NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

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

DEPARTMENT OF AERONAUTICAL ENGINEERING

B.E. AERONAUTICAL ENGINEERING

CURRICULUM AND SYLLABI

REGULATION 2021

NOORUL ISLAM CENTRE FOR HIGHER EDUCATION, Kumaracoil
Regulation : 2021

Curriculum and Syllabi

B.E. Programme
DEPARTMENT OF AERONAUTICAL ENGINEERING

B.E. AERONAUTICAL 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.

Faculty of Aeronautical and Space Technology

Department of Aeronautical Engineering

Vision Statement of the Department: To train discerning graduates to become well educated in Aeronautical Engineering Masters with required knowledge with effective teaching, learning, analytical thinking, written and oral communication skills, creativity, vision, enthusiasm and above all professional ethics to become leaders in industry, research & society etc.

Mission Statement of the Department: To offer a world-class, affordable education, in Aeronautical Engineering, backed by the services of engineering fundamentals augmented by the development of interpersonal skills, social values, experiential learning, and flair for life-long learning with highly qualified faculty and extensive experience in basic and applied research, covering different areas of Aeronautical Engineering.

Description of the programme

Programme Educational Objectives - PEO	
PEO-01	To strengthen the fundamental subject knowledge and practical skills of the aeronautical Students for meeting the requirements of Aeronautical industries and educational institutions including research centre.
PEO-02	To give quality technical education to the students covering latest technological concepts for facilitating them to diagnose and solve industrial problems.
PEO-03	To provide necessary technical, managerial and soft skills to the students for making them industry ready.
PEO-04	To shape the students for becoming socially, intellectually and ethically responsible Aeronautical Engineers.
PEO-05	To mould graduates to acquire and exercise efficient communication skills, eminent leadership qualities and team work to challenge the contemporary issues to broader social context.

	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 communities
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	To apply the knowledge of mathematics, science and engineering.
PO-B	Ability to analyze, interpret and solve complex engineering problems.
PO-C	Ability to visualize and work on laboratory for multidisciplinary needs.
P0-D	Ability to integrate all the modes of analysis for accuracy solutions during arbitrary problems.
PO-E	Ability to demonstrate the skills using modern engineering tools and equipment.

PO-F	Ability to function on multidisciplinary teams.
PO-G	Graduates will be able to communicate effectively in both verbal and written form.
PO-H	Graduates will contribute to the needs of the society.
PO-I	Able to get broad education necessary to understand the impact of engineering solutions in Global economic and social content.
PO-J	Ability to demonstrate the knowledge of professional and ethical responsibilities.
PO-K	Graduates will achieve successful career in Global industry.
PO-L	Graduates will develop confidence for self-esteem and ability for lifelong learning.
PO-M	Ability to lead the future of Aeronautics.

Mapping of Graduate Attributes and Programme 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	N	A	N	A	N	A	N	A	A
PEO-02	A	A	N	H	A	A	N	N	N	N	A	A
PEO-03	N	N	N	N	N	H	A	A	N	N	H	A
PE0-04	N	N	A	H	N	A	N	N	N	H	N	A
PEO-05	N	A	N	A	N	A	N	H	N	N	N	N

H-Highly Associated A-Associated N – Not Associated

Mapping of Graduate Attributes and Programme 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	N	A	N	A	N	N	N	N	N	N	N	N
PO-B	H	A	N	N	A	N	H	N	H	N	N	N
PO-C	A	H	A	N	N	N	N	N	A	N	N	N
PO-D	H	A	A	N	N	N	A	N	H	N	N	A
PO-E	H	A	A	N	N	N	A	N	A	N	N	N
PO-F	A	A	A	N	N	N	A	N	H	A	A	A
PO-G	N	N	N	H	N	A	N	A	N	N	H	N
PO-H	N	A	A	H	N	A	N	A	N	A	A	A
PO-I	N	A	A	H	N	A	N	A	N	A	A	A
PO-J	N	A	A	H	N	A	N	H	N	H	A	A

H-Highly Associated A-Associated N – 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	N	N	N
PO-B	A	A	N	N	N
PO-C	H	A	N	N	N
PO-D	A	A	N	N	N
PO-E	A	A	N	A	N
PO-F	A	A	N	N	N
PO-G	A	N	H	A	H
PO-H	N	N	A	A	A
PO-I	N	N	N	A	N
PO-J	N	N	N	H	N

