or partial differential equation.

Course Outcome		Cognitive Skill
CO-01	Understand the fundamental theorem and compute the solution of non linear equations using Newton's method and fixed point iteration method. To solve the linear equations using direct and indirect methods.	U,A
CO-02	Apply interpolation for equal intervals using Newton's forward and backward formula and using Newton's divided difference formula for unequal intervals and Lagrange's formula.	A,An
CO-03	Discuss about numerical differentiation and integration. To apply Newton's forward and backward formula, Lagrange's formula and divided difference formula. To evaluate the integrals by using Trapezoidal rule and Simpson's rule.	R,U
CO-04	Understand the first order differential equation. To solve the first order differential equation by using single step method. To apply multi step method to find the solution of first order differential equation.	E, S
CO-05	To study about classification of partial differential equations. To find the finite difference solution of one dimensional heat equation and wave equation. To solve the two dimensional Laplace and poisson equations.	A,An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	M	S	M	M	L	L	M	M	M	M
CO-02	S	S	M	S	M	L	M	L	M	S	M	L
CO-03	S	S	M	S	M	M	M	M	L	M	M	M
CO-04	S	S	M	S	M	L	L	L	M	L	M	L
CO-05	S	S	L	S	M	L	L	L	L	M	M	L

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Solution of Equations **9**

Solution of non-linear equations–Newton Raphson method , Fixed point iteration method – Solution of linear system of Equations-Direct methods: Gaussian elimination and Gauss-Jordan methods – Iterative methods: Gauss Jacobi and Gauss – Seidel methods.

Unit II: Interpolation **9**

Forward and Backward Differences – Interpolation for equal intervals- Newton's forward and Backward formula- Interpolation for unequal intervals-Newton's divided difference and Lagrange's formula.

Unit III: Numerical Differentiation and Integration 9

Numerical differentiation using Newton's Forward, Backward, Newton's divided difference and Lagrange's formula – Numerical integration by Trapezoidal, Simpson's 1/3and 3/8rules– Gaussian Quadrature -Two and three point formulae.

Unit IV: Initial Value Problems for Ordinary Differential Equation 9

Solution of first order differential equations -Single step Methods : Taylor Series, Euler, Modified Euler methods and Fourth order Runge-Kutta method. Multi-step methods : Milne's and Adam's Predictor and Corrector methods.

Unit V: Numerical Solution of Boundary Value Problems 9

Classification of partial differential equation- Finite difference solution of one dimensional heat equation by implicit and explicit methods – One dimensional wave equation and two dimensional Laplace and Poisson equations.

TOTAL: 45 HOURS

TEXT BOOK

1. Venkatraman M.K, "Numerical Methods" Fifth Edition, National Pub. Company, Chennai 2005.

REFERENCES

1. Kandasamy, P.Thilakavathy, K and Gunavathy, K. "Numerical Methods" Second Edition, 2008 S.Chand and Co. New Delhi.
2. Scarborough, James B, "Numerical Mathematical Analysis"Oxford Book Company 1930
3. Balagurusamy, E., "Numerical Methods", First Edition, Tata McGraw-Hill Pub. Co. Ltd., New Delhi. 2009
4. Gerald, C.F, and Wheatley, P.O, "Applied Numerical Analysis", Sixth Edition, Pearson Education Asia, New Delhi, 2006.

BS3103	ENVIRONMENTAL STUDIES	L	T	P	C
		3	0	0	2

OBJECTIVES

To understand the basic concepts in environmental science
To gain the knowledge about structure and natural cycles of environment.
To get an idea about control methods of pollution.
To know the information about conservation methods of forest and wild life.

Course Outcome		Cognitive Skill
CO-01	Student will be able to demonstrate a general understanding of interdisciplinary nature of environmental uses and able to characterize natural resources.	U, A, An

CO-02	Students will be able to explain the effects of air, water, soil, noise and thermal pollution environment and suggest ways to reduce them.	R, E ,A
CO-03	Students will be able to explain the effects of air, water, soil, noise and thermal pollution environment and suggest ways to reduce them.	R, U, A
CO-04	Students will be able to understand the effects of human population and know about the awareness programme.	R, A, E
CO-05	Students apply systems concept and methodologies to analyse and understand interaction between social and environmental process.	R, A, An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	M	S	M	M	S	S	S	M	S	S	M
CO-02	M	M	S	M	S	S	S	S	M	S	S	M
CO-03	M	M	S	M	S	S	S	S	M	S	S	M
CO-04	M	M	S	S	M	S	S	S	M	S	S	M
CO-05	M	M	S	S	L	S	M	S	M	S	S	L

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Nature of Environment Studies And Natural Resources 9

Environment studies- definition – scope and importance- need for public awareness-Methods to create environmental awareness- Natural resources- Forest resources- energy resources- food resources- water resources – land resources - mineral resources.

Unit II: Eco Systems And Bio-Diversity 9

Concept and component of eco systems- producer, consumer, decomposer- structure and function of eco system- food chain and food web- energy flow model- aquatic eco system forest eco system- desert eco system- pyramid of biomass- ocean eco system- grass land eco system- Bio diversity in India- value of bio diversity- biodiversity threatens- biodiversity protection- In-situ and Ex-situ conservation.

Unit III: Environmental Pollution 9

Meaning of environmental pollution- air pollution- acid rain – global warming- water pollution- water pollution control- soil pollution- urban waste and soil pollution- marine pollution- noise pollution- thermal pollution- solid and hazardous waste management- waste disposal methods- solid waste and India- natural disaster and disaster management.

Unit IV: Human Population And Environment **9**

Population growth- distribution of population- factors affecting variation in population theories of population- future of human population- family welfare programme- HIV and AIDS- environment and human health- human rights- value education- women and child welfare.

Unit V: Social Issues And The Environment **9**

Unsustainable to sustainable development- sustainable development in India- water conservation, watershed management and water harvesting- environmental ethics- role of engineer in environmental protection.

TOTAL: 45 HOURS

TEXT BOOKS

1. Cunnigham&saigo: 'Environmental science :A global concern' 4th Ed.W.c. Brown Publishers. USA. 1997 2.Chauhan A.S, 'Environmental studies' 2nd revised ed.2004, Jain Brother publishers, New Delhi

REFERENCES:

1. Benny Joseph : 'Environmental Science and Engineering', 2006, Tata McGraw- Hill Publication. 2. Siddique K.A. : Elements of Ecology and Environmental Pollution, 1st Ed. 2002, Kushal Publication, Varanasi. M

AS3204	AERODYNAMICS I	L	T	P	C
		3	0	0	3

OBJECTIVES

To understand the behavior of airflow over bodies with particular emphasis on airfoil sections in the incompressible flow regime.

Course Outcome		Cognitive Skill
CO-01	Apply the basic knowledge of engineering to basic aerodynamic and fluid mechanics.	A
CO-02	Ability to analyze the subsonic flows for engineering concepts.	An
CO-03	To apply the knowledge of engineering to understand airfoil and wing characteristics.	A
CO-04	To apply the knowledge of aerodynamic sciences to understand incompressible flow over wings.	A

CO-05	Ability to solve the complex engineering concepts and problems on viscous flows.	S

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	M	S	S	S	M	N	N	M	M	L	M	M
CO-02	L	S	L	N	L	M	S	L	L	S	S	S
CO-03	L	L	S	S	L	N	S	N	M	M	S	S
CO-04	M	L	M	M	N	M	S	S	M	S	M	L
CO-05	M	L	M	M	M	L	N	S	M	L	M	S

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Review Of Basic Fluid Mechanics **9**

Incompressible Bernoulli's equation – circulation and vorticity - Continuity, momentum and energy equations.

Unit II: Two Dimensional Flows **9**

Basic flows – Source, Sink, Free and Forced vortex, uniform parallel flow. Their combinations, Pressure and velocity distributions on bodies with and without circulation in ideal and real fluid flows.Kutta Joukowski's theorem.

Unit III: Conformal Transformation **9**

Kutta Joukowski's theorem – Joukowski transformation and its application to fluid flow problems, Kutta condition, Blasius theorem.

Unit IV: Airfoil And Wing Theory **9**

Joukowski, Karman - Trefftz, Profiles - Thin aerofoil theory and its applications. Vortex line, Horse shoe vortex, Biot and Savart law, Lifting line theory and its limitations.

Unit V: Viscous Flow **9**

Newton's law of viscosity, Boundary Layer, Navier-Stokes equation, displacement, Momentum thickness, Flow over a flat plate, Blasius solution.

TOTAL: 45 HOURS

TEXT BOOKS

1. Anderson, J.D.Jr., "Fundamentals of Aerodynamics", McGraw-Hill Book Co., New York, 1985.

REFERENCES

1. Houghton, E.L., and Carruthers, N.B., "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989.
2. Milne Thomson, L.H., "Theoretical aerodynamics", Macmillan, 1985.
3. Clancy, L.J., "Aerodynamics", Pitman, 1986

AS3205	AEROSPACE STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVES

To study the behavior of various aircraft structural components under different types of loads.

Course Outcome		Cognitive Skill
CO-01	Students will learn the basic principles and theoretical foundation for structural analysis.	An
CO-02	Students will attain the skill to approach structural problems related to trusses, single and multicell structure panels and webbed beams,	S
CO-03	Students will get exposed to various alternate methods to solve and analyze the aerospace structural problems.	A
CO-04	Students will come to know the importance and criticality of the structural design in the mission of an aerospace application.	An
CO-05	Students will be equipped with necessary skills to collect data and analyze any aerospace structural research work.	A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	L	M	M	M	L	S	M	N	L	S	M
CO-02	M	L	L	M	M	M	L	S	L	M	N	M
CO-03	S	L	L	M	L	L	M	N	S	L	M	M
CO-04	M	M	M	L	L	L	M	N	L	L	M	L

CO-05	M	L	L	L	M	M	L	S	L	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Unsymmetrical Bending **9**

Bending stresses in beams of unsymmetrical sections – Bending of symmetric sections with skew loads.

Unit II: Statically Determinate And Indeterminate Structures **9**

Analysis of plane truss – Method of joints – 3 D Truss - Plane frames. Composite beam - Clapeyron's Three Moment Equation - Moment Distribution Method.

Unit III: Shear Flow In Open Sections **9**

Thin walled beams, Concept of shear flow, shear center, Elastic axis. With one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections. Bredt – Batho formula, Single and multi – cell structures. Approximate methods. Shear flow in single & multi-cell structures under torsion. Shear flow in single and multi-cell under bending with walls effective and ineffective.

Unit IV: Buckling Of Plates **9**

Rectangular sheets under compression, Local buckling stress of thin walled sections, Crippling stresses by Needham's and Gerard's methods, Thin walled column strength. Sheet stiffener panels. Effective width, inter rivet and sheet wrinkling failures.

Unit V: Stress Analysis And Failure Theory **9**

Procedure – Shear and bending moment distribution for semi cantilever and other types of wings and fuselage, thin webbed beam. With parallel and nonparallel flanges, Shear resistant web beams, Tension field web beams (Wagner's). Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.

TOTAL: 45 HOURS

TEXT BOOK

1. Peery, D.J., and Azar, J.J., "Aircraft Structures", 2nd edition, McGraw–Hill, N.Y., 1993.

REFEENCES

2. Megson, T.M.G., "Aircraft Structures for Engineering Students", Edward Arnold, 1995.
3. Bruhn. E.H. "Analysis and Design of Flight vehicles Structures", Tri – state off set company, USA, 1985.
4. Rivello, R.M., "Theory and Analysis of Flight Structures", McGraw-Hill, 1993.

AS3206	WIND TUNNEL TESTING	L	T	P	C
		3	0	0	3

OBJECTIVES

To introduce the basic concepts of measurement of forces and moments on models during the wind tunnel testing.

Course Outcome		Cognitive Skill
CO-01	Study about the basic calculations involved in wind tunnels.	U, A
CO-02	Learn about various types of wind tunnels and it's classification based on speed, size etc.	An, E
CO-03	An idea about calibration of wind tunnels, instruments involved and calculations.	An, E
CO-04	Study about various balances used in wind tunnels.	E
CO-05	Gain a good knowledge about high speed wind tunnels and also flow visualization techniques involved	R,A,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	S	S	S	M	L	N	L	N	S	L
CO-02	M	S	M	S	S	S	L	N	L	N	S	L
CO-03	S	S	M	S	S	L	L	N	L	N	S	L
CO-04	S	M	S	S	S	L	L	N	L	N	S	L
CO-05	M	M	S	S	S	L	L	N	L	N	S	L

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Principles Of Model Testing **6**

Buckingham Theorem – Non-Dimensional Numbers –Scale Effect Types of Similarities.

Unit II: Wind Tunnels **8**

Classification – Special problems of Testing in Subsonic, Transonic, supersonic and hypersonic speed regions – Layouts – sizing and design parameters.

Unit III: Calibration Of Wind Tunnels **11**

Test section speed – Horizontal buoyancy – Flow angularities – Turbulence measurements – Associated instrumentation – Calibration of supersonic tunnels.

Unit IV: Wind Tunnel Measurements **12**

Pressure and velocity measurements – Force measurements – Three component and six component balances – Internal balances.

Unit V: High Speed Wind Tunnels **8**

Blow down, in-draft and induction tunnel layouts and their design features, Transonic, supersonic and hypersonic tunnels and their peculiarities, Helium and
gun tunnels, Shock tubes, Optical methods of flow visualization.

TOTAL: 45 HOURS

TEXT BOOK

1. Rae, W.H. and Pope, A. "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984.

REFERENCE

1. Pope, A., and Goin, L., "High Speed wind Tunnel Testing", John Wiley, 1985.

AE3208	MECHANICS OF MACHINES	L	T	P	C
		3	0	0	3

OBJECTIVES

To expose the students the different mechanisms, their method of working, forces involved and consequent vibration during working.

Course Outcome		Cognitive Skill
CO-01	To apply mathematics and science to simple mechanisms	A
CO-02	Ability to solve complex problems in friction	E
CO-03	Ability to analyze, interpret and solve complex engineering problems in gears and cams	An

CO-04	To know the basics of balancing of rotating and reciprocating masses	U
CO-05	Ability to evaluate the problems on vibration	E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	M	S	M	M	N	N	L	M	L	L	N
CO-02	M	S	S	L	M	N	N	M	L	N	M	N
CO-03	M	S	M	M	N	N	N	M	L	N	M	N
CO-04	M	M	S	L	N	N	N	L	L	N	M	N
CO-05	S	M	M	S	M	N	N	M	M	M	M	N

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Mechanisms **9**

Machine Structure – Kinematic link, pair and chain – Gruebler criteria – Constrained motion – Degrees of freedom - Slider crank and crank rocker mechanisms – Inversions – applications – Crank and slotted lever mechanism – Whitworth quick return mechanism - Kinematic analysis of simple mechanisms – Determination of velocity and acceleration.

Unit II: Friction **9**

Friction in screw and nut – Pivot and collar – Thrust bearing – Plate and disc clutches – Belt (flat and V) and rope drives. Ratio of tensions – Effect of centrifugal and initial tension – Condition for maximum power transmission – Open and crossed belt drive.

Unit III: Gearing And Cams **9**

Gear profile and geometry – Nomenclature of spur gear – Gear trains: Simple, compound gear trains and epicylic gear trains - Determination of speed and torque - Cams – Types of cams – Design of profiles – Knife edged, flat faced and roller ended followers with and without offsets for various types of follower motions.

Unit IV: Balancing **9**

Static and dynamic balancing – Single and several masses in different planes –Balancing of reciprocating masses- primary balancing and concepts of secondary balancing – Single and multi cylinder-Inline engines– Balancing of radial V engine - direct and reverse crank method.

Unit V: Vibration **9**

Free, forced and damped vibrations of single degree of freedom systems – Force transmitted to supports – Vibration isolation – Vibration absorption – Torsional vibration of shaft – Single and multi rotor systems – Geared shafts – Critical speed of shaft.

TOTAL: 45 HOURS

TEXT BOOKS

1. Rattan.S.S, "Theory of Machines", Tata McGraw–Hill Publishing Co, New Delhi, 2004.
2. Ballaney.P.L, "Theory of Machines", Khanna Publishers, New Delhi, 2002.

REFERENCES

1. Rao, J.S and Dukkipati, R.V, "Mechanism and Machine Theory", Second Edition, Wiley Eastern Ltd., 1992.
2. Malhotra, D.R and Gupta, H.C., "The Theory of Machines", SatyaPrakasam, Tech. India Publications, 1989.
3. Gosh, A. and Mallick, A.K., "Theory of Machines and Mechanisms", Affiliated East West Press, 1989.
4. Shigley, J.E. and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw-Hill, 1980.
5. Burton Paul, "Kinematics and Dynamic of Planer Machinery", Prentice Hall, 1979.

AS3273	AEROSPACE STRUCTURES LAB	L	T	P	C
		0	0	2	1

OBJECTIVES

To experimentally study the unsymmetrical bending of beams, find the location of shear center , obtain the stresses in circular discs and beams using photo - elastic techniques, calibration of photo – elastic materials and study on vibration of beams,

Course Outcome		Cognitive Skill
CO-01	Students will study various equipment used for structural analysis	An,E
CO-02	Students will understand the procedure to determine the shear centre location for various sections.	A,E
CO-03	Students will attain the skill to use the photo elastic and strain gauge equipment and apply it for structure problems.	An,E
CO-04	Students will get hand on experience on maintenance process like riveting.	An,E
CO-05	Students will apply the theoretical knowledge about buckling and crippling using the equipments in the lab.	R,U,A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	S	M	S	L	L	L	L	N	S	M
CO-02	L	S	S	L	S	M	L	L	L	N	S	M
CO-03	M	S	S	M	S	M	L	L	L	N	S	M
CO-04	M	S	S	L	S	M	L	L	L	N	S	M
CO-05	M	S	S	M	S	L	L	L	L	N	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS

1. Calibration of Photo- elastic materials (Circular Disc)
2. Column - Testing
3. Wagner beam – Tension field beam
4. Shear center location for closed sections
5. Shear center location for open sections
6. Calibration of strain gauge
7. Beam test apparatus
8. Riveted Joints.
9. Vibrations of beams
10. Study of principle plane of unsymmetrical beams

TOTAL : 45 HOURS

LIST OF EQUIPMENT
(for a batch of 30 students)

Sl.No.	Name of the Equipment	Quantity	Experiments Number
1	Photo – elastic apparatus	1	1
2	Wagner beam	1	3
3	Screw Jack	1	3
4	Beam Test set –up	2	4
5	Rivet Gun	1	8
6	Strain indicator and strain gauges	One set	6
7	Amplifier	2	9
8	Exciter	2	9
9	Pick – up	2	9
10	Oscilloscope	2	9

11	Unsymmetrical sections like ‘Z’ sections	2	5,4,10
12	Channel section and angle section	2	5,4,10
13	Dial gauges	12	5,4,7,10
14	Weights 1Kg	10	2,5,4,10
15	Weights 2 Kg	10	2,5,4,10

AS3274	FLIGHT SYSTEMS LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES

To train the students “ON HAND” experience in maintenance of various air frame systems in aircraft and rectification of common snags.

Course Outcome		Cognitive Skill
CO-01	Illustrate the operations of jacking up and levelling of aircraft with DGCA guidelines.	U,A
CO-02	Demonstrate rigging and symmetry check on an aircraft	An,E
CO-03	Report and analyses results for flow test, pressure test, functional test and brake torque load test.	An,E
CO-04	Review, inspect and safely perform maintenance and troubleshooting on hydraulic systems as per airworthiness standards.	R,A,E
CO-05	Review, inspect and safely perform maintenance and troubleshooting on fuel systems as per airworthiness standards.	R,A,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	S	S	S	M	L	N	L	N	S	L

CO-02	M	S	M	S	S	S	L	N	L	N	S	L
CO-03	S	S	M	S	S	L	L	N	L	N	S	L
CO-04	S	M	S	S	S	L	L	N	L	N	S	L
CO-05	M	M	S	S	S	L	L	N	L	N	S	L

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS

1. Study of various aircraft systems and the safety precautions before handling them.
2. Aircraft "Jacking Up" procedure
3. Aircraft "Levelling" Check
4. Aircraft flight controls Rigging check.
5. Aircraft "Symmetry Check" procedure
6. "Flow test" to assess of filter element clogging
7. "Pressure Test" To assess hydraulic External/Internal Leakage
8. "Functional Test" to adjust operating pressure
9. "Pressure Test" procedure on fuel system components
10 "Brake Torque Load Test" on wheel brake units
11 Maintenance and rectification of snags in hydraulic and fuel systems.

TOTAL: 45 HOURS

LIST OF EQUIPMENTS
(for a batch of 30 students)

S.No.	Items	Quantity	Experiment No.
1.	Serviceable aircraft with all above systems	1	1,2,3,4,5,6,7,8,9,10
2.	Hydraulic Jacks (Screw Jack)	5	1,2,4,8
3.	Trestle adjustable	5	1,2,4,8
4.	Spirit Level	2	3,4
5.	Levelling Boards	2	3,4
6.	Cable Tensiometer	1	4
7.	Adjustable Spirit Level	1	3,4
8.	Plumb Bob	1	5

AS3275	LOW SPEED WIND TUNNEL TESTING LAB	L	T	P	C
		0	0	2	1

OBJECTIVES

To study experimentally the aerodynamic forces on different bodies at low speeds.

Course Outcome		Cognitive Skill
CO-01	Ability to evaluate the subsonic wind tunnel for accuracy of solutions.	U
CO-02	Ability to analyse the pressure distribution over cylinder.	An
CO-03	Ability to analyse the pressure distribution over cambered airfoils and thin airfoils.	An
CO-04	To understand the flow visualization studies over cylinder.	U
CO-05	To understand the flow visualization studies over airfoils with different angle of incidence.	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	M	S	M	L	M	M	L	M	L	L	M
CO-02	M	S	M	M	M	M	L	L	M	S	N	L
CO-03	S	M	L	L	M	L	M	M	L	L	L	L
CO-04	M	L	L	L	L	M	L	L	L	M	M	L
CO-05	M	M	L	L	L	M	M	L	L	L	M	L

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS

1. Calibration of subsonic wind tunnel.
2. Pressure distribution over smooth and rough cylinder.
3. Pressure distribution over symmetric airfoils.
4. Pressure distribution over cambered airfoils and thin airfoils.
5. Force measurement using wind tunnel balance.
6. Flow over a flat plate at different angles of incidence
7. Flow visualization studies in low speed flows over cylinders
8. Flow visualization studies in low speed flows over airfoil with different angle of incidence

9. Calibration of supersonic wind tunnel.
10. Supersonic flow visualization with Schlieren system.

TOTAL: 45 HOURS

LIST OF EQUIPMENTS
(for a batch of 30 students)

Sl.No.	Items	Quantity	Experiment No.
1.	Wind Tunnel test section size around 300 x 300 mm with test section flow speed of 70 m/s.	1 No.	1,2,3,4,5
2.	Wings of various airfoil sections (Symmetrical & cambered airfoils)	2 Nos. each	3,4
3.	Angle of incidence changing mechanism	1 No.	3,4
4.	Multiple Manometer stands with 20 – 30 manometer tubes	4 Nos.	2,3,4
5.	U-Tube Manometer	1 No.	1,2,3,4
6.	Static Pressure Probes	4 Nos.	1,2,3,4
7.	Total Pressure Probes	4 Nos.	1,2,3,4
8.	Pitot-static Tubes	4 Nos.	1,2,3,4
9.	Wooden Models of Three Dimensional bodies (eg. Cylinder etc.,)	2 Nos. each	2
10.	Wind Tunnel balances (3 or 5 or 6 components)	1 No.	5
11.	Pressure Transducers with digital display	1 No.	1,2,3,4
12.	Hele-Shaw apparatus, Smoke Tunnel, Water flow channel	1 each	6,7,8
13.	Supersonic Wind Tunnel of section size 100 x 100 mm with storage tank capacity of 500 ft^2 at 20 bar	1 No.	9,10
14.	Wooden models of cone, wedge and blunt body configurations of suitable size for flow visualization in a supersonic wind tunnel test section	1 No.	9,10
15.	Schlieren System	1 No.	9,10

SEMESTER V

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	MS3201	Professional and Business Ethics	3	0	0	3
2.	AS3209	Aerospace Production Techniques	3	0	0	3
3.	AS3210	Aerodynamics II	3	0	0	3
4.	AS3211	Aerospace Propulsion I	3	0	0	3
5.	AS3212	Aircraft Performance, Stability and	3	0	0	3
6.	*****	Elective-I	3	0	0	3
PRACTICAL						
7.	AS3276	CAD modeling and analysis Laboratory	0	0	3	1
8.	AS3277	Aerospace Design Project I	0	0	3	1
TOTAL			**18**	**0**	**6**	**20**

MS3201	PROFESSIONAL AND BUSINESS ETHICS	L	T	P	C
		3	0	0	3

OBJECTIVES

Upon completing this course, students will be able to define and apply ethical principles, theories, and frameworks to resolve moral conflicts and make informed decisions in personal and professional settings. Students will develop critical thinking, problem-solving, and decision-making skills to navigate complex ethical issues, cultivate personal and professional integrity, and promote a culture of accountability and responsibility in business and professional contexts.

Course Outcome		Cognitive Skill
CO-01	Explore the relationship between ethics and business across different cultural traditions.	U, A
CO-02	Explain the connection between ethics, morals, and values in the workplace.	E
CO-03	Formulate an ethical philosophy and relate it to current practices.	An

CO-04	Assess the ethical implications of business activities and competing demands on businesses.	E
CO-05	Critically analyse real-world contexts and conduct research projects on topics related to business ethics.	S

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	S	S	S	M	S	N	S	N	S	M
CO-02	M	S	M	S	S	S	L	M	L	N	S	L
CO-03	M	S	M	M	S	L	L	N	L	N	L	L
CO-04	S	S	S	S	M	L	M	N	M	N	S	L
CO-05	M	M	S	S	S	L	L	N	L	N	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: Human Values **9**

Morals, Values, and Ethics -Integrity and Work Ethic - Service Learning and Civic Virtue - Respect for Others and Living Peacefully - Caring, Sharing, and Honesty - Courage, Valuing Time, and Co- operation - Commitment, Empathy, and Self-Confidence - Character and Spirituality.

Unit II: Engineering Ethics **9**

Senses of 'Engineering Ethics' and Moral Issues - Types of Inquiry and Moral Dilemmas - Moral Autonomy and Ethical Theories - Models of Professional Roles - Self-Interest, Customs, and Religion.

Unit III: Engineering as Social Experimentation **9**

Engineering as Experimentation - Engineers as Responsible Experimenters - Codes of Ethics and Legal Perspectives - Case Study: The Challenger Incident

UnitIV: Safety, Responsibilities, and Rights **9**

Safety, Risk, and Risk Assessment - Risk-Benefit Analysis and Risk Reduction - Case Studies: Three Mile Island and Chernobyl - Collegiality, Loyalty, and Respect for Authority - Conflicts of Interest and Occupational Crime - Professional and Employee Rights - Intellectual Property Rights (IPR) and Discrimination

Unit V: Global Issues **9**

Multinational Corporations and Environmental Ethics - Computer Ethics and Weapons Development - Engineers as Managers, Consultants, and Expert Witnesses - Sample Codes of Ethics from Professional
Organizations.

Total: 45 hours

Textbooks:

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering," McGraw-Hill, New York, Latest edition: 4th edition (2022).

2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics," Prentice Hall of India, New Delhi, Latest edition: 2nd edition (2021).

References:

1. Charles D. Fleddermann, "Engineering Ethics," Pearson Education/Prentice Hall, New Jersey, Latest edition: 4th edition (2022).

2. Charles E Harris, Michael S. Protchard, and Michael J Rabins, "Engineering Ethics - Concepts and Cases," Wadsworth Thompson Learning, United States, Latest edition: 2nd edition (2023).

3. John R Boatright, "Ethics and the Conduct of Business," Pearson Education, New Delhi, Latest edition: 8th edition (2021).

4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers," Oxford University Press, Oxford, Latest edition: 2nd edition (2022).

AS3209	AEROSPACE PRODUCTION TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES

Upon completing this course, students will be able to apply aerospace production techniques, including materials selection, machining, joining, and inspection methods. They will utilize CAD/CAM software, interpret engineering drawings, and adhere to lean manufacturing principles, ensuring compliance with industry standards and safety protocols in aircraft and spacecraft component production.

Course Outcome		Cognitive Skill
CO-01	To study the performance of various production techniques	U, A
CO-02	Evaluate the knowledge in depth details of Mechanical productions	E
CO-03	Analyze the knowledge in Lathes, carpentry and plumbing works	An

CO-04	Knowing about Fitting and special machine works	E
CO-05	Interpret the knowledge in Cutting Techniques	S

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	S	S	S	M	S	N	S	N	S	M
CO-02	M	S	M	S	S	S	L	M	L	N	S	L
CO-03	M	S	M	M	S	L	L	N	L	N	L	L
CO-04	S	S	S	S	M	L	M	N	M	N	S	L
CO-05	M	M	S	S	S	L	L	N	L	N	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: CASTING AND WELDING 9

General principles of various Casting Processes - Sand casting, die-casting, centrifugal casting, investment casting and shell molding types- Principles and equipment used in arc welding, gas welding, resistance welding - Laser welding, Electron Beam welding - Soldering and brazing techniques.

UNIT II : MACHINING OPERATIONS 9

General Principles of working of lathe, types of lathes and commonly performed operation in lathe- General Principles of working, types and operation of grinding and drilling machines - General Principles of working, types and operation of Shaper and milling machines - General Principles of working, types and operation of CNC Machining.

UNIT III: UNCONVENTIONAL MACHINING PROCESSES 9

Principles of working and Application of Abrasive Jet Machining, Ultrasonic Machining- Principles of working and Application of Electric Discharge Machining, Electrochemical Machining, Chemical Machining - Principles of working and Application of LASER Beam Machining, Electron Beam Machining, Plasma Arc Machining.

UNIT IV: FORMING OPERATIONS **9**

Forming of metals Forging of metals, Rolling, Extrusion and Drawing. Sheet metal operations shearing, punching, super plastic forming, diffusion bonding, and different operations in bending. - Riveting types and techniques used in aerospace industry.

UNIT V: CUTTING TECHNIQUES **9**

Significance of machining processes in engineering / aerospace applications- theory and mechanics of machining using single point and multipoint cutting tools- configuration and working of conventional machine tools- cutting parameters-machinability of materials-cutting tool materials and concept of tool life.

TOTAL : 45 HOURS

TEXTBOOK:

1.Keshu S.C, Ganapathy K.K, "Aircraft production technique' Interline Publishing House, Bangalore1993.
2.Dr.PCSharma,"ATextbookofProductionTechnology"S.CHANDandcompanyPvt. Ltd. NewDelhi, Eighth edition 2014.

REFERENCES:

1. R.K.Jain"Productiontechnology"-Khanna Publishers New Delhi 2002.
2, O.P.Kanna and lal "Production Technology" M.Dhanapatrai publications,New Delhi 1997.
3.Airframe and Powerplant Mechanics,"Aircraft hand Book"Federal Aviation Administration,Shr off publishers and distributors Pvt. Ltd. New Delhi 2010.
4. Kalpakjian, S and Schmidt, S.R Manufacturing processes for engineering methods, 5t ed.,Pearson Education (2007).

AS3210	AERODYNAMICS II	L	T	P	C
		3	0	0	3

OBJECTIVES

Upon completing Aerodynamics II, students will analyze and apply advanced aerodynamic concepts, including compressible flow, boundary layers, turbulence, and viscous flow. They will calculate lift, drag, and thrust, and design aerodynamic shapes using computational fluid dynamics (CFD) and wind tunnel testing, preparing them for real-world aerospace engineering applications.

Course Outcome		Cognitive Skill
CO-01	Students able to understand the Navier stokes equation for compressible and incompressible flows	U
CO-02	Students able to know the types of shocks	An
CO-03	Students able to know the convex corner and expansion waves	A
CO-04	Students able to know the subsonic and supersonic airfoils	U
CO-05	Students able to understand the high speed flows and wind tunnels	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	L	M	M	M	L	S	M	N	L	S	M
CO-02	M	L	L	M	M	M	L	S	L	M	N	M
CO-03	S	L	L	M	L	L	M	N	S	L	M	M
CO-04	M	M	M	L	L	L	M	N	L	L	M	L
CO-05	M	L	L	L	M	M	L	S	L	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I : ONE DIMENSIONAL COMPRESSIBLE FLOW **7**

Continuity, Momentum, Energy and state equations, velocity of sound, Adiabatic steady state flow equations, Flow through converging and diverging passages, Performance under various back pressures, Isentropic and Area Mach number Relation.

UNIT II : NORMALAND OBLIQUE SHOCKS 15

Prandtl equation and Rankine - Hugonoit relation, Normal shock equations, Pitot static tube, corrections for subsonic and supersonic flows, Oblique shocks and corresponding equations, Hodograph and pressure turning angle, shock polars, flow past wedges and concave corners, strong, weak and detached shocks.

UNIT III: EXPANSION WAVES AND METHOD OF CHARACTERISTICS 8

Flow past convex corners, Expansion hodograph, Reflection and interaction ofshocks and expansion waves, Families of shocks, Methods of Characteristics, Two dimensional supersonic nozzle contours. Rayleigh and Fanno Flow.

UNIT IV: DIFFERENTIALEQUATIONSOFMOTIONFORSTEADY COMPRESSIBLE FLOWS 9

Small perturbation potential theory, solutions for supersonic flows, Mach waves and Mach angles, Prandtl-Glauert affine transformation relations for subsonic flows, Linearised two dimensional supersonic flow theory-Lift, drag pitching moment and center of pressure of supersonic aerofoils.

UNIT V : HIGH SPEED FLOWS AND WIND TUNNELS 6

Lower and upper critical Mach numbers, Lift and drag divergence, shock induced separation, Characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects. Blow down, in draft and induction tunnel layouts and their design features.

TOTAL HOURS: 45

TEXT BOOKS:

1. Rathakrishnan, E., ”Gas Dynamics”, Prentice Hall of India, 2003.

REFERENCES:

1. Shapiro, A.H., ”Dynamics and Thermodynamics of Compressible Fluid Flow”, Ronold Press, 1982.
2. Zucrow, M.J. and Anderson, J.D., ”Elements of gas dynamics”, McGraw-Hill Book Co., New York, 1989.
3. McCornick.W.,”Aerodynamics, Aeronautics and Flight Mechanics”, John Wiley, New York, 1979.
4. Anderson Jr.,D.,-”Modern compressible flows”, McGraw-Hill Book Co., New York 1999.
5. J.D. Anderson,” Fundamentals of Aerodynamics” by McGraw-Hill Book Co., New York 1999.

AS3211	AEROSPACE PROPULSION-I	L	T	P	C
		3	0	0	3

OBJECTIVES

Upon completing Aerospace Propulsion-I, students will understand and analyze fundamental propulsion concepts, including thermodynamics, fluid dynamics, and rocket performance. They will design and evaluate propulsion systems, including rocket engines, turbojets, and turboprops, and calculate thrust, specific impulse, and efficiency, preparing them for aerospace engineering applications in aircraft and spacecraft.

Course Outcome		Cognitive Skill
CO-01	Apply the knowledge of engineering to understand the basics of gas turbines.	U
CO-02	Ability to analyze the concepts of inlets& nozzles.	A
CO-03	Apply the knowledge of engineering to understand the fundamentals and working of combustion chamber	A
CO-04	Ability to analyze the concepts of nozzles	An
CO-05	Students will understand the propeller theory.	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	S	M	M	M	M	L	L	S	S	S
CO-02	S	S	S	M	L	N	S	M	M	M	M	L
CO-03	M	M	S	S	L	L	M	M	L	S	S	L
CO-04	L	S	S	M	N	L	S	M	M	M	M	M
CO-05	L	L	M	N	L	N	N	S	M	N	M	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I : FUNDAMENTALS OF GAS TURBINE ENGINES 9

Basic principles ofgas turbine engine - The thrust equation - Factors affecting thrust - Effect of pressure, velocity and temperature changes of air entering compressor- Methods of thrust

augmentation-Turboprop, turbofan and turbojet engines- Performance and characteristics. Types of Propellants and their characteristics.

UNIT II: INLETS AND NOZZLES 9

Internal flow and Stall in subsonic inlets - Boundary layer separation - Major features of external flow near a subsonic inlet – Diffuser Performance-Supersonic inlets. Theory of flow in isentropic nozzles - Convergent nozzles and nozzle choking – Nozzle efficiency-Losses in nozzles - Thrust reversal.

UNIT III: COMBUSTION CHAMBERS 9

Classification of combustion chambers-Important factors affecting combustion chamber design-Combustion process - Combustion chamber performance - Effect of operating variables on performance - Flame tube cooling - Flame stabilization - Use of flame holders - Numerical problems.

UNIT IV: COMPRESSORS 9

Principle of operation of centrifugal compressor - Work done and pressure rise - Velocity diagrams- Diffuser vane design considerations- Concept of pre whirl- Rotation stall-Elementary theory of axial flow compressor - Velocity triangles - degree of reaction - Three dimensional - Air angle distributions for free vortex and constant reaction designs - Compressor blade design - Centrifugal and Axial compressor performance characteristics

UNITV: PROPELLER THEORY 9

Propeller power losses – Propeller performance – Incompressible theory for positive thrust – Incompressible theory for negative thrust. Prediction of static thrust – Prediction of in-flight thrust. Propeller thrust control – Propeller noise control – Propeller chart.

TOTAL: 45 HOURS

TEXT BOOK:

1. Hill, P.G. & Peterson, C.R. ”Mechanics & Thermodynamics of Propulsion” Addison - Wesley Longman INC, 1999.

2. Mattingly, Jack D. Elements of gas turbine propulsion. Vol. 1. McGraw-Hill Science, Engineering & Mathematics,1996.

3. Yahya, S. M. Fundamentals of Compressible Flow: With Aircraft and Rocket Propulsion.
New Age Science,2010.

REFERENCES:

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, 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. ”Rolls Royce Jet Engine” - Third Edition -1983.

4.Mathur,M.L.andSharma,R.P.,”GasTurbine,JetandRocketPropulsion”,StandardPublishers &
Distributors, Delhi,1999.

AS3212	AIRCRAFT PERFORMANCE, STABILITY AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES

Upon completing this course, students will analyze and evaluate aircraft performance, stability, and control characteristics, including takeoff/landing, climb/descent, and maneuverability. They will calculate range, endurance, and load factors, applying aerodynamic principles to ensure safe and efficient flight operations.

Course Outcome		Cognitive Skill
CO-01	Understanding the basic concept of cruising performance	R
CO-02	Study and Understanding the basic concept of maneuvering flight performance	U,An
CO-03	Knowledge about the longitudinal stability.	R,A
CO-04	Understanding the basic of lateral & directional stability	R,U
CO-05	Understanding the basic of dynamic stability	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	S	S	S	M	N	N	N	N	S	L
CO-02	M	S	M	S	S	S	N	N	N	M	S	L
CO-03	S	S	M	S	S	L	N	N	N	L	S	L

CO-04	S	M	S	S	S	L	N	N	N	M	S	L
CO-05	M	M	S	S	S	L	N	N	N	L	S	L

S-Strong, M-Medium,L-Low,N-Not relevant

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

Degreeoffreedomofrigidbodiesinspace-Staticanddynamicstability-Purposeofcontrols 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 8

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

TOTAL HOURS: 45

TEXT BOOK:

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley & Son:, Inc, NY,1988.
2. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co.,2004.
3. Mc Cornick. W., "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, NY,1979.

REFERENCE :

1. Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, NY,1982.

2.Babister,A.W.,"AircraftDynamicStabilityandResponse",PergamonPress,Oxford,1980.

3. Dommasch, D.O., Sherby, S.S., and Connolly, T.F., "Aeroplane Aero dynamics", Third Edition, Issac Pitman, London,1981.

4. Mc Cornick B. W," Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, NY, 1995.

AS32A1	UAV DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES

Upon completing this course, students will design, analyze, and optimize Unmanned Aerial Vehicle (UAV) systems, integrating aerodynamics, structures, propulsion, and avionics. They will apply design principles to ensure UAV performance, stability, control, and safety for various mission requirements.

Course Outcome		Cognitive Skill
CO-01	Students able to Knowledge on History of UAV	U
CO-02	Students able to Acquiring basics of flights	An
CO-03	Students able to Understand the navigation and guidance	A
CO-04	Students able to Know the UAV design using Xflr5	U
CO-05	Students able to Understand the ground testing of UAV	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	L	M	M	M	L	S	M	N	L	S	M
CO-02	M	L	L	M	M	M	L	S	L	M	N	M
CO-03	S	L	L	M	L	L	M	N	S	L	M	M
CO-04	M	M	M	L	L	L	M	N	L	L	M	L
CO-05	M	L	L	L	M	M	L	S	L	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I : INTRODUCTION TO UAV **9**

Introduction to UAV-History of UAV – classification- Fixed-Wing Unmanned Aerial Vehicles Multi-Rotor Unmanned Aerial Vehicles – Introduction to Unmanned Aircraft Systems–models and prototypes – System Composition-applications.

UNIT II: BASICS OF FLIGHT **9**

Different types of flight vehicles-Drones- Components and functions of an airplane- Forces acting on Airplane-Structure of the atmosphere-Aerodynamics-Lift and drag-Airplane Structures.

UNIT III: NAVIGATION AND GUIDANCE **9**

AvionicsHardware-Autopilot-AGL-pressuresensors-sensors-RFCommunications-Antennas-servos-accelerometer-gyros-actuators- power supply processor, integration, installation, configuration, and testing.

UNIT IV: UAV DESIGNUSING XFLR5 **11**

UAVdevelopmentusingXflr5software-Airfoilnomenclature-wing–fuselage-HorizontalTail-Vertical Tail-Aerodynamic parameters-Lift,drag,weight and moment estimation.

UNIT V: GROUND TESTING OF UAV **7**

Development of Uav Systems-Waypoints navigation-ground control software-System Ground Testing- System In-flight Testing-Future Prospects and Challenges-Case Studies –Mini and Micro UAVs.

TOTAL : 45 HOURS

TEXT BOOK:

1. John Anderson.,"Aircraft Performance and design",WCB/McGraw- Hill,2003.
2. Zoran Gacovski, "Unmanned Aerial Vehicles and Drones", Arcler Education Inc,2020
3. Myron Kayton ,Waltern R. Fried, "Avionics Navigation systems", Technology and Engineering,1997

REFERENCES:

1. ArmandJ. Chaput, "Design of Unmanned Air Vehicle Systems",Lockheed Martin Aeronautics Company, 2001.
2. KimonP.Valavanis,"AdvancesinUnmannedAerialVehicles:StateoftheArtandthe Road to Autonomy", Springer, 2007.
3. PaulGFahlstrom,ThomasJGleason,"IntroductiontoUAVSystems",UAVSystems, Inc,1998.
4. RegAustin"unmannedaircraftsystemsUAVdesign,developmentanddeployment", Wiley,2010.
5. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

AS3276	CAD MODELING AND ANALYSIS LAB	L	T	P	C
		0	0	3	1

OBJECTIVES

Upon completing this course, students will create and analyze complex 3D models using Computer-Aided Design (CAD) software, applying geometric dimensioning and tolerancing (GD&T) principles. They will perform simulations, stress analyses, and optimization techniques to validate designs for manufacturing and functionality.

Course Outcome		Cognitive Skill
CO-01	Ability to apply the behavior of beam structure by applying various loads.	U
CO-02	Ability to analyses the complete beam structure using ANSYS software.	A
CO-03	To apply the knowledge of engineering by testing various types of beams.	A
CO-04	To apply the knowledge of engineering by drawing various aircraft parts.	An
CO-05	To understand the commands of AUTOCAD software & ANSYS software.	An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	M	S	S	L	S	S	N	L	L	L	S	N
CO-02	M	S	M	S	S	M	N	M	L	L	S	M
CO-03	N	M	S	L	L	S	M	M	L	L	M	L
CO-04	L	L	S	M	M	N	N	L	L	L	M	L
CO-05	N	L	N	M	S	S	N	L	L	L	S	L

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS:

1. Scaling, rotation, translation, editing, dimensioning - Typical CAD command structure.
2. Computer aided modeling of typical aircraft wing.
3. Computer aided modeling of typical fuselage structure.

4. Computer aided modeling of landing gear
5. Computer aided modeling of other a/c components.
6. Static & Dynamic analysis of beams.
7. 2D truss analysis.
8. Stress analysis of circular hole.
9. Building graphical aircraft design using MATLAB.
10. Next generation aerospace collaborative simulation by using MATLAB tools.
11. Study of CNC.

TOTAL: 45 HOURS

AS3277	AEROSPACE DESIGN PROJECT–I	L	T	P	C
		0	0	3	1

OBJECTIVES

Upon completing Aerospace Design Project-I, students will conceptualize, design, and propose an aerospace system or component, applying aerodynamics, structures, propulsion, and systems engineering principles. They will develop a detailed design report, model, and presentation, demonstrating feasibility and innovation.

Course Outcome		Cognitive Skill
CO-01	Students able to Know the Comparative study of aircraft	U
CO-02	Students able to Understand the preliminary design of weight estimation	An
CO-03	Students able to Know the Aircraft wing, Tail section and power plant	A
CO-04	Students able to Understand the performance and stability estimation	U
CO-05	Students able to Know to draw the Three view diagrams of Aircraft	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	L	M	M	M	L	S	M	N	L	S	M
CO-02	M	L	L	M	M	M	L	S	L	M	N	M
CO-03	S	L	L	M	L	L	M	N	S	L	M	M

CO-04	M	M	M	L	L	L	M	N	L	L	M	L
CO-05	M	L	L	L	M	M	L	S	L	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS:

1. Literature Survey of different types of Airplanes, Helicopter, Rockets and UAV
2. Comparative studies of different types of airplanes and their specification sand performance details with reference to the design work under taken.
3. Preparation of comparative data sheets
4. Worksheet layout procedures
5. Comparative graphs preparation and selection of main parameters for the design
6. Preliminary weight estimations, selection of main parameters
7. Power plant selection, Aerofoil selection, Wing tail and control surfaces
8. Preparation of layouts of balance diagram and three view drawings
9. Drag estimation
10. Detailed performance calculations and stability estimates
11. Preparation of layout drawing, construction of balance and three view diagrams of the airplane under consideration.

TOTAL PERIODS : 45

SEMESTER VI

Sl. No	Course Code	Course Title	L	T	P	C
THEORY						
1.	AI32D1	Fundamentals of Artificial Intelligence (Open Elective)	3	0	0	3
2.	AS3213	Finite Element Analysis	3	0	0	3
3.	AS3214	Aerospace propulsion II	3	0	0	3
4.	AS32A5	Avionics (Department Elective-II)	3	0	0	3
5.	AS32A6	Cryogenics (Department Elective-III)	3	0	0	3
PRACTICAL						
7.	AS3278	Aerospace Propulsion Laboratory	0	0	3	1
8.	AS3279	Aerospace Design Project II	0	0	3	1
9.	AS3280	Navigation and Guidance Laboratory	0	0	3	1
10.	AS32P2	Summer Internship II	0	0	0	2
TOTAL			**15**	**0**	**9**	**20**

AI32D1	FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3

OBJECTIVES

Upon completing this course, students will understand AI concepts, including machine learning, natural language processing, and computer vision. They will design and implement intelligent systems, applying algorithms and techniques to solve real-world problems, and evaluate AI models for performance and ethics.

Course Outcome		Cognitive Skill
CO-01	Explain autonomous agents that make effective decisions in fully informed, partially observable, and adversarial settings.	U
CO-02	Choose appropriate algorithms for solving given AI problems	A

CO-03	Design and implement logical reasoning agents	R, A
CO-04	Design and implement agents that can reason under uncertainty	R,A
CO-05	Understand the basic areas of artificial intelligence including problem solving, knowledge representation, reasoning, decision making, planning, perception and action.	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	S	M	M	M	N	N	N	S	S	S
CO-02	S	S	S	M	L	N	N	N	N	M	M	L
CO-03	M	M	S	S	L	L	N	N	N	S	S	L
CO-04	L	S	S	M	N	L	N	N	N	M	M	M
CO-05	L	L	M	N	L	N	N	N	N	N	M	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT I: AI AGENTS **9**

Introduction to AI – Agents and Environments – Concept of rationality – Nature of environments –Structure of agents – Problem solving agents–Search algorithms– Uninformed search strategies.

UNIT II: PROBLEM SOLVING **9**

Heuristic search strategies–heuristic functions - Local search and optimization problems – Local search in continuous space – Search with non-deterministic actions – Search in partially observable environments – Online search agents and unknown environments.

UNIT III: THEORY OF GAME PLAYING **9**

Game theory – Optimal decisions in games – Alpha-beta search – Monte-Carlo tree search – Stochastic games– Partially observable games. Constraint Satisfaction Problems – Constraint propagation – Backtracking search for CSP –Local search for CSP– Structure of CSP.

UNIT IV: KNOWLEDGE BASED LOGICAL AGENTS **9**

Knowledge-based agents – Propositional logic – Propositional theorem proving –

Propositional model checking– Agents based onpro positional logic.First-order logic – Syntax and semantics – Knowledge representation and engineering –Inferences in first-order logic– Forward chaining– Backward chaining–Resolution.

UNIT V: KNOWLEDGE REPRESENTATION 9

Onto logical engineering Objects and categories–Events–Mental objects and Modallogic– Reasoning systems for categories – Reasoning with default information.Classicalplanning–Algorithmsforclassicalplanning–Heuristicsforplanning– Hierarchicalplanning–Non-deterministic domains–Time,Schedule, and Resources–Analysis.

TOTAL PERIODS : 45

TEXTBOOKS

1. Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition,PearsonEducation,2020.

REFERENCES

1. DanW.Patterson,"IntroductiontoAIandES",PearsonEducation,2007.
2. KevinNight,ElaineRich,andNairB.,"ArtificialIntelligence",McGrawHill,2008.
3. Patrick H.Winston,"ArtificialIntelligence",Thirdedition, PearsonEdition,2006.
4. Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education, 2013.
5.Artificial Intelligence by Example: Develop machine intelligence from scratch using real artificial intelligence use cases –by Dennis Rothman,2018.

AS3213	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES

Upon completing Finite Element Analysis, students will apply numerical methods to simulate and analyze complex engineering problems, including structural mechanics, heat transfer, and fluid dynamics. They will use commercial FEA software to model, analyze, and optimize systems for stress, deformation, and performance.

Course Outcome		Cognitive Skill
CO-01	To obtain an understanding of the fundamental theory of FEA method.	R,A
CO-02	To understand the use of basic finite elements for structural applications using truss, beam, frame and plane elements.	U,A
CO-03	Able to apply suitable boundary conditions to a global equation for bars, beams, truss, axisymmetric and solve them displacements, stress and strain induced.	An,E

CO-04	To demonstrate the ability to create models for trusses, frames, plate, machine parts components using ANSYS general purpose software.	A,An
CO-05	To understand the application and use of FE method for heat transfer problems.	U,An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	S	M	M	M	N	N	N	S	S	S
CO-02	S	S	S	M	L	N	N	N	N	M	M	L
CO-03	M	M	S	S	L	L	N	N	N	S	S	L
CO-04	L	S	S	M	N	L	N	N	N	M	M	M
CO-05	L	L	M	N	L	N	N	N	N	N	M	L

S-Strong, M-Medium-Low,N-Not relevant

UNIT – I INTRODUCTION 9

Fundamental Concepts of Engineering Analysis - Historical Background –General Steps of FEA– Discretization –Weighted Residual Methods– Governing equation and convergence criteria of finite element method. Advantages, Disadvantages & Application of FEA

UNIT – II ONE DIMENSIONAL PROBLEMS 9

Introduction - Finite Element Modelling - Derivation of Shape functions and Stiffness matrices and force vectors for Bar, Frame, beam elements– Galerkin approach- Application to static, dynamic and stability analysis.

UNIT – III TWO-DIMENSIONAL CONTINUUM ELEMENTS 9

Introduction - Finite Element Modelling –Constant Strain Triangular elements – Shape functions and element matrices and vectors – poisons Equation and Laplace Equation - .Application to plane stress, plane strain and axisymmetric problems.

UNIT – IV ISOPARAMETRIC ELEMENTS 9

Natural co-ordinate systems – Iso parametric elements – Shape functions for iso parametric elements–Applications to two and three-dimensional problems. -Introduction to analysis software – FEA Software Packages

UNIT – V FIELD PROBLEM 9

Applications to other field problems like heat transfer and fluid flow. Application to Bar Element – Heat transfer – Thermal Problems 2D

TOTAL: 45 HOURS

TEXT BOOKS

1. Lakshmi Narasaiah, "Finite Element analysis" 2nd Edition, BSP Books, 2022

REFERENCES

1. Tirupathi.R. Chandrapatha and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall India, Third Edition, 2003.

2. Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butterworth Heinemann, 2004

3. Reddy J.N. "An Introduction to Finite Element Method", McGraw-Hill, 2000.Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw-Hill, 2000

AS3214	AEROSPACE PROPULSION-II	L	T	P	C
		3	0	0	3

OBJECTIVES

Upon completing Aerospace Propulsion-II, students will analyze and design advanced propulsion systems, including liquid rocket engines, solid motors, and electric propulsion. They will evaluate performance, efficiency, and thrust-to-weight ratios, applying thermodynamic and fluid dynamic principles to optimize system design and operation.

Course Outcome		Cognitive Skill
CO-01	Ability to learn the gas turbines performance, profiles, designs, working principle.	A
CO-02	To understand the air breathing propulsion engines and their performance, design.	U
CO-03	To study the fundamentals of rocket propulsion, classification & performance,	R
CO-04	Ability to apply the fundamentals of chemical rockets, criteria for selection, limitations.	An
CO-05	Ability to learn the advanced propulsion techniques like electric, ion, nuclear propulsions.	A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	M	M	M	M	L	S	N	N	L	S	L
CO-02	M	S	L	L	S	M	L	N	M	L	N	M
CO-03	M	L	S	M	S	M	L	N	N	L	L	M
CO-04	S	M	M	L	L	L	M	N	N	L	M	L
CO-05	M	M	L	L	S	M	L	N	N	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNITI: GASTURBINES 9

Impulse and reaction blading of gas turbines - Velocity triangles and power output - Elementary theory-Vortex theory-Choice of blade profile, pitch and chord-Estimation of stage performance - Limiting factors in gas turbine design-Overall turbine performance-Methods of blade cooling - Matching of turbine and compressor – Numerical problems.

UNITII: RAM JET & SCRAM JET PROPULSION 9

Basic principle of ramjet engine - Sub critical, critical and supercritical operation - Combustion in ramjet engine - Ramjet performance - Sample ramjet design calculations - Basic principle of scramjet engine- Preliminary concepts in supersonic combustion - Integral ram engine-Numerical problems.

UNIT III : FUNDAMENTALS OF ROCKET PROPULSION 9

Operating principle-Specificimpulseofarocket-internalballistics-Rocketnozzleclassification- Rocket performance considerations.

UNIT IV : CHEMICALROCKETS 9

Solidpropellantrockets-Selectioncriteriaofsolidpropellants-Importanthardwarecomponents of solid rockets - Propellant grain design considerations - Liquid propellant rockets - Selection of liquid propellants-Thrust control in liquid rockets-Cooling in liquid rockets-Limitations of hybrid rockets-Relative advantages of liquid rockets over solid rockets-Numerical Problems-Propellant Combustion-Thrusters.

UNIT V : ADVANCED PROPULSION TECHNIQUES 9

ElectricPropellants-Ionpropulsiontechniques-Nuclearrocket-Types-Solarsail-Preliminary Concepts in nozzle less propulsion.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Sutton, G.P.,"RocketPropulsionElements",JohnWiley&SonsInc.,NewYork,5thEdn., 1993.

2. Hill, P.G. & Peterson, C.R. ”Mechanics & Thermodynamics of Propulsion” Addison - Wesley Longman INC, 1999.
3. Mattingly, Jack D. Elements of gas turbine propulsion. Vol. 1. McGraw-Hill Science, Engineering & Mathematics,1996.

REFERENCES:

1. Cohen, H., Rogers, G.F.C. and Saravanamuttoo, H.I.H., ”Gas Turbine Theory”, Longman Co., ELBS Ed.,1989.
2. Gorden, C.V., ”Aero thermodynamics of Gas Turbine and Rocket Propulsion”, AIAA Education Series, New York,1989.

AS32A2	EXPERIMENTAL STRESS ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES

Upon completing Experimental Stress Analysis, students will design and conduct experiments to measure stresses, strains, and deformations in aerospace structures. They will utilize sensors, data acquisition systems, and analytical techniques to validate theoretical models, identify potential failures, and optimize structural design for safety and performance.

Course Outcome		Cognitive Skill
CO-01	Students will come to know the basic principles, accuracy, sensitivity and range of measurements	A
CO-02	Students can understand the working principles, uses and applications of various extensometers	A
CO-03	Students can understand the principle, operation and requirements of electrical resistance strain gauges	A
CO-04	Students will come to know the concept behind the 2D photo elasticity and get some idea of 3D photo elasticity	A
CO-05	Students can elaborately study various non-destructive testing method and its features	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L

CO-01	S	M	M	M	M	L	S	N	N	L	S	L
CO-02	M	S	L	L	S	M	L	N	M	L	N	M
CO-03	M	L	S	M	S	M	L	N	N	L	L	M
CO-04	S	M	M	L	L	L	M	N	N	L	M	L
CO-05	M	M	L	L	S	M	L	N	N	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNIT-I MEASUREMENTS 4

Principles of measurements, Accuracy, Sensitivity and range of measurements.

UNIT-II EXTENSOMETERS 6

Mechanical, Optical Acoustical and Electrical extensometers and their uses, Advantages and disadvantages.

UNIT-III ELECTRICALRESISTANCESTRAINGAUGES 10

Principle of operation and requirements, Types and their uses, Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheastone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.

UNIT IV: PHOTOELASTICITY 10

Two dimensional photo elasticity, Concept of light - photoelastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials. Introduction to three dimensional photoelasticity.

UNIT V: NON-DESTRUCTIVETESTING 15

Fundamentals of NDT, Radiography, ultrasonic, magnetic particle inspection, Fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique, Fundamentals of brittle coating methods, Introduction to Moir techniques, Holography, ultrasonic C- Scan, Thermograph, Fiber- optic Sensors.

TOTAL: 45 HOURS

TEXTBOOK:

1. Srinath,L.S.,Raghava,M.R.,Lingaiah,K.,Garagesha,G.,PantB.,andRamachandra,K., ”Experimental Stress Analysis”, Tata McGraw-Hill, New Delhi, 1984.

REFERENCES:

1. Dally,J.W.,andRiley,W.F.,”ExperimentalStressAnalysis”,McGraw-HillInc.,New York, 1998.
2. Hetyenyi, M., ”Hand book of Experimental Stress Analysis”, John Wiley and Sons Inc., New York, 1972.

3. PollockA.A.,"AcousticEmissioninAcousticsandVibrationProgress",Ed.Stephens R.W.B.,
Chapman and Hall, 1993.

4. Dally J.W. and Riley W.F. "Experimental Stress Analysis" McGraw Hill inc., New York 1998.

AS32A3	EXPERIMENTAL AERODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES

Upon completing Experimental Aerodynamics, students will design, conduct, and analyze wind tunnel tests to measure aerodynamic forces, pressures, and flow characteristics. They will utilize instrumentation, data acquisition systems, and visualization techniques to validate theoretical models, evaluate aircraft performance, and optimize aerodynamic design.

Course Outcome		Cognitive Skill
CO-01	Students able to get knowledge on measurement techniques in aerodynamic flow.	U
CO-02	Students able to acquiring basics of wind tunnel measurement systems	An
CO-03	Students able to get knowledge on specific instruments for flow parameter measurement like pressure, velocity.	A
CO-04	Students able to use measurement techniques involved in Aerodynamic testing.	U
CO-05	Students able to analyze the model measurements, Lift and drag measurements through various techniques and testing of different models.	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	L	M	M	M	L	S	M	N	L	S	M
CO-02	M	L	L	M	M	M	L	S	L	M	N	M
CO-03	S	L	L	M	L	L	M	N	S	L	M	M
CO-04	M	M	M	L	L	L	M	N	L	L	M	L

CO-05	M	L	L	L	M	M	L	S	L	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

UNITI: BASIC MEASUREMENTS IN FLUID MECHANICS 7

Objective of experimental studies–Fluid mechanics measurements–Properties of fluids - Measuring instruments–Performance terms associated with measurement systems–Direct measurements–Analogue methods–Flow visualization–Components of measuring systems - Importance of model studies.

UNIT II : WINDTUNNELMEASUREMENTS 7

Wind Tunnel Measurements-Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels – Power losses in a wind tunnel –Instrumentation and calibration of wind tunnels -Turbulence- Wind tunnel balance – Wire balance – Strut-type – Platform-type – Yoke-type -Pyramid type – Strain gauge balance – Balance calibration.

UNIT III: FLOWVISUALIZATIONANDANALOGUEMETHODS 11

Visualization techniques- Smoke tunnel- Hele shaw Apparatus- Interferometer- Fringe Displacement method- Schlieren system- Shadowgraph- Hydraulic analogy- Hydraulic jumps- Electrolytic tank.

UNIT IV: PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS 7

Pressure, Velocity and Temperature measurements-Pitot – static tube characteristics – Velocity measurements – Hot-wire anemometry – Constant current and Constant temperature Hot-Wire anemometer – Pressure measurement techniques -Pressure transducers – Temperature measurements.

UNIT V: SPECIAL FLOWS AND UNCERTAINTY ANALYSIS 13

Special Flows and Uncertainty Analysis-Experiments on Taylor-Proudman theorem and Ekman layer–Measurements in boundary layers -Data acquisition and processing – Signal conditioning - Uncertaintyanalysis–Estimationofmeasurementerrors–Externalestimate of the error– Internal estimate of the error – Uncertainty calculation – Uses of uncertainty analysis.

TOTAL: 45 HOURS

TEXTBOOKS:

1. Rathakrishnan,E.,Instrumentation,Measurements,andExperimentsinFluids,CRC Press - Taylor and Francis, 2007.
2. Robert B Northrop, Introduction to Instrumentation and Measurements, Second Edition, CRC Press, Taylor and Francis, 2006.

REFERENCES:

1. Bradsaw"ExperimentalFluidMechanics",Elsevier,2nd edition,1970.
2. Pope,A.,andGoin,L.,"HighSpeedWindTunnelTesting",JohnWiley,1985.

AS3278	AEROSPACE PROPULSION LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES

Upon completing Aerospace Propulsion Laboratory, students will experimentally investigate propulsion system performance, measuring thrust, specific impulse, and efficiency. They will design, test, and analyze rocket engines, turbojets, and other propulsion systems, applying theoretical knowledge to practical problems and validating simulation models with empirical data.

Course Outcome		Cognitive Skill
CO-01	Apply the knowledge of engineering to understand the basics of aircraft gas turbines.	U
CO-02	Ability to analyze the concepts of subsonic & supersonic inlets.	A
CO-03	Apply the knowledge of engineering to understand the fundamentals and working of combustion chamber	U
CO-04	Ability to analyze the concepts of nozzles	U
CO-05	Understand about various advanced rocket propulsion compressor.	A

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	M	S	S	L	S	S	N	L	L	L	S	N
CO-02	M	S	M	S	S	M	N	M	L	L	S	M
CO-03	N	M	S	L	L	S	M	M	L	L	M	L
CO-04	L	L	S	M	M	N	N	L	L	L	M	L
CO-05	N	L	N	M	S	S	N	L	L	L	S	L

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS:

1. Safety precautions to be followed during engine service
2. Stud of performance of a propeller
3. Study of Engine Starting Procedure
4. Study of lubricating oils used in engines
5. Determination of heat of combustion of aviation fuel.
6. Study of an aircraft piston engine. (Includes study of assembly of subsystems)
7. Study of an aircraft jet engine (Includes study of assembly of subsystems)
8. Study of Ramjet Engine (Includes various components, their functions and operating principles)
9 Study of scram jet engines (Includes various components, their functions and operating principles)
10. Study of rocket engine (Includes various components, their functions and operating principles)

TOTAL: 45 HOURS

AS3279	AEROSPACE DESIGN PROJECT-II	L	T	P	C
		0	0	3	1

OBJECTIVES

Upon completing Aerospace Design Project-II, students will integrate multidisciplinary knowledge to design, optimize, and present a comprehensive aerospace system or vehicle. They will apply industry standards, consider regulatory requirements, and demonstrate feasibility, performance, and innovation through detailed reports, models, and presentations.

Course Outcome		Cognitive Skill
CO-01	Understand the detailed design of Aircraft wing	U
CO-02	Understand the detailed design of Aircraft fuselage	An
CO-03	Know the calculation of balancing and maneuvering loads of aircraft	A
CO-04	Understand the V-n design calculation	U
CO-05	Know to draw the Three view diagrams of Aircraft	U

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	L	M	M	M	L	S	M	N	L	S	M
CO-02	M	L	L	M	M	M	L	S	L	M	N	M
CO-03	S	L	L	M	L	L	M	N	S	L	M	M
CO-04	M	M	M	L	L	L	M	N	L	L	M	L
CO-05	M	L	L	L	M	M	L	S	L	M	L	L

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS:

1. Preliminary design of an aircraft wing– Shrenck's curve, structural load distribution, shear force, bending moment and torque diagrams.
2. Detailed design of an aircraft wing–Design of spars and stringers,bending stress and shear flow calculations – buckling analysis of wing panels.
3. Preliminary design of an aircraft fuselage – load distribution on an aircraft fuselage.
4. Detaileddesignofanaircraftfuselage–designofbulkheadsandlongerons–bending stress and shear flow calculations – buckling analysis of fuselage panels.
5. Designofcontrolsurfaces–balancingandmaneuveringloadsonthetailplaneand aileron, rudder loads.
6. Design of wing-root attachment.
7. Landing gear design.
8. V-n diagram for the designs tudy
9. Gust and maneuverability envelopes
10.Critical loading performance and final V-N graph calculation
11. Preparation of a detailed design report with CAD drawings

AS3280	NAVIGATION AND GUIDANCE LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES

Upon completing Navigation and Guidance Laboratory, students will design, implement, and test navigation and guidance systems for aerospace applications. They will integrate sensors,

GPS, and control systems, analyzing performance, accuracy, and reliability, and validating simulation models through hands-on experimentation and data analysis.

Course Outcome		Cognitive Skill
CO-01	To introduce the MAT LAB , Working With Matrix and Expressions	S
CO-02	Ability to design and relate the logic operations	S
CO-03	Analyze the microprocessors additions, subtractions of 8 bit and 16 bit numbers	An, E
CO-04	Students will understand the Multiplication & Division of 8-bit numbers	E
CO-05	Students will understand the sorting of Data in Ascending & Descending order	R,A,E

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L
CO-01	S	S	S	S	S	M	L	N	L	N	S	L
CO-02	M	S	M	S	S	S	L	N	L	N	S	L
CO-03	S	S	M	S	S	L	L	N	L	N	S	L
CO-04	S	M	S	S	S	L	L	N	L	N	S	L
CO-05	M	M	S	S	S	L	L	N	L	N	S	L

S-Strong, M-Medium,L-Low,N-Not relevant

EXPERIMENT: MATLAB

1. Study of the basic features and various tools of the Computational Software (MATLAB).
2. Solving basic algebraic equations, solving system of equations, two dimensional plots.
3. Working with Matrices, Expressions, Relational and Logical Operations.
4. Plotting Root locus and Bode plot .
5. Solution of Kepler's Equation for different orbits
6. Calculation of the state vector given the initial state vector and the time lapse t.
7. Calculation of the orbital elements from the state vector.
8. Analysis of Spacecraft relative Motion using MATLAB.

MICROPROCESSORS

1. Addition and Subtraction of 8-bit numbers.
2. Addition and Subtraction of 16-bit numbers.
3. Multiplication and division of 8 bit numbers.
4. Sorting of Data in Ascending order.
5. Sorting of Data in Descending order.

TOTAL: 45 HOURS

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	AS3215	Computational Fluid Dynamic Techniques	3	0	0	3
2.	AS32B9	Space Propulsion Systems (Department Elective-IV)	3	0	0	3
3.	AS32C5	Rockets and missiles (Department Elective-V)	3	0	0	3
4.	MS3202	Principles of Management (Open Elective-II)	2	0	0	2
5.	IT32B2	Fundamentals of Data Science (Open Elective-III)	3	0	0	3
PRACTICAL						
6.	AS3281	Aerospace Computational Laboratory	0	0	2	1
7.	AS3282	Composite Material Laboratory	0	0	2	1
8.	AS32P3	Mini Project	0	0	6	3
TOTAL			**14**	**0**	**10**	**19**

AS3215	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	**0**	**0**	**3**

OBJECTIVES: This course will enable students

1. To introduce Governing Equations of viscous fluid flows

2. To introduce numerical modelling and its role in the field of fluid flow and heat transfer

3. To enable the students to understand the various discretization methods, solution procedures and turbulence modelling.

4. To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

5. To make the students familiarize with the industrial applications of CFD and its role in the design of various components in engineering

Course Outcome		Cognitive Skill
CO-01	To understand the significance of both conservative and non-conservative forms of governing equations for fluid flows	A
CO-02	To analyse the grid quality and assess its suitability for using it for obtaining CFD solutions	An
CO-03	To apply the panel methods to the various CFD Problems	A
CO-04	To apply suitable time dependent methods with proper numerical schemes for finding solutions either by steady or unsteady approach for aeronautical and aerospace problems	S
CO-05	To understand and analyse the FVM in CFD	An

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	S	N	M	L	L	L	L	M
CO-02	L	S	L	N	S	M	M	L	L	L	L	S
CO-03	L	S	S	S	S	N	M	L	L	L	L	S
CO-04	M	S	M	M	S	M	M	L	L	L	L	L
CO-05	M	S	M	M	S	L	M	L	L	L	L	S

UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 9

Introduction – Basic Equations of Fluid Dynamics – Mathematical properties of Fluid Dynamics Equations – Elliptic, Parabolic and Hyperbolic equations – Well posed problems – discretization of partial Differential Equations – Transformations and grids – Explicit finite difference methods of subsonic, supersonic and viscous flows.

UNIT II GRID GENERATION 9

Structured grids. Types and transformations. Generation of structured grids. Unstructured grids. Delaunay triangulation. Grid Independence study.

UNIT III PANEL METHODS 9

Discretization of inviscid and viscous compressible flows, time dependent methods. Concept of numerical dissipation – Stability properties of explicit and implicit methods – Conservative upwind discretization for Hyperbolic systems, Unwind differencing.

UNIT IV TIME DEPENDENT METHODS 9

Overview of Finite Element Techniques in Computational Fluid Dynamics. Finite difference methods. Central, Upwind type discretization, Treatment of Derivatives.

UNIT V FINITE VOLUME TECHNIQUES 9

Finite Volume Techniques – Cell Centered and Cell Vertex Formulation – Lax-Wendoroff Time Stepping – Runge-Kutta Time Stepping – Multi – Stage Time Stepping – Accuracy – Cell Vortex Formulation – Multistage Time Stepping. Pressure correction solvers – SIMPLE, PESO – Implicit/semi-implicit schemes.

TOTAL : 45 PERIODS

TEXTBOOKS:

1.Bose. TK, "Numerical Fluid Dynamics", Narosa Publishing House, 2001.

2. Chung. TJ, "Computational Fluid Dynamics", Cambridge University Press, 2010.

3.John D. Anderson, "Computational Fluid Dynamics", McGraw Hill Education, 2017.

REFERENCES:

1.Hirsch,A.A, "Introduction to Computational Fluid Dynamics", McGraw-Hill, 1989.

2.SedatBiringen&Chuen-Yen Chow, "Introduction to Computational Fluid Dynamics by Example", Wiley publishers, 2nd edition, 2011.

3.Wirz, HJ &Smeldern, JJ, "Numerical Methods in Fluid Dynamics", Washington: Hemisphere Pub. Corp., 1978.

MS3202	PRINCIPLES OF MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES: This course will enable students

1. To introduce students to the basic concepts and functions of management.

2. To understand the role and responsibilities of managers in various organizational settings.

3. To develop an understanding of the planning, organizing, leading, and controlling functions of management.

4. To examine the impact of management theories and practices on organizational performance.

5. To equip students with the skills necessary to manage people and processes effectively in a technical environment.

Course Outcome		Cognitive Skill
CO-01	Define and explain the key concepts and functions of management.	A
CO-02	Analyze the roles and responsibilities of managers in different organizational contexts.	An
CO-03	Apply planning, organizing, leading, and controlling principles to real-world scenarios.	A
CO-04	Evaluate the effectiveness of different management theories and practices.	S
CO-05	Demonstrate management skills necessary for leading teams and projects in a technical environment	An

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	S	N	M	L	L	L	L	M
CO-02	L	S	L	N	S	M	M	L	L	L	L	S
CO-03	L	S	S	S	S	N	M	L	L	L	L	S
CO-04	M	S	M	M	S	M	M	L	L	L	L	L
CO-05	M	S	M	M	S	L	M	L	L	L	L	S

UNIT I Introduction to Management **7**

Definition, nature, and importance of management - Functions of management: Planning, Organizing, Leading, Controlling - Roles and skills of managers - Evolution of management thought: Classical, Behavioral, and Modern theories - Scientific Management (Taylor) - Administrative Theory (Fayol) - Human Relations Movement (Mayo) - Contemporary approaches (Systems Theory, Contingency Theory)

UNIT II Planning 5

Nature and purpose of planning - Types of plans: Strategic, Tactical, Operational - Planning process and techniques - SWOT Analysis, SMART Goals , Scenario Planning - Decision making: Process, types, and tools- Rational Decision-Making Model - Bounded Rationality - Group Decision-Making Techniques (Brainstorming, Delphi Technique)

UNIT III Organizing 5

Organizational structure and design - Types of organizational structures: Functional, Divisional, Matrix, Network - Authority, responsibility, and delegation - Coordination and communication within organizations - Formal and Informal Communication Channels - Role of Technology in Organizational Communication (Emails, Video Conferencing, Collaborative Tools)

UNIT IV Leading 7

Leadership theories and styles - Trait Theory - Behavioral Theories (Ohio State Studies, Michigan Studies) - Contingency Theories (Fiedler's Model, Path-Goal Theory) - Transformational vs. Transactional Leadership - Motivation theories and practices, Maslow's Hierarchy of Needs, Herzberg's Two-Factor Theory, McClelland's Theory of Needs, Modern Approaches (Self-Determination Theory) -Group dynamics and team management - Stages of Team Development (Forming, Storming, Norming, Performing) - Managing Virtual Teams

UNIT V Controlling 6

Nature and purpose of control - Control process and techniques, Establishing Standards, Measuring Performance, Correcting Deviations - Types of control: Feed forward, Concurrent, Feedback - Quality control and management, Total Quality Management (TQM), Six Sigma, Lean Management, Use of Data Analytics in Quality Control

TOTAL : 45 PERIODS

TEXTBOOKS:

1. Robbins, S. P., Coulter, M., & DeCenzo, D. A. (2020). *Fundamentals of Management* (11th ed.). Pearson.
2. Griffin, R. W. (2022). *Management: Principles and Practices* (12th ed.). Cengage Learning.
3. Jones, G. R., & George, J. M. (2021). *Essentials of Contemporary Management* (9th ed.). McGraw-Hill Education.

REFERENCES:

1. Bateman, T. S., & Snell, S. A. (2020). *Management: Leading & Collaborating in a Competitive World* (14th ed.). McGraw-Hill Education.
2. Schermerhorn, J. R. (2021). *Management* (14th ed.). Wiley.
3. Hill, C. W. L., Schilling, M. A., & Jones, G. R. (2020). *Strategic Management: Theory & Cases* (13th ed.). Cengage Learning.
4. Kinicki, A., & Williams, B. K. (2021). *Management: A Practical Introduction* (10th ed.). McGraw-Hill Education.

AS3281	AEROSPACE COMPUTATIONAL LABORATORY	L	T	P	C
		0	1	2	2

Objectives:

1. To familiarize the students with Structural analysis of beams and aircraft structural components
2. To familiarize the students with Subsonic and supersonic flow analysis over the objects
3. To familiarize the students with Heat transfer analysis over the objects

Course Outcome		Cognitive Skill
CO-01	Students will learn to use ANSYS and MATLAB for simulating complex engineering problems in fluid dynamics, heat transfer, and structural analysis.	An,E
CO-02	Students will gain a deeper understanding of physical phenomena such as diffusion, conduction, convection, and combustion through hands-on numerical simulations.	A,E
CO-03	Students will develop skills in generating structured grids for airfoil sections and other geometries, crucial for accurate computational fluid dynamics (CFD) analysis.	An,E
CO-04	Students will learn to conduct multidimensional analyses, including 2-D and 3-D simulations, to study heat conduction, fluid flow, and structural behavior.	An,E
CO-05	Students will apply numerical methods to solve real-world engineering problems, enhancing their problem-solving abilities and preparing them for advanced research or industry roles.	U,A, S

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	S	S	S	M	S	L	L	M	S	S	S	S
CO-02	L	S	S	L	S	M	L	M	S	S	S	S
CO-03	M	S	S	M	S	M	L	M	S	S	S	S
CO-04	M	S	S	L	S	M	L	M	S	S	S	S
CO-05	M	S	S	M	S	L	L	M	S	S	S	S

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS

ANSYS

1. Numerical simulation of 1-D diffusion and conduction in fluid flows
2. Numerical simulation of 1-D convection-diffusion problems
3. Numerical simulation of 2-D unsteady state heat conduction problem
4. Numerical simulation of 2-D diffusion and 1-D convection combined problems
5. Structured grid generation over airfoil section
6. 3-D numerical simulation of flow through CD nozzles
7. 3-D numerical simulation of flow development of a subsonic and supersonic jets
8. Numerical simulation of boundary layer development
9. Numerical simulation of subsonic combustion in a ramjet combustor
10. Numerical simulation of transonic flow over airfoils

MATLAB.

1. Structural Analysis of a 2-D continuous beam using MATLAB code
2. Heat Transfer analysis in a Thin Plate using MATLAB code

TOTAL: 45 HOURS

LIST OF EQUIPMENT

(For a batch of 20 students)

Sl. No.	Name of the Equipment	Quantity
1	Computer nodes	40
2	ANSYS- 12 (CFD Version)	1 license
3	MATLAB	10 licenses
4	UPS	1

AS3282	COMPOSITE MATERIALS LAB	L	T	P	C
		0	1	2	2

OBJECTIVE

The objective of these experiments is to understand and apply various techniques and methods for joining, repairing, and fabricating aircraft components, including wood gluing, welding, riveting, composite laminate and sandwich panel preparation, and the determination and repair of composite material properties, in accordance with ASTM standards.

Course Outcome		Cognitive Skill
CO-01	Design, Fabricate, and Test Composite Specimens.	An,E
CO-02	Analyze and Interpret Composite Material Properties	A,E
CO-03	Characterize Composite Material Microstructure and Damage.	An,E
CO-04	Apply Composite Material Selection Criteria and Design Principles	An,E
CO-05	Integrate Theory and Experimentation for Composite Material Development	S

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	S	S	S	M	M	L	M	S	S	S	S	S
CO-02	L	S	S	L	M	M	M	S	S	S	S	S
CO-03	M	S	S	M	M	M	M	S	S	S	S	S
CO-04	M	S	S	L	M	M	M	S	S	S	S	S
CO-05	M	S	S	M	M	L	M	S	S	S	S	S

S-Strong, M-Medium,L-Low,N-Not relevant

LIST OF EXPERIMENTS

1. Aircraft wood gluing – single scarf joint
2. Aircraft wood gluing – Double scarf joint
3. Study of MIG, TIG and PLASMA Welding of aircraft components
4. Riveted Joints
5. Riveted patch repairs.
6. Fabric Patch repair
7. Preparation of Epoxy/Glass fiber composite Laminates and Specimens as per ASTM standards.
8. Preparation of Sandwich panel and Specimens as per ASTM standards.

9. Determination of Elastic constants of Composite Specimens
10. Repair of composites

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	Carbide Gas Plant	1
7	MIG Weld Plant	1
8	TIG Weld Plant	1
9	Glass Fiber and Epoxy Resin	1
10	Strain Gauges and strain indicator	1

AS32P3	MINI PROJECT	L	T	P	C
		0	0	6	3

OBJECTIVE

The objective of the project work is to enable the students in convenient groups of not more than 4 members on a project involving theoretical and experimental studies related to the branch of study. Every project work shall have a guide who is the member of the faculty of the institution. Six periods per week shall be allotted in the time table and this time shall be utilized by the students to receive the directions from the guide, on library reading, laboratory work, computer analysis or field work as assigned by the guide and also to present in periodical seminars on the progress made in the project. Each student shall finally produce a comprehensive report covering background information, literature survey, problem statement, project work details and conclusion. This final report shall be typewritten form as specified in the guidelines**.**

Course Outcome		Cognitive Skill
CO-01	Define and Scope a Real-World Engineering Problem	An,E
CO-02	Apply Engineering Principles and Theories to Solve Problems	A,E
CO-03	Design, Develop, and Test a Prototype or Model	An,E

CO-04	Communicate Technical Information Effectively	An,E
CO-05	Work Collaboratively in a Team Environment	S

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	S	S	S	M	M	L	M	S	S	S	S	S
CO-02	L	S	S	L	M	M	M	S	S	S	S	S
CO-03	M	S	S	M	M	M	M	S	S	S	S	S
CO-04	M	S	S	L	M	M	M	S	S	S	S	S
CO-05	M	S	S	M	M	L	M	S	S	S	S	S

S-Strong, M-Medium, L-Low, N-Not relevant

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	AS32**	Department Elective-VI	3	0	0	3
2.	AS32**	Department Elective-VII	3	0	0	3
PRACTICAL						
3.	AS32P5	Project Work Phase –II	0	0	20	10
TOTAL			6	0	20	16

LIST OF ELECTIVES

SI. NO	COURSE CODE	COURSE TITLE	L	T	P	C
List of Department Electives						
1	AS32A1	UAV Design	3	0	0	3
2	AS32A2	Computer Integrated Manufacturing	3	0	0	3
3	AS32A3	Space Mechanics	3	0	0	3
4	AS32A4	Rockets and Missiles	3	0	0	3
5	AS32A5	Avionics	3	0	0	3
6	AS32A6	Cryogenics	3	0	0	3
7	AS32A7	Theory of Elasticity	3	0	0	3
8	AS32A8	Experimental Stress Analysis	3	0	0	3
9	AS32A9	Hypersonic Aerodynamics	3	0	0	3
10	AS32B1	Introduction to Optimization	3	0	0	3
11	AS32B2	Experimental Aerodynamics	3	0	0	3
12	AS32B3	Wind Tunnel Testing	3	0	0	3
13	AS32B4	Space Mechanics	3	0	0	3
14	AS32B5	Aircraft Design	3	0	0	3
15	AS32B6	Air Transportation and Aircraft Maintenance	3	0	0	3
16	AS32B7	Chemical Rocket Technology	3	0	0	3
17	AS32B8	High Speed Jet Flows	3	0	0	3
18	AS32B9	Space Propulsion Systems	3	0	0	3
19	AS32C1	Elements of Satellite Technology	3	0	0	3
20	AS32C2	Space Vehicle Aerodynamics	3	0	0	3
21	AS32C3	Hypersonic Aerodynamics for Aerospace Vehicles	3	0	0	3
22	AS32C4	Orbital Mechanics	3	0	0	3
23	AS32C5	Rockets And Missiles	3	0	0	3

DEPARTMENT ELECTIVES

AS32A1	UAV DESIGN	L	T	P	C
		3	0	0	3

Objective:

Upon completing UAV Design, students will conceptualize, design, and optimize Unmanned Aerial Vehicle (UAV) systems, integrating aerodynamics, structures, propulsion, and avionics. They will apply industry standards, consider regulatory requirements, and demonstrate performance, efficiency, and safety through detailed designs, simulations, and prototypes.

Course Outcome		Cognitive Skill
CO-01	Develop UAV mission planning and operation strategies.	A
CO-02	Evaluate UAV performance using wind tunnel testing, flight testing, or simulation.	An
CO-03	Apply materials selection and structural analysis for UAV components.	A
CO-04	Investigate UAV applications in areas such as surveillance, mapping, or package delivery.	S
CO-05	Collaborate in multidisciplinary teams to design and develop UAV systems.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNITI: INTRODUCTION TO UAV **9**

Introduction to UAV-History of UAV – classification- Fixed-Wing Unmanned Aerial Vehicles Multi-Rotor Unmanned Aerial Vehicles – Introduction to Unmanned Aircraft Systems–models and prototypes – System Composition-applications.

UNIT II: BASICS OF FLIGHT **9**

Different types of flight vehicles-Drones- Components and functions of an airplane- Forces acting on Airplane-Structure of the atmosphere-Aerodynamics-Lift and drag-Airplane Structures.

UNIT III: NAVIGATION AND GUIDANCE **9**

Avionics Hardware-Autopilot-AGL –pressure sensors-sensors-RF Communications-Antennas-servos – accelerometer -gyros-actuators- power supply processor, integration, installation, configuration, and testing.

UNITIV: UAV DESIGN USING XFLR5 **11**

UAVdevelopmentusingXflr5software-Airfoilnomenclature-wing–fuselage-HorizontalTail-Vertical Tail-Aerodynamic parameters-Lift, drag, weight and moment estimation.

UNITV: GROUND TESTING OF UAV **7**

Development of Uav Systems-Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing-Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.

TOTAL: 45 HOURS

TEXT BOOK:

1. John Anderson.,"Aircraft Performance and design",WCB/McGraw- Hill,2003.
2. ZoranGacovski, "Unmanned Aerial Vehicles and Drones", Arcler Education Inc,2020
3. Myron Kayton ,Waltern R. Fried, "Avionics Navigation systems", Technology and Engineering,1997

REFERENCES:

1. ArmandJ.Chaput,"DesignofUnmannedAirVehicleSystems",LockheedMartin Aeronautics Company, 2001.
2. KimonP.Valavanis,"AdvancesinUnmannedAerialVehicles:StateoftheArtandthe Road to Autonomy", Springer, 2007.
3. PaulGFahlstrom,Thomas J Gleason,"Introduction to UAV Systems",UAV Systems, Inc,1998.
4. Reg Austin"unmanned aircraft systems UAV design, development and deployment", Wiley,2010.
5. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

AS32A2	COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
		3	0	0	3

Objective:

Upon completing Computer Integrated Manufacturing, students will design, analyze, and implement automated manufacturing systems using computer-aided design (CAD), computer-aided manufacturing (CAM), and computer numerical control (CNC). They will optimize production processes, ensuring efficiency, precision, and cost-effectiveness in various industrial settings.

Course Outcome		Cognitive Skill
CO-01	Apply computer vision and machine learning in manufacturing.	A
CO-02	Develop sustainable and lean manufacturing strategies.	An
CO-03	Integrate additive manufacturing (3D printing) technologies.	A
CO-04	Collaborate in multidisciplinary teams to design and implement CIM systems.	S
CO-05	Evaluate return on investment (ROI) and total cost of ownership (TCO) for CIM solutions.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT – I: INTRODUCTION **9**

The meaning and origin of CIM- the changing manufacturing and management scene - External communication - islands of automation and software-dedicated and open systems-manufacturing automation protocol - product related activities of a company- marketing engineering - production planning - plant operations - physical distribution- business and financial management.

UNIT – II: GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING **9**

History of group technology- role of G.T. in CAD/CAM integration - part families - classification and coding - DCLASS and MICLASS and OPITZ coding systems-facility design using G.T. - benefits of G.T. - cellular manufacturing. Process planning - role of process planning in CAD/CAM integration - approaches to computer aided process planning - variant approach and generative approaches - CAPP and CMPP process planning systems.

UNIT – III: SHOP FLOOR CONTROL AND INTRODUCTION OF FMS **9**

Shop floor control-phases -factory data collection system -automatic identification methods- Bar code technology-automated data collection system. FMS-components of FMS - types -FMS

workstation -material handling and storage systems- FMS layout -computer control systems- application and benefits.

UNIT – IV: CIM IMPLEMENTATION AND DATA COMMUNICATION 9

CIM and company strategy - system modeling tools -IDEF models - activity cycle diagram CIM open system architecture (CIMOSA)- manufacturing enterprise wheel-CIM architecture- Product data management-CIM implementation software. Communication fundamentals- local area networks -topology -LAN implementations - network management and installations.

UNIT – V: OPEN SYSTEM AND DATABASE FOR CIM 9

Open systems-open system inter connection - manufacturing automations protocol and technical office protocol (MAP /TOP). Development of databases -database terminology- architecture of database systems-data modeling and data associations -relational data bases - database operators - advantages of data base and relational database.

TOTAL: 45 HOURS

TEXT BOOK

1. Mikell.P.Groover "Automation, Production Systems and computer integrated manufacturing", Pearson Education 2001.

REFERENCES

1. Yorem koren, "Computer Integrated Manufacturing System", McGraw-Hill, 1983.
2. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice Hall International, 1986.
3. David D.Bedworth, Mark R.Hendersan, Phillip M.Wolfe "Computer Integrated Design and Manufacturing", McGraw-Hill Inc.
4. Roger Hanman "Computer Intergrated Manufacturing", Addison – Wesley, 1997.
5. Mikell.P.Groover and Emory Zimmers Jr., "CAD/CAM", Prentice Hall of India Pvt. Ltd., New Delhi-1, 1998.
6. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India, 2003.
7. Radhakrishnan P, Subramanyan S.and Raju V., "CAD/CAM/CIM", 2nd Edition New Age International (P) Ltd., New Delhi

AS32A3	SPACE MECHANICS	L	T	P	C
		3	0	0	3

Objective:

Upon completing Space Mechanics, students will analyze and predict the motion of spacecraft, satellites, and celestial bodies. They will apply principles of orbital mechanics, gravitational dynamics, and attitude control to design and optimize space missions, trajectories, and navigation systems.

Course Outcome		Cognitive Skill
CO-01	Analyze space debris and mitigation strategies.	A
CO-02	Apply space weather and radiation effects on spacecraft.	An
CO-03	Design and optimize spacecraft structures and materials.	A
CO-04	Evaluate spacecraft navigation and guidance systems.	S
CO-05	Collaborate in multidisciplinary teams to design and operate space missions.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT I: BASIC CONCEPTS AND THE GENERAL N- BODY PROBLEM 9

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 II: SATELLITE INJECTION AND SATELLITE PERTURBATIONS 9

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 III: INTERPLANETARY TRAJECTORIES 9

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 IV: 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 ofimpact point – influence coefficients.

UNIT V: MATERIALS FOR SPACECRAFT **9**

Space environment – peculiarities of space environment – effect of space environment on materials of spacecraft structure – materials required for the construction of space craft – TPS for re-entry space vehicles.

TOTAL: 45 HOURS

TEXT BOOKS:

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.

AS32A4	ROCKETS AND MISSILES	L	T	P	C
		3	0	0	3

Objective:

Upon completing Rockets and Missiles, students will design, analyze, and optimize rocket and missile systems, including propulsion, aerodynamics, guidance, and control. They will evaluate performance, range, accuracy, and survivability, applying principles of ballistics, trajectory dynamics, and system integration.

Course Outcome		Cognitive Skill
CO-01	Apply rocket safety and reliability principles.	A
CO-02	Evaluate rocket aerodynamics and thermal effects.	An
CO-03	Design and optimize rocket control systems.	A
CO-04	Analyze rocket mission planning and optimization.	S
CO-05	Collaborate in multidisciplinary teams to design and operate rocket systems.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT I: ROCKET SYSTEMS 9

Ignition system in rockets – types of igniters and igniter design considerations –injection system and propellant feed systems of liquid rockets and their design considerations – design considerations of liquid rocket thrust chambers – combustion mechanisms of liquid and solid propellants.

UNIT II: AERODYNAMICS OF ROCKETS AND MISSILES 9

Airframe components of rockets and missiles – forces acting on a missile while passing through atmosphere – classification of missiles – slender body aerodynamics- method of describing forces and moments – lift force and lateral moment –lateral aerodynamic damping moment – longitudinal moment – drag estimation – body upwash and body downwash in missiles – rocket dispersion.

UNIT III: ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD 9

One dimensional and two-dimensional rocket motions in free space and homogeneous gravitational fields – description of vertical, inclined and gravity turn trajectories – determination of range and altitude – simple approximations to burn out velocity and altitude – estimation of culmination time and altitude.

UNIT IV: STAGING AND CONTROL OF ROCKETS AND MISSILES 9

Design philosophy behind multistaging of launch vehicles and ballistic missiles –multistage vehicle optimization – stage separation techniques in atmosphere and in space – stage separation dynamics and lateral separation characteristics – various types of thrust vector control methods including secondary injection thrust vector control – numerical problems on stage separation and multistaging.

UNIT V: MATERIALS FOR ROCKETS AND MISSILES 9

Selection criteria of materials for rockets and missiles – materials for various airframe components and engine parts – materials for thrust control devices – various adverse conditions faced by aerospace vehicles and the requirement of materials to perform under these conditions.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W. Freeman &Co.,Ltd, London, 1982
2. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York,5th Edition, 1993.

REFERENCES:

1. Parker, E.R., "Materials for Missiles and Spacecraft", Mc.Graw Hill Book Co. Inc.,1982.

AS32A5	AVIONICS	L	T	P	C
		3	0	0	3

Objective:

Upon completing Avionics, students will design, integrate, and test aircraft electronic systems, including communication, navigation, surveillance, and flight control. They will apply knowledge of digital signal processing, software development, and hardware interfacing to ensure safe, efficient, and reliable aviation operations.

Course Outcome		Cognitive Skill
CO-01	Evaluate avionics system performance and reliability.	A
CO-02	Apply software development methodologies for avionics.	An
CO-03	Design and implement avionics human-machine interfaces (HMIs).	A
CO-04	Analyze avionics system security and cybersecurity.	S
CO-05	Collaborate in multidisciplinary teams to design and integrate avionics systems.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L

CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

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.

UNIT II: PRINCIPLE OF DIGITAL SYSTEMS 9

Digital computer – Microprocessors – Memories.

UNIT III: DIGITAL AVIONICS ARCHITECTURE 9

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

UNIT IV: 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 V: INTODUCTION TO AVIONICS SYSTEMS 9

Communications systems- Navigation systems – Flight control systems – Radar – Electronic Warfare – Utility systems Reliability and maintainability – Certification.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Middleton, D.H., Ed., Avionics systems, Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
2. Spitzer, C.R. Digital Avionics Systems, Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 1987.

REFERENCES:

1. Malvino, A.P. and Leach, D.P. Digital Principles and Applications, Tata McGrawHill, 1990.
2. Gaokar, R.S. Microprocessors Architecture-Programming and Applications, Wileyand Sons Ltd., New Delhi, 1990.

AS32A6	CRYOGENICS	L	T	P	C
		3	0	0	3

Objective:

Upon completing Cryogenics, students will understand the principles and applications of extremely low-temperature systems, designing and analyzing cryogenic storage, handling, and transfer systems. They will apply knowledge of thermodynamics, heat transfer, and materials science to optimize cryogenic systems for aerospace, medical, and industrial applications.

Course Outcome		Cognitive Skill
CO-01	Analyze cryogenic fluid dynamics and flow behavior.	A
CO-02	Design cryogenic insulation systems and thermal protection.	An
CO-03	Evaluate cryogenic materials and structural integrity.	A
CO-04	Understand cryogenic refrigeration techniques and cycles.	S
CO-05	Collaborate in multidisciplinary teams to design and operate cryogenic systems.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT I: INTRODUCTION **9**

Introduction: Historical development – present areas involving cryogenic engineering. Basic thermodynamic as applied to liquefaction and refrigeration process – isothermal, adiabatic and Joule Thomson expansion process – adiabatic demagnetization – pay off functions –Figure of Merrit.

UNIT II: MATERIALS AND PROPERTIES **9**

Low temperature properties of engineering materials: mechanical properties – thermal Properties – electrical and magnetic properties. Properties of cryogenic fluids – materials of constructions for cryogenics applications.

UNIT III: LIQUEFICATION SYSTEM **9**

Gas liquefaction systems: Production of low temperatures - general liquefaction systems – liquefaction systems for neon, hydrogen, nitrogen, and helium, oxygen.

UNIT IV: REFRIGRATION SYSTEM **9**

Cryogenic refrigeration systems: ideal refrigeration systems – refrigerators using liquids and gases as refrigerants – refrigerators using solids as working media.

UNIT V: STORAGE SYSTEM **9**

Cryogenic storage and transfer systems – Cryogenic fluid storage vessels, cryogenic fluid transfer systems. Application of cryogenics – cryopumping – superconductivity and super fluidity – cryogenics in space technology – cryogenics in biology and medicine**.**

TOTAL: 45 HOURS

TEXT BOOKS:

1. Randall F. Barron., 'Cryogenic Systems', McGraw Hill, 1985.
2. Klaus D. Timmerhaus and Thomas M. Flynn., 'Cryogenic Process Engineering',Plenum Press, New York, 1989.

REFERENCE BOOKS:

1. Herald Weinstock., 'Cryogenic Technology', 1969.
2. Scott R.B., 'Cryogenics Engineering', Van Nostrand & Co., 1962.
3. Robert W. Vance., 'Cryogenic Technology', John Wiley & Sons Inc., New York,London, 1971.
4. Sengapatha, Bose A., 'Cryogenics – Progress and Applications', Tata McGraw Hill,1987.

AS32A7	THEORY OF ELASTICITY	L	T	P	C
		3	0	0	3

Objective:

Upon completing Theory of Elasticity, students will analyze stress, strain, and deformation in solids, applying mathematical models to predict mechanical behavior. They will solve boundary value problems, determine stress concentrations, and optimize structural design for aerospace, mechanical, and civil engineering applications.

Course Outcome		Cognitive Skill
CO-01	Derive and apply constitutive equations for various materials.	A
CO-02	Analyze dynamic elasticity and vibration problems.	An
CO-03	Evaluate elasticity in composite materials and structures.	A
CO-04	Apply numerical methods (e.g., FEM, BEM) to elasticity problems.	S
CO-05	Collaborate in multidisciplinary teams to solve complex elasticity problems.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT I ASSUMPTIONS IN ELASTICITY 4

Definitions- notations and sign conventions for stress and strain, Equations of equilibrium.

UNIT II BASIC EQUATIONS OF ELASTICITY 15

Strain – displacement relations, Stress – strain relations, Lame's constant – cubical dilation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for stresses and strains, Principal stresses and principal strains, Mohr's circle, Saint Venant's principle.

UNIT III PLANE STRESS AND PLANE STRAIN PROBLEMS 8

Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams, etc.

UNIT IV POLAR COORDINATES 10

Equations of equilibrium, Strain displacement relations, Stress – strain relations, Axi – symmetric problems, Kirsch, Michell's and Boussinesque problems.

UNIT V TORSION 8

Navier's theory, St. Venant's theory, Prandtl's theory on torsion, The semi- inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections.

TOTAL: 45 PERIODS

TEXT BOOK

1. Timoshenko, S., and Goodier, T.N., "Theory of Elasticity", McGraw–Hill Ltd., Tokyo, 1990.

REFERENCE BOOKS:

1. Enrico Volterra& J.H. Caines, "Advanced Strength of Materials", Prentice Hall New Jersey, 1991.
2. Wng, C.T., "Applied Elasticity", McGraw–Hill Co., New York, 1993.
3. Sokolnikoff, I.S., "Mathematical Theory of Elasticity", McGraw–Hill New York, 1978.

AS32A8	EXPERIMENTAL STRESS ANALYSIS	L	T	P	C
		3	0	0	3

Objective:

Upon completing Experimental Stress Analysis, students will design and conduct experiments to measure stress, strain, and deformation in mechanical structures. They will utilize techniques such as strain gauges, photoelasticity, and digital image correlation to validate theoretical models and optimize structural design for real-world applications.

Course Outcome		Cognitive Skill
CO-01	Apply experimental stress analysis to various fields (e.g., aerospace, biomedical, automotive).	A
CO-02	Evaluate dynamic and fatigue behavior of mechanical components.	An
CO-03	Develop and implement custom measurement systems.	A
CO-04	Collaborate in multidisciplinary teams to solve complex engineering problems.	S
CO-05	Communicate experimental results through technical reports and presentations.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNITI: MEASUREMENTS **4**

Principles of measurements, Accuracy, Sensitivity and range of measurements.

UNITII: EXTENSOMETERS **6**

Mechanical, Optical Acoustical and Electrical extensometers and the issues, Advantages and disadvantages.

UNITIII: ELECTRICALRESISTANCESTRAINGAUGES **10**

Principle of operation and requirements, Types and their uses, Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheastone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.

UNITIV: PHOTOELASTICITY **10**

Two-dimensional photo elasticity, Concept of light – photo elastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials. Introduction to three-dimensional photo elasticity.

UNITV: NON-DESTRUCTIVETESTING **15**

Fundamentals of NDT, Radiography, ultrasonic, magnetic particle inspection, Fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique, Fundamentals of brittle coating methods, Introduction to Moir techniques, Holography, ultrasonic C- Scan, Thermograph, Fiber optic sensors.

TOTAL: 45 HOURS

TEXTBOOK:

1. Srinath,L.S.,Raghava,M.R.,Lingaiah,K.,Garagesha,G.,PantB.,andRamachandra ,K “Experimental Stress Analysis”, Tata McGraw-Hill, New Delhi, 1984.

REFERENCES:

1. Dally,J.W.,andRiley,W.F.,"ExperimentalStressAnalysis",McGraw-HillInc.,New York, 1998.
2. Hetyenyi, M., "Hand book of Experimental Stress Analysis", John Wiley and Sons Inc., New York, 1972.
3. PollockA.A.,Acoustic Emissionin Acoustics and Vibration Progress", Ed.Stephens R.W.B., Chapman and Hall, 1993.
4. Dally J.W. and Riley W.F." Experimental Stress Analysis" McGraw Hill inc., New York 1998.

		L	T	P	C
AS32A9	**HYPERSONIC AERODYNAMICS**	**3**	**0**	**0**	**3**

Objective:

Upon completing Hypersonic Aerodynamics, students will analyze high-speed airflow, shock waves, and heat transfer phenomena for vehicles traveling at Mach 5+. They will apply principles of gas dynamics, boundary layer theory, and computational fluid dynamics to design and optimize hypersonic vehicles, re-entry vehicles, and scramjets.

Course Outcome		**Cognitive Skill**
CO-01	Apply hypersonic aerodynamics to space exploration and re-entry.	A
CO-02	Evaluate hypersonic aerodynamic materials and thermal protection systems.	An
CO-03	Investigate hypersonic propulsion systems and air-breathing engines.	A
CO-04	Collaborate in multidisciplinary teams to design and optimize hypersonic systems.	S
CO-05	Communicate technical results through publications and presentations.	An

PO / **CO**	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L

CO-05	M	S	M	M	M	L	M	L	L	L	L	S

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 no 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", Mc. Graw hill Series, New York, 1996.

REFERENCES:

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

AS32B1	INTRODUCTION TO OPTIMIZATION	L	T	P	C
		3	0	0	3

Objective:

Upon completing Introduction to Optimization, students will formulate and solve optimization problems using mathematical and computational methods. They will apply linear and nonlinear programming techniques, gradient-based algorithms, and heuristic methods to minimize or maximize real-world engineering systems, processes, and designs.

Course Outcome		Cognitive Skill
CO-01	Develop programming skills in optimization software.	A
CO-02	Investigate advanced optimization topics (e.g., dynamic programming, stochastic optimization).	An
CO-03	Collaborate in multidisciplinary teams to solve complex optimization problems.	A
CO-04	Evaluate ethical implications of optimization solutions.	S
CO-05	Develop programming skills in optimization software.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT I: SINGLE VARIABLE OPTIMIZATION ALGORITHMS 9

Optimizing criteria-bracketing methods-exhaustive search method-bounding phase method-region elimination method-interval halving method-fibonacci search method-golden section search method.

UNIT II: MULTIVARIABLE OPTIMIZATION ALGORITHM 9

Optimizing criteria-unidirectional search-direct search method-gradient based methods- cauchy's (steepest descent method).

UNIT III: LINEAR PROGRAMMING 9

Formulation and graphical solutions-simplex method-big m method-primal- dual relationships

UNIT IV: CLASSICAL OPTIMIZATION THEORY 9

Unstrained external problems-necessary and sufficient for extrema-newton raphson method – equality constrains-jacobian method-legrangian method-inequality constrains-kuhn-tucker conditions.

UNIT V: NON-TRADITIONAL OPTIMIZATION ALGORITHMS 9

Genetic algorithms-simulated annealing-working principles-similarity between genetic algorithms and traditional methods-ga for constrained optimization-real coded ga-advanced ga-global optimization using the steepest decent method.

TOTAL: 45 HOURS

TEXTBOOKS:

1. Deb, K., Optimization For Engineering Design: Algorithms And Examples, Prentice Hall of India (2004).

REFERENCE:

1. Rao, S. S., Engineering Optimization - Theory and Practice, Wiley Eastern (1996).

AS32B2	EXPERIMENTAL AERODYNAMICS	L	T	P	C
		3	0	0	3

Objective:

Upon completing Experimental Aerodynamics, students will design, conduct, and analyze wind tunnel tests to measure aerodynamic forces, pressures, and flow visualization. They will apply experimental techniques, data acquisition, and uncertainty analysis to validate computational models and optimize aerodynamic performance of aircraft, vehicles, and other fluid-flow systems.

Course Outcome		Cognitive Skill
CO-01	Investigate high-speed and hypersonic aerodynamics.	A
CO-02	Evaluate aerodynamic noise and vibration.	An
CO-03	Apply experimental aerodynamics to non-traditional configurations (e.g., rotorcraft, wind turbines).	A

CO-04	Collaborate in multidisciplinary teams to solve complex aerodynamic problems.	S
CO-05	Communicate technical results through publications and presentations.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNITI: BASIC MEASUREMENTSINFLUID MECHANICS 7

Objective of experimental studies–Fluid mechanics measurements–Properties of fluids–Measuring instruments– Performance terms associated with measurement systems–Direct measurements– Analogue methods– Flow visualization– Components of measuring systems - Importance of model studies.

UNITII: WINDTUNNELMEASUREMENTS 7

Wind Tunnel Measurements-Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels – Power losses in a wind tunnel –Instrumentation and calibration of wind tunnels -Turbulence- Wind tunnel balance – Wire balance – Strut-type – Platform-type – Yoke-type -Pyramid type – Strain gauge balance – Balance calibration.

UNITIII: FLOWVISUALIZATIONANDANALOGUEMETHODS 11

Visualization techniques – Smoke tunnel – Heleshaw Apparatus – Interferometer-Fringe Displacement method – Schlieren system – Shadowgraph – Hydraulic analogy-Hydraulic jumps-Electrolytic tank.

UNITIV: PRESSURE, VELOCITY ANDT EMPERATURE MEASUREMENTS 7

Pressure, Velocity and Temperature measurements-Pitot – static tube characteristics – Velocity measurements – Hot-wire anemometry – Constant current and Constant temperature Hot-Wire anemometer – Pressure measurement techniques -Pressure transducers – Temperature measurements.

UNIT V: SPECIAL FLOWS AND UNCERTAINTY ANALYSIS 13

Special Flows and Uncertainty Analysis-Experiments on Taylor-Proudman theorem and Ekman layer–Measurements in boundary layers -Data acquisition and processing – Signal conditioning – Uncertaintyanalysis–Estimationofmeasurementerrors–Externalestimateoftheerror– Internal estimate of the error – Uncertainty calculation – Uses of uncertainty analysis.

TOTAL: 45 HOURS

TEXTBOOKS:

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

REFERENCES:

1. Bradsaw"ExperimentalFluidMechanics",Elsevier,2nd edition,1970.
2. Pope,A.,andGoin,L.,"HighSpeedWindTunnelTesting",JohnWiley,1985.

AS32B3	WIND TUNNEL TESTING	L	T	P	C
		3	0	0	3

Objective:

Upon completing Wind Tunnel Testing, students will design, execute, and analyze wind tunnel experiments to measure aerodynamic and hydrodynamic forces, pressures, and flow characteristics. They will apply tunnel operations, instrumentation, data acquisition, and uncertainty analysis to validate designs, optimize performance, and support computational fluid dynamics simulations.

Course Outcome		Cognitive Skill
CO-01	Investigate specialized wind tunnel testing techniques (e.g., particle image velocimetry, laser Doppler velocimetry).	A
CO-02	Evaluate wind tunnel design and construction considerations.	An
CO-03	Apply wind tunnel testing to non-traditional configurations (e.g., rotorcraft, wind turbines).	A
CO-04	Collaborate in multidisciplinary teams to solve complex aerodynamic problems.	S
CO-05	Develop programming skills in data acquisition and analysis software.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT I: PRINCIPLES OF MODEL TESTING **6**

Buckingham Theorem – Non-Dimensional Numbers –Scale Effect Types of Similarities.

UNIT II: WIND TUNNELS **8**

Classification – Special problems of Testing in Subsonic, Transonic, supersonic and hypersonic speed regions – Layouts – sizing and design parameters.

UNIT III: CALIBRATION OF WIND TUNNELS **11**

Test section speed – Horizontal buoyancy – Flow angularities – Turbulence measurements – Associated instrumentation – Calibration of supersonic tunnels.

UNIT IV: WIND TUNNEL MEASUREMENTS **12**

Pressure and velocity measurements – Force measurements – Three component and six component balances – Internal balances.

UNIT V: HIGH SPEED WIND TUNNELS **8**

Blow down, in-draft and induction tunnel layouts and their design features, Transonic, supersonic and hypersonic tunnels and their peculiarities, Helium and guntunnels, Shock tubes, Optical methods of flow visualization.

TOTAL: 45 HOURS

TEXT BOOK

1. Rae, W.H. and Pope, A. “Low Speed Wind Tunnel Testing”, John Wiley Publication, 1984.

REFERENCE

1. Pope, A., and Goin, L., "High Speed wind Tunnel Testing", John Wiley, 1985.

AS32B4	SPACE MECHANICS	L	T	P	C
		3	0	0	3

Objective:

Upon completing Space Mechanics, students will analyze and predict the motion of spacecraft, rockets, and celestial bodies. They will apply principles of orbital mechanics, gravitational dynamics, attitude control, and trajectory design to optimize space mission planning, navigation, and control systems.

Course Outcome		Cognitive Skill
CO-01	Investigate advanced space propulsion systems (e.g., electric, nuclear).	A
CO-02	Evaluate space weather and radiation effects on spacecraft.	An
CO-03	Apply space mechanics to planetary defense and asteroid redirection.	A
CO-04	Collaborate in multidisciplinary teams to design and operate space missions.	S
CO-05	Develop programming skills in space mission simulation software.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT I: BASIC CONCEPTS AND THE GENERAL N- BODY PROBLEM 9

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 II: SATELLITE INJECTION AND SATELLITE PERTURBATIONS 9

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 III: INTERPLANETARY TRAJECTORIES 9

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 IV: 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 ofimpact point – influence coefficients.

UNIT V: MATERIALS FOR SPACECRAFT 9

Space environment – peculiarities of space environment – effect of space environment on materials of spacecraft structure – materials required for the construction of space craft – TPS for re-entry space vehicles.

TOTAL: 45 HOURS

TEXT BOOKS:

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.

AS32B5	AIRCRAFT DESIGN	L	T	P	C
		3	0	0	3

Objective:

Upon completing Aircraft Design, students will conceptualize, design, and optimize aircraft configurations, integrating aerodynamics, structures, propulsion, and systems. They will apply design methodologies, performance analysis, and regulatory requirements to create efficient, safe, and viable aircraft designs for various missions and operational requirements.

Course Outcome	Cognitive Skill

CO-01	Investigate advanced aircraft design concepts (e.g., blended wing, folding wing).	A
CO-02	Evaluate aircraft design for sustainability and environmental impact.	An
CO-03	Apply aircraft design principles to unmanned aerial vehicles (UAVs).	A
CO-04	Collaborate in multidisciplinary teams to design and optimize aircraft.	S
CO-05	Develop programming skills in aircraft design and simulation software.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT-I: POWER PLANT TYPES AND CHARACTERISTICS **9**

Characteristics of different types of power plants Propeller characteristics and selection Relative merits of location of power plant. Propellers - Froud momentum and blade element theories, propeller coefficients, use of propeller charts, performance of fixed and variable pitch propeller.

UNIT-II: PERFORMANCE DESIGN **9**

Selection of geometric and aerodynamic parameters Weight estimation and balance diagram Drag estimation of complete aircraft Level flight, climb, take-off and landing calculations range and endurance.

UNIT-III: STABILITY DESIGN **9**

Static and dynamic stability estimates control requirements. Maximum range of climb, shallow angle of climb, High Lift devices

UNIT-IV: SPECIAL PROBLEMS **9**

Layout peculiarities of subsonic and supersonic aircraft optimization of wing loading to achieve desired performance loads on undercarriages and design requirements.

UNIT-V: STRUCTURAL DESIGN **9**

Estimation of loads on complete aircraft and components Structural design of fuselage, wings and undercarriages, controls, connections and joints. Materials for modern aircraft Methods of analysis, testing and fabrication.

TOTAL: 45 HOURS

TEXT BOOK:

1. G. Corning, Supersonic & Subsonic Airplane Design, II Edition, Edwards Brothers Inc., Michigan, 1953.
2. E.F. Bruhn, Analysis and Design of Flight Vehicle Structures, Tristate Offset Co., U.S.A., 1980.
3. A.A. Lebedenski, Notes on airplane design, Part-I, I.I.Sc., Bangalore, 1971.
4. Anderson, J.D Aircraft Performance and Design McGraw Hill Education; 1 edition, 2017.

R**EFERENCES:**

1. E. Torenbeek, Synthesis of Subsonic Airplane Design, Delft University Press, London, 1976.
2. D.P. Raymer, Aircraft conceptual design, AIAA Series, 1988.
3. H.N.Kota, Integrated design approach to Design fly by wire Lecture notes Interline Pub. Bangalore, 1992.
4. S.C. Keshu & K.K. Ganapathi Aircraft Production Techniques and Management, 1995.
5. Perkins C.D., & Hage, R.E, Airplane performance, stability and control, Wiley Toppan, 1974.

AS32B6	AIR TRANSPORTATION AND AIRCRAFT MAINTENANCE	L	T	P	C
		3	0	0	3

OBJECTIVES

Upon completing Air Transportation and Aircraft Maintenance, students will understand commercial air transport operations, regulations, and logistics. They will apply maintenance principles, safety protocols, and quality control measures to ensure airworthiness, efficiency, and reliability of aircraft systems, meeting FAA and industry standards.

Course Outcome		Cognitive Skill
CO-01	Investigate advanced aircraft maintenance topics (e.g., avionics, propulsion systems).	A
CO-02	Evaluate unmanned aerial vehicle (UAV) maintenance and operations.	An
CO-03	Apply lean manufacturing principles to aircraft maintenance.	A
CO-04	Collaborate in multidisciplinary teams to solve aviation maintenance problems.	S
CO-05	Develop programming skills in aircraft maintenance software.	An

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	M	S	S	S	M	N	M	L	L	L	L	M	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S	L
CO-03	L	S	S	S	L	M	M	L	L	L	L	S	L
CO-04	M	S	M	M	M	M	M	L	L	L	L	L	M
CO-05	M	S	M	M	M	L	M	L	L	L	L	S	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: INTRODUCTION **9**

Development of air transportation, comparison with other modes of transport – Role of IATA, ICAO – The general aviation industry airline – Factors affecting general aviation, use of aircraft, airport: airline management and organization – levels of management, functions of management, Principles of organisation planning the organisation – chart, staff departments & line departments.

Unit II: AIRLINE ECONOMICS **9**

Forecasting – Fleet size, Fleet planning, the aircraft selection process, operating cost, passenger capacity, load factor etc. – Passenger fare and tariffs – Influence of geographical, economic & political factors on routes and route selection.
FLEET PLANNING: The aircraft selection process – Fleet commonality, factors affecting

choice of fleet, route selection and Capitol acquisition – Valuation & Depreciation – Budgeting, Cost planning – Aircrew evaluation – Route analysis – Aircraft evaluation.

Unit III: PRINCIPLES OF AIRLINES SCHEDULING 9

Equipment maintenance, Flight operations and crew scheduling, Ground operations and facility limitations, equipments and types of schedule – hub & spoke scheduling, advantages / disadvantages & preparing flight plans – Aircraft scheduling in line with aircraft maintenance practices.

Unit IV: AIRCRAFT RELIABILITY 9

Aircraft reliability – The maintenance schedule & its determinations – Condition monitoring maintenance – Extended range operations (EROPS) & ETOPS – Ageing aircraft maintenance production

Unit V: TECHNOLOGY IN AIRCRAFT MAINTENANCE 9

Airlines scheduling (with reference to engineering) – Product support and spares – Maintenance sharing – Equipments and tools for aircraft maintenance – Aircraft weight control – Budgetary control.

On board maintenance systems – Engine monitoring – Turbine engine oil maintenance – Turbine engine vibration monitoring in aircraft – Life usage monitoring – Current capabilities of NDT – Helicopter maintenance – Future of aircraft maintenance.

TOTAL: 45 HOURS

TEXT BOOKS

1. FEDRIC J.H., "Airport Management", 2000.
2. C.H. FRIEND, "Aircraft Maintenance Management", 2000.

REFERENCES:

1. GENE KROPF, "Airline Procedures".
2. WILSON & BRYON, "Air Transportation".
3. PHILIP LOCKLIN D, "Economics of Transportation".

AS32B7	CHEMICAL ROCKET TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

To classify the rockets and can develop the thrust equation.
To impart knowledge to the students on solid, liquid and hybrid rocket propulsion.
To provide knowledge on the types of igniters and injectors used in solid and liquid rocket systems.
To conduct various rocket testing and to analyze various modes of combustion instabilities.

Course Outcome		Cognitive Skill
CO-01	To identify the rocket propulsion system and its applications.	A
CO-02	Analyze the performance of solid propellant rocket engines.	An
CO-03	Describe and classify liquid propellant rocket motors and its components.	A
CO-04	Analyze propellants properties and advanced propulsion systems	An
CO-05	Describe and classify combustion properties and instabilities in the various propulsion systems.	S

R-Remember,U-Understand,A-Apply,An-Analyze,E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-K	PO-L	PO-M
CO-01	M	S	S	S	M	N	M	L	L	L	L	M	M
CO-02	L	S	L	N	L	M	S	L	L	L	L	M	L
CO-03	L	L	S	S	L	N	S	L	L	L	L	M	L
CO-04	M	L	M	M	N	M	S	L	L	L	L	M	M
CO-05	M	L	M	M	M	L	M	L	L	L	L	M	M

S-Strong, M-Medium,L-Low,N-Not relevant

Unit I: ROCKET PERFORMANCE **9**

Classification of Rockets - Propellants classification -Thrust equation, specific impulses, total impulse, characteristic velocity – Thrust coefficient – Efficiency: Real and ideal nozzle characteristic, Adiabatic flame temperature and its calculation, Criterion for Choice of propellants- flight performance of a rocket vehicle- flight trajectory of a single stage rocket vehicle

Unit II: SOLID ROCKET MOTORS **9**

Viscous subsystems of solid rocket motor and their function – Igniters - Type of igniters – Internal ballistics properties– Burning rate - Factor affecting burning rate - Equilibrium Chamber pressure– Propellant grain geometry design, Erosive burning – Pressure vs Time curve- thrust vs time curve – Special problems of solid rocket nozzle – Combustion mechanism of solid propellants – Solid rocket motor design.

Unit III: LIQUID ROCKET ENGINES **9**

Classification of liquid rocket engine — Injectors and its types - various of types of feeding system - performance and choice of feed system cycle – Propellants tank and propellant slosh - Gas requirement for propellant draining - Thrust chamber – Thrust chamber cooling – Cryogenic propellants – Problems peculiar to cryogenic engine -– Turbo pumps – Ignition system - Combustion of liquid rocket – Thrust chamber design.

Unit IV: HYBRID PROPULSION SYSTEM **9**

Standard and reverse hybrid rocket – Application – Limitation - Advanced fuel – Combustion mechanism of hybrid rocket – Regression rate measurement – Methods for improving regression rate - composite propulsion

Unit V: ROCKET TESTING AND COMBUSTION INSTABILITIES **9**

Burning rate measurement techniques - Rocket testing – Static testing of rockets – Instrumentation and safety procedures – Ignition delay testing – Combustion instability - L* instability – different modes of combustion instability – Bulk and wave mode of combustion instability in solid and liquid rockets – Pogo instability.

TOTAL: 45 HOURS

TEXT BOOKS

1. Martin J. Chiaverini& Kenneth K. Kuo, "Fundamentals of Hybrid Rocket Combustion and Propulsion", Progress in Astronautics and Aeronautics (book218), 1st edition, 2007.

2.Ramamurthi,K, "Rocket Propulsion", Laxmi Publications Private Limited, 1st edition, 2016.

3.Sutton,GP "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 9th Edition, 2016.

AS32B8	HIGH SPEED JET FLOWS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: This course will enable students

1. To get insight into the basic aspects of jets and types of jets.
2. To learn the basic properties of jets and its characteristics
3. To get knowledge on various active and passive jet control methods
4. To gain knowledge into the basic aspects of jet acoustics

5. To acquire in-depth knowledge on how and what type of control methods can be implemented practically.

Course Outcome		Cognitive Skill
CO-01	To acquire knowledge on the unique features of jet flows.	A
CO-02	To analyse the characteristics of jets.	An
CO-03	To have through knowledge on active and passive control methods of jets.	A
CO-04	To acquire knowledge on jet acoustics and methods for suppression of jet noise.	An
CO-05	To demonstrate various experimental techniques to determine jet characteristics.	S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	S	N	L	M	M	L	L	L	L	M
CO-03	L	M	S	S	L	N	S	L	L	L	L	M
CO-04	M	M	S	M	M	M	S	L	L	L	L	M
CO-05	M	M	S	M	M	L	M	L	L	L	L	M

UNIT I INTRODUCTION 9

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

UNIT II TYPES OF JETS 9

Types of Jets - Plane free-jets. Round jets. Plane jets in a co-flowing stream. Round jet in Co flowing stream- Swirling jets-Radial jets- Wall jets- Jet Characteristics centerline velocity, Radial profile and isocontours of symmetric and asymmetric jets. Under expanded and over expanded jet chock –cells structure using different types of visualization techniques

UNIT III ACTIVE JET CONTROL METHODS 9

Active control methods- Actuators-Fluidic, Thermal, Acoustic, Piezoelectric, Electromagnetic, MEMS, Synthetic Jets, Controls and Sensors, Active controls techniques by air tabs .applications

UNIT IV PASSIVE JET CONTROL METHODS 9

Passive control techniques- Tabs, Grooves, Chevrons, non-circular nozzles, Notches and wires, vortex generators and physics of their jet characterizers. Optical Flow Visualization, Applications.

UNIT V JET ACOUSTICS 9

Introduction to Jet Acoustics – Types of jet noise – Source of generation- Travelling wave solution, standing wave solution – multi-dimensional acoustics-Theoretical Concepts of Jet Noise Generation and Suppression– Jet Noise suppression techniques – anechoic chamber design and instrument for the measurement of nose

TOTAL : 45 PERIODS

TEXT BOOKS:

1.EthirajanRathakrishnan, “Applied Gas Dynamics”, John Wiley, New York, 2010.
2.Liepmann and Roshko, “Elements of Gas Dynamics”, Dover Publishers, 2017.
3.GenrikhAbramovich,”The Theory of Turbulent Jets” MIT Press, 1963

REFERENCES:

4.Shapiro, AH, “Dynamics and Thermodynamics of Compressible Fluid Flow, Vols. I & II”, Ronald Press, New York, 1953.
5.H. Schlichting, K. Gersten, “Boundary Layer Theory” Springer 2017
6.Ginevsky A .S. “Acoustic Control of Turbulent Jets” Springer; Softcover reprint of hardcover 1st ed. 2004 edition (8 December 2010)

AS32B9	SPACE PROPULSION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: This course will enable students

1. To impart knowledge on the basic concepts of space propulsion.
2. To learn about the physics of ionized gases.
3. To get familiarize with the types of nuclear rockets and the basic concepts of nuclear propulsion systems.
4. To study about the radioisotope propulsion.
5. To realise the importance of advanced space propulsion concepts.

Course Outcome		Cognitive Skill
CO-01	Know about different types of Space propulsion	A
CO-02	Have understanding on the classification and working principle of Electric propulsion	An
CO-03	Acquire the knowledge on types of nuclear rockets with their design considerations.	A
CO-04	Learn the basics of micro propulsion and the different types of that with the working concept.	An
CO-05	Know more about the advancements in the space propulsion and their diverse fields of new studies.	S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	N	L	L	L	L	M
CO-02	L	S	L	N	M	M	M	L	L	L	L	S
CO-03	L	S	S	S	M	N	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	N	L	L	L	L	S

UNIT I INTRODUCTION TO SPACE PROPULSION 9

Background and Fundamentals of Space propulsion - Classification of Propulsion Systems, Scramjet Propulsion - Scramjet Inlets; Scramjet Performance, Normal and Oblique Shocks, Chemical rocket Propulsion-Tri propellants; Metalized Propellants; Free Radical Propulsion.

UNIT II ELECTRIC PROPULSION 9

Electric propulsion working principle- Classification of electric propulsion systems- Electrothermal, Electrostatic and Electromagnetic, Resistojet and arcjet concept, Electrostatic – concepts of Ion Thruster, Hall Thruster, Field Emission Thruster, Colloid Thruster, Low power neutralizers concept with diagram, Laser Accelerated Plasma Propulsion, Electromagnetic thrusters' types – MPD, PPT, VASIMAR

UNIT III NUCLEAR ROCKET PROPULSION 9

Nuclear Rocket Engine Design and Performance, Types of Nuclear Rockets, Overall Engine Design, Nuclear Rocket Performance, Component Design, Nuclear Rocket Reactors, General Design Considerations, Reactor Core Materials, Thermal Design, Mechanical Design, Nuclear Design, Shielding, Nuclear Rocket Nozzles, General Design Considerations, Heat-Transfer Analysis, Over-all Problem, Hot-Gas Boundary, Cold-Gas Boundary, Fusion Propulsion, Radioisotope Propulsion.

UNIT IV MICROPROPULSION 9

Introduction to Micropropulsion - types of Micropropulsion -Micropropulsion Requirements - Mechanism ofSolid Microthrusters, Micro Mono and bi-propellant Thrusters, Cold Gas Thruster - Microchip laser thruster concept - Comparison between Micro Ion Thruster, Low Power Hall Thruster, Micro PPT Thruster, MEMS FEEP/Colloid Thruster and Microchip Laser Thruster

UNIT V ADVANCED SPACE PROPULSION CONCEPTS 9

Introduction, General Consideration for Propulsion in Space, Power Supply, Propellant Storage and Handling Facilities, Advanced Electric Propulsion Systems for Space Vehicles, Sputtering, A Thrust Generation Mechanism, Sputtering Phenomena, Possible Performance of Sputtering Thrusters, Energy Efficiency of the Sputtering Process, Propellant less Propulsion

TOTAL : 45 PERIODS

TEXTBOOKS:

1. George P. Sutton & Oscar Biblarz, "Rocket Propulsion Elements, John Wiley & Sons Inc.,NewYork, 9th Edition, 2016.
2. Martin Tajmar, "Advanced Space Propulsion Systems" Springer Verlag GmbH, 2003.

George W. Sutton, "Engineering Magnetohydrodynamics", Dover Publications Inc., New York, 2005.

REFERENCES:

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons; 8th Edition 2010.
2. Bruno Claudio and Paul A. Czysz, "Future Spacecraft Propulsion Systems", Springer, Praxis Publishing Ltd, 2006.
3. Robert G. Jahn, "Physics of Electric Propulsion", McGraw-Hill Series, New York, 1968.

William J. Emrich, "Principles of Nuclear Rocket Propulsion" Elsevier Science, 2016.

AS32C1	ELEMENTS OF SATELLITE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: This course will enable students

1. To learn the satellite mission and configurations

2. To have a basic idea on power system of satellites

3. To learn the attitude and orbit control systems of satellites

4. To gain knowledge on basic of propulsion systems, structures, and thermal controls involved in satellites.

5. To learn the basic aspects of telemetry systems

Course Outcome		Cognitive Skill
CO-01	Be able to describe the main components of a satellite and its importance	A
CO-02	Compare the merits and demerits of various power systems used	An
CO-03	Be able to learn the dynamics of the satellite	A
CO-04	Be able to study the design of propulsion systems, structures needed for satellites.	An
CO-05	Acquire knowledge on satellite orbit control and telemetry systems	S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	M	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	S	L	L	L	L	S
CO-03	L	L	S	S	L	M	S	L	L	L	L	S
CO-04	M	L	M	M	M	M	S	L	L	L	L	L
CO-05	M	L	M	M	M	L	S	L	L	L	L	S

UNIT I SATELLITE MISSION AND CONFIGURATION 9

Mission Overview – Requirements for different missions – Space Environment, Spacecraft Configuration-Spacecraft Bus–Payload–Requirements and constraints– Initial configuration decisions and Trade-offs–Spacecraft configuration process– Broad design of Spacecraft Bus– Subsystem layout–Types of Satellites–Constellations– Applications

UNIT II POWER SYSTEM 9

Power sources–Energy storage–Solar panels–Deployable solar panels–Spacecraft Power management – Power distribution–Deep Space Probes.

UNIT III ATTITUDE AND ORBIT CONTROL SYSTEM (AOCS) 9

Coordinate system –AOCS requirements–Environment effects – Attitude stabilization – Attitude sensors –Actuators–Design of control algorithms

UNIT IV PROPULSION SYSTEMS, STRUCTURES AND THERMAL CONTROL 9

Systems Trade-off–Mono-propellant systems –Thermal consideration–System integration design factors – Pre-flight test requirements–System reliability Configuration design of Spacecraft structure– Structural elements–Material selection–Environmental Loads Vibrations– Structural fabrication– Orbital environments -Average temperature in Space– Transient temperature evaluation– Thermal control techniques– Temperature calculation for a spacecraft– Thermal design and analysis program structure – Thermal design verification– Active thermal control techniques

UNIT V TELEMETRY SYSTEMS 9

Base Band Telemetry system– Modulation– TT & CRF system–Telecommand system– Ground Control Systems

TOTAL : 45 PERIODS

TEXTBOOKS:

1. Albert D. Helfrick, "Modern Aviation Electronics", Second Ed., Prentice Hall Career &Technology, 1994.
2. James R Wertz, "Spacecraft Attitude Determination and control", Reidel Publications, 1978.
3. Kaplan, M. H., "Modern Spacecraft Dynamics and Control", Wiley India Pvt Ltd, 2011.
4. Marcel J. Sidi, "Spacecraft Dynamics and Control: A Practical Engineering Approach",Cambridge University Press, 2000.
5. Maxwell Noton, "Spacecraft navigation and guidance", Springer (London, New York), 1998.
6. Slater, J. M. Donnel, C.F.O and others, "Inertial Navigation Analysis and Design", McGraw-Hill Book Company, New York, 1964.

REFERENCES:

1. Blake Lock, J.H, "Automatic control of Aircraft and missiles", John Wiley Sons, New York,1990.
2. George M Siouris, "Aerospace Avionics System; A Modern Synthesis", Academic Press Inc.,1993.
3. Meyer Rudolph X, "Elements of Space Technology for Aerospace Engineers", AcademicPress,1999.
4. Myron Kyton, Walfred Fried, "Avionics Navigation Systems", John Wiley & Sons, 1997
5. Tsui. J. B.Y, "Fundamentals of Global Positioning System Receiver", John Wiley an Sons Inc,2000.
6. Vladimir A Chobotov, "Spacecraft Attitude Dynamics and Control (Orbit)", Krieger Publishing Company Publishers.

AS32C2	SPACE VEHICLE AERODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: This course will enable students

1. Gain knowledge on the basics of low-speed aerodynamics

2.

3. Provide enough knowledge on boundary layers and their interactions.

4. Impart knowledge on the aerodynamic characteristics of missile components.

5. Gain an idea about aerodynamic heating phenomena.

Course Outcome		Cognitive Skill
CO-01	Have through knowledge on the concepts of incompressible aerodynamics.	A
CO-02	Be able to analyse practical problems involving Fanno and Rayleigh flow.	An

CO-03	Have knowledge on the concepts of laminar and turbulent boundary layer flows and their interaction with shock waves.	A
CO-04	Able to demonstrate and analyse different configurations of missiles and their characteristics.	S
CO-05	Be able to design efficient re-entry vehicles by solving the problem of aerodynamic heating.	An

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	M	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT-I BASICS OF INCOMPRESSIBLEFLOW 9

Aerodynamic forces and moments - Centre of pressure - Aerodynamic centre - Continuity equation - Momentum equation - Stream function - Potential function - Elementary flows - Flow over cylinder, sphere and cones.

UNITII COMPRESSIBLEFLOWS 9

Compressibility - Speed of sound - Normal shock - Oblique shock - Expansion fan - Variable area ducts - Unsteady shock waves - Fanno flow - Rayleigh flow - Wave drag- Crocco's Theorem - Method of characteristics.

UNITIII BOUNDARY LAYERTHEORY 9

Boundary layer thickness - Displacement thickness - Momentum thickness - Laminar boundary layer - turbulent boundary layer - Blasius solution - Skin friction drag estimation - Shock wave- boundary layer interactions.

UNIT IV AERODYNAMIC CHARACTERISTICSOFMISSILES 9

Airframe components of missiles - Forebody shapes - Prediction of component characteristics - Wing planform for missiles Delta wing - Vortex break down - Compressibility effect on deltawing- Wing-body interference effects - Transonic and Supersonic drag reduction methods – Findrag- Bodydrag.

UNIT V AERODYNAMIC HEATING 9

Heat transfer process - Basic parameters in aerodynamic heating - Reference temperature method -

Aerodynamic heating on conical surfaces - Variable entropy effects - Heat transfer across junctures - Non isothermal wall effects - Swept shock interactions - Application of methodology in practical missile design.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Anderson, JD, "Fundamentals of Aerodynamics", McGraw-Hill Book Co,2010.
2. Chin SS, "Missile Configuration Design", Mc GrawHill,1961.

REFERENCES:

1. Hermann Schlichting, "Boundary Layer Theory", Springer, 8th edition,2000.
2. Michael Mendenhall, "Tactical Missile Aerodynamics: Prediction Methodology, Progress in Astronautics and Aeronautics", 1992.
3. Nielson, Jack N, Stever, Gutford, "Missile Aerodynamics", McGraw Hill,1960.

AS32C3	HYPERSONIC AERODYNAMICS FOR AEROSPACE VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: This course will enable students

1. To realise the importance of studying the peculiar hypersonic speed flow characteristics pertaining to flight vehicles.

2. To provide knowledge on various surface inclination methods for hypersonic inviscid flows.

3. To arrive at the approximate solution methods for hypersonic flows.

4. To impart knowledge on hypersonic viscous interactions.

5. To impart knowledge on the effect on aerodynamic heating on hypersonic vehicles.

Course Outcome		Cognitive Skill
CO-01	Apply problem-solving techniques to analyze and solve inviscid and viscous hypersonic flow problems.	A
CO-02	Evaluate the impact of high temperature on hypersonic aerodynamics and its effects.	E
CO-03	Generate and assess different solution methods to mitigate aerodynamic heating challenges in hypersonic vehicles.	An
CO-04	Evaluate and analyze design considerations and issues associated with hypersonic vehicles.	E
CO-05	Demonstrate an understanding of the significance and application of relevant equations in modeling viscous hypersonic flows.	S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	M	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	N	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT-I BASICS OF HYPERSONIC AERODYNAMICS 9

Thin shock layers – entropy layers – low density and high-density flows – hypersonic flight paths – hypersonic flight similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT II SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS 9

. Local surface inclination methods – modified Newtonian Law – Newtonian theory – tangent wedge or tangent cone and shock expansion methods – Calculation of surface flow properties.

UNIT III APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS 9

Approximate methods – hypersonic small disturbance equation and theory – thin shock layer theory – blast wave theory – entropy effects – rotational method of characteristics – hypersonic shock wave, shapes and correlations.

UNIT IV VISCOUS HYPERSONIC FLOW THEORY 9

Navier-Stokes equations – boundary layer equations for hypersonic flow – hypersonic boundary layer – hypersonic boundary layer theory and non-similar hypersonic boundary layers – hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating – heat flux estimation.

UNIT V VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9

Strong and weak viscous interactions – hypersonic shockwaves and boundary layer interactions – Estimation of hypersonic boundary layer transition – Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Anderson, JD, "Fundamentals of Aerodynamics", McGraw-Hill Book Co,2010.
2. Chin SS, "Missile Configuration Design", Mc GrawHill,1961.

REFERENCES:

3. William H. Heiser and David T. Pratt, Hypersonic Air Breathing propulsion, AIAA Education Series, 1994.
4. John T. Bertin, Hypersonic Aerothermodynamics, AIAA Education Series, 1993

AS32C4	ORBITAL MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: This course will enable students

1. To introduce special needs for manned space missions and pre calculation of space environment to students.

2. To impart the knowledge on basis concepts of space mechanics like Newton's law of gravitation and its applications, reference co-ordinate systems and position vs time relationships of celestial bodies.

3. To acquaint students on the methodologies for computation of satellite orbit perturbations

4. To elucidate the concepts of space of influence and its purpose in computing interplanetary trajectories to students.

5. Toimpartknowledgeofvariousphasesofballistictrajectoriesandspecialfeaturesofre-entryphase to students also to calculate simple orbital rendezvous and phasing maneuvers

Course Outcome		Cognitive Skill
CO-01	apply the basic knowledge in the calculation of space orbits and the purpose & applications of space missions	A
CO-02	analyze the motion of space objects with time with the choice of using modern computer software	An
CO-03	apply orbit control methods and determine injection errors of satellites by analyzing the orbit and trajectory data using the relevant computer software tools	A
CO-04	perform calculations and analyze the suitability pertaining to trajectories for interplanetary missions	An
CO-05	Analyse the various trajectory complications n the ballistic missiles.	An

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT I SPACE ENVIRONMENT 9

Peculiarities of space environment and its description– International Standard Atmosphere -radiation and magnetic fields - effect of space environment on materials of spacecraft structure and astronauts- manned space missions – effect on satellite life time. The solar system – reference frames and coordinate systems – terminology related to the celestial sphere and its associated concepts – Newton's universal law of gravitation

UNIT II CHARACTERISTICS OF VARIOUS ORBITS 9

Two Body Motion: equations of motion – Kepler laws – solution to two-body problem - Properties of elliptic, Parabolic and hyperbolic properties in terms of orbital elements – relations between position and time – Barker's theorem – Whittaker's theory – Sphere of influence - Kepler equation

UNIT III SATELLITE INJECTION AND SATELLITE PERTURBATIONS 9

General aspects of satellite injection – satellite orbit transfer – various cases – orbit deviations due to injection errors – special and general perturbations – Cowell's method and Enake's method – method of variations of orbital elements – general perturbations approach.

UNIT IV INTERPLANETARY TRAJECTORIES 9

Orbital Maneuvers in earth satellite and deep space missions-Hohmann transfer – inclination change maneuvers, combined maneuvers, bi-elliptic maneuvers - Hoelker and Silber Transfers-Two-dimensional interplanetary trajectories – fast interplanetary trajectories –Planetary Departure – Planetary Arrival-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. Curtis, H. D., Orbital Mechanics for Engineering Students, 2 nd ed., Elsevier (2009).
2. Chobotov, V. A., Orbital Mechanics, 3 rd ed., AIAA Edu. Series (2002).
3. Craig A Kluever , Space Flight Dynamics, Aerospace series (2018)

REFERENCES:

1. Wiesel, W. E., Spaceflight Dynamics , 2 nd ed., McGraw-Hill (1996).
2. Brown, C. D., Spacecraft Mission Design , 2 nd ed., AIAA Edu. Series (1998).
3. Escobal, P. R., Methods of Orbit Determination , 2 nd ed., Krieger Pub. Co. (1976).
4. Tewari, A., Atmospheric and Space Flight Dynamics: Modeling and Simulation with MAT- LAB and Simulink ,Birkhuser (2007).

AS32C5	ROCKETS AND MISSILES	L	T	P	C
		3	0	0	3

Course Outcome		Cognitive Skill
CO-01	apply the basic knowledge for the understanding of various types of propellants and combustion systems	A
CO-02	Analyze the fundamental aerodynamics applied on the rockets and missiles	An
CO-03	analyze the motion of space objects with time with the choice of using modern computer software	An
CO-04	Design and develop the optimization in rocket staging	A
CO-05	Perform the material characterization study on the various materials to be used in aerospace applications	S

R-Remember, U-Understand, A-Apply, An-Analyze, E-Evaluate, S-Synthesis

Mapping of Course Outcome with Programme Outcome

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	M	L	L	M
CO-02	L	S	L	N	L	M	M	L	M	L	L	M
CO-03	L	S	S	S	L	N	M	L	M	L	L	M
CO-04	M	S	M	M	N	M	M	L	M	L	L	L
CO-05	M	S	M	M	M	L	M	L	M	L	L	L

UNIT I: ROCKET SYSTEMS **9**

Ignition system in rockets – types of igniters and igniter design considerations –injection system and propellant feed systems of liquid rockets and their design considerations – design considerations of liquid rocket thrust chambers – combustion mechanisms of liquid and solid propellants.

UNIT II: AERODYNAMICS OF ROCKETS AND MISSILES **9**

Airframe components of rockets and missiles – forces acting on a missile while passing through atmosphere – classification of missiles – slender body aerodynamics- method of describing forces and moments – lift force and lateral moment –lateral aerodynamic damping moment – longitudinal moment – drag estimation – body upwash and body downwash in missiles – rocket dispersion.

UNIT III: ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD 9

One dimensional and two-dimensional rocket motions in free space and homogeneous gravitational fields – description of vertical, inclined and gravity turn trajectories – determination of range and altitude – simple approximations to burn out velocity and altitude – estimation of culmination time and altitude.

UNIT IV: STAGING AND CONTROL OF ROCKETS AND MISSILES **9**

Design philosophy behind multistaging of launch vehicles and ballistic missiles –multistage vehicle optimization – stage separation techniques in atmosphere and inspace – stage separation dynamics and lateral separation characteristics – various types of thrust vector control methods including secondary injection thrust vector control – numerical problems on stage separation and multistaging.

UNIT V: MATERIALS FOR ROCKETS AND MISSILES **9**

Selection criteria of materials for rockets and missiles – materials for various airframe components and engine parts – materials for thrust control devices – various adverse conditions faced by aerospace vehicles and the requirement of materials to perform under these conditions.

TOTAL: 45 HOURS

TEXT BOOKS:

3. Cornelisse, J.W., “Rocket Propulsion and Space Dynamics”, J.W. Freeman &Co.,Ltd, London, 1982
4. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York,5th Edition, 1993.

REFERENCES:

1. Parker, E.R., “Materials for Missiles and Spacecraft”, Mc.Graw Hill Book Co. Inc.,1982.
2. Mathur, M.L., and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”,Standard Publishers and Distributors, Delhi, 1988.

OPEN ELECTIVES

AS32D1	LAUNCH VEHICLE CONFIGURATION DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

Upon completing Launch Vehicle Configuration Design, students will synthesize and optimize launch vehicle architectures, integrating payload, propulsion, structural, and guidance systems. They will apply design methodologies, performance analysis, and mission requirements to ensure efficient, reliable, and cost-effective access to space, meeting stakeholder and industry standards.

Course Outcome		Cognitive Skill
CO-01	CO1: Analyze mission requirements and stakeholder needs to define launch vehicle configuration specifications.	A
CO-02	Design and optimize launch vehicle architectures, integrating payload, propulsion, structural, and guidance systems.	An
CO-03	Apply systems engineering principles to ensure compatibility and interface management between subsystems.	A
CO-04	Evaluate launch vehicle performance using trajectory simulation, mass properties, and payload capacity analysis.	S
CO-05	Assess design trades, risks, and costs to recommend optimal launch vehicle configurations meeting program objectives and industry standards.	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT I FUNDAMENTAL ASPECTS 9

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

UNIT II SELECTION OF ROCKET PROPULSION SYSTEMS 9

Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

UNIT III ENGINE SYSTEMS, CONTROLS, AND INTEGRATION 9

Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization.

UNIT IV THRUST VECTOR CONTROL 9

TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing - Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

UNIT V NOSE CONE CONFIGURATION 9

Aerodynamic aspects on the selection of nose shape of a launch vehicle design factors in the fi nalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Michael D. Griffin, James R. French, "Space Vehicle Design", AIAA, 2nd Ed., 2004
2. Karl Dawson Wood, "Aerospace Vehicle Design: Spacecraft Design", Johnson Publishing Company, 1964

REFERENCES:

1. Bong Wie, "Space Vehicle Dynamics and Control", AIAA, 1998.
2. Anton H. de Ruiter, Christopher Damaren, James R. Forbes, "Spacecraft Dyna mics and Control: An Introduction", John Wiley & Sons, 2012.
3. Marcel J. Sidi, "Spacecraft Dynamics and Control: A Practical Engineering Ap proach", Cambridge University Press, 2000.

AS32D2	SPACECRAFT SENSORS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

Upon completing Spacecraft Sensors and Instrumentation, students will design and integrate sensors/instruments for space missions, ensuring accurate data collection through

measurement principles, calibration, and error mitigation for scientific, navigation, and operational applications.

Course Outcome		Cognitive Skill
CO-01	Define and explain the key concepts and functions of management.	A
CO-02	Analyze the roles and responsibilities of managers in different organizational contexts.	An
CO-03	Apply planning, organizing, leading, and controlling principles to real-world scenarios.	A
CO-04	Evaluate the effectiveness of different management theories and practices.	S
CO-05	Demonstrate management skills necessary for leading teams and projects in a technical environment	An

PO / CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H	PO-I	PO-J	PO-k	PO-L
CO-01	M	S	S	S	M	N	M	L	L	L	L	M
CO-02	L	S	L	N	L	M	M	L	L	L	L	S
CO-03	L	S	S	S	L	M	M	L	L	L	L	S
CO-04	M	S	M	M	M	M	M	L	L	L	L	L
CO-05	M	S	M	M	M	L	M	L	L	L	L	S

UNIT – I: INTRODUCTION **8**

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

UNIT – II: MEASUREMENTS OF CHARGED AND NEUTRAL PARTICLES **10**

Pulse and Current modes – Pulse height spectra and analysis – Counting curves and plateaus – Energy resolution - Detector efficiency – Dead time – Analysers: Electrostatic, Magnetic-field, Time-of-flight – Detectors: Solid state, Scintillation counters, Electron multipliers – Actual
instruments – Analog or pulse height spectroscopy electronics – Digital techniques – Impact of microprocessors on inflight data processing units – Power supplies – Neutral particle imagers.

UNIT III MEASUREMENT OF MAGNETIC AND ELECTRIC FIELDS 9

Fluxgate magnetometer – Search coil magnetometer – Optical absorption magnetometer. Electric Fields: Double probe technique – Beam experiments –
Observation of electric fields parallel to the magnetic field.

UNIT IV PHOTON COUNTING SENSORS AND IMAGERS 9

Auroral imagers: Optical, UV, X-ray – X-ray sensors and imagers - Detection techniques, Grazing incidence optics – Charged Coupled Devices – Other imaging techniques – tomography.

UNIT V SPACECRAFT SYSTEMS AND SATELLITE ORBITS 9

Subsystems – Testing and Qualifications – Trade-offs – Role of orbit to investigation – Unusual orbital techniques: L1 orbit, double lunar swing-by.

TOTAL: 45 PERIODS

TEXT BOOK

1.Abid, Mohamed M., "Spacecraft Sensors", Chichester, England; Hoboken, NJ: J. Wiley, 2005

2. Kohichiro Oyama, ChioZong Cheng, "An introduction to space instrumentation", Tokyo, Japan: Terrapub, 2013.

REFERENCES

2. Yuri Surkov, "Exploration of Terrestrial Planets from Spacecraft: Instrumentation, Investigation, Interpretation", Wiley-Praxis Series in Astronomy & Astrophysics, Ellis Horwood Ltd, 2nd Ed., 1990.