H-Highly Associated A-Associated N – Not Associated

Duration of the BE Program: 4 Years
Total Credit: 163

Curriculum

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.	AE3101	Aircraft Production Technology	3	0	0	3
6.	ME3101	Engineering Graphics	3	0	2	4
PRACTICALS						
7.	BE3173	Manufacturing Practices Laboratory	0	0	2	1
8.	BE3171	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1
TOTAL			**18**	**1**	**6**	**22**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA3201	Engineering Mathematics – III	3	1	0	4
2.	ME3204	Fluid Mechanics and Machinery	3	0	0	3
3.	AE3204	Solid Mechanics	3	0	0	3
4.	AE3203	Introduction to Aircraft Structures	3	0	0	3
5.	AE3201	Aero Engineering Thermodynamics	3	0	0	3
6.	AE3202	Fundamental of Aeronautics	3	0	0	3
PRACTICAL						
7.	ME3272	Fluid Mechanics and Machinery Lab	0	0	2	1
8.	AE3272	Solid Mechanics Lab	0	0	2	1
9.	AE3271	Aero Thermodynamics Lab	0	0	2	1
TOTAL			**18**	**1**	**6**	**22**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA3203	Numerical Methods	2	1	0	3
2.	BS3201	Environmental Studies	3	0	0	2
3.	AE3205	Aircraft Structures	3	0	0	3
4.	AE3206	Aircraft Systems and Instrumentation	3	0	0	3
5.	AE3207	Low speed Aerodynamics	3	0	0	3
6.	AE3208	Mechanics of Machines	3	0	0	3
PRACTICALS						
7.	AE3273	Aerodynamics Lab	0	0	2	1
8.	AE3274	Aircraft Structures Lab	0	0	2	1
9.	AE3275	Aircraft Systems Lab	0	0	2	1
10.	AE32P1	Summer Internship-I	0	0	0	2
TOTAL			**17**	**1**	**6**	**22**

SEMESTER V

SL. No.	Course Code	Course Title	L	T	P	C
THEORY						
1.	MS3201	Professional and Business Ethics	3	0	0	2
2.	AE3209	Aircraft Composite Materials and Structures	3	0	0	3
3.	AE3210	Air Breathing Propulsion	3	0	0	3
4.	AE3211	High Speed Aerodynamics	3	0	0	3
5.	AE3212	Flight Dynamics	3	0	0	3
6.	AE32**	Department Elective	3	0	0	3
PRACTICAL						
7.	AE3276	Part Design and Assembly Lab	0	0	3	1
8.	AE3277	UAV & Aero modeling Lab	0	0	3	1
9.	AE3278	Airframe & Composite Materials Lab	0	0	3	1
TOTAL			**18**	**0**	**9**	**20**

SEMESTER VI

SL. No.	Course Code	Course Title	L	T	P	C
THEORY						
1.	AI32D1	Fundamentals of Artificial Intelligence	3	0	0	3
2.	AE3213	Finite Element Analysis for Aircraft Structures	3	0	0	3
3.	AE3214	Advanced Propulsion Systems	3	0	0	3
4.	AE32**	Department Elective	3	0	0	3
5.	AE32**	Department Elective	3	0	0	3
6.	AE32**	Department Elective	3	0	0	3
PRACTICAL						
7.	AE3279	Aero Engines Lab	0	0	3	1
8.	AE3280	Aircraft Design Project I	0	0	3	1
9.	AE3282	Finite Element Analysis Lab	0	0	3	1
10.	AE32P2	Summer Internship II	0	0	0	2
TOTAL			**18**	**0**	**9**	**23**

SEMESTERVII

SL. No.	Course Code	Course Title	L	T	P	C
THEORY						
1.	AE3215	Grid Generation Techniques	3	0	0	3
2.	MS3202	Principle of Management	3	0	0	2
3.	AE****	Department Elective	3	0	0	3
4.	AE****	Department Elective	3	0	0	3
5.	XXXX	Open Elective	3	0	0	3
PRACTICAL						
6.	AE3283	Computational Fluid Dynamics Lab	0	0	2	1
7.	AE3284	Aircraft Design Project - II	0	0	2	1
8.	AE32P3	Project Work Phase - I	0	0	6	3
TOTAL			**15**	**0**	**10**	**19**

SEMESTER VIII

SL. No.	Course Code	Course Title	L	T	P	C
THEORY						
1.	AE****	Department Elective	3	0	0	3
2.	AE****	Department Elective	3	0	0	3
PRACTICAL						
3.	AE32P5	Project Work Phase - II	0	0	24	8
TOTAL			**6**	**0**	**24**	**14**

LIST OF DEPARTMENT ELECTIVES

Sl. NO	Course Code	Course Title	L	T	P	C
1.	AE32A1	Renewable Energy Technologies	3	0	0	3
2.	AE32A2	Industrial Aerodynamics	3	0	0	3
3.	AE32A3	Heat Transfer in Space Applications	3	0	0	3
4.	AE32A4	Computational Fluid Dynamics	3	0	0	3
5.	AE32A5	Aero Engine Maintenance and Repair	3	0	0	3
6.	AE32A6	Design of Gas Turbine Engine Components	3	0	0	3
7.	AE32A7	Space Mechanics	3	0	0	3
8.	AE32A8	Theory of Vibration	3	0	0	3
9.	AE32A9	Rockets and Missiles	3	0	0	3
10.	AE32B1	Theory of Elasticity	3	0	0	3
11.	AE32B2	Wind Tunnel Techniques	3	0	0	3
12.	AE32B3	UAV Design	3	0	0	3

13.	AE32B4	Non Destructive Testing and Evaluation	3	0	0	3
14.	AE32B5	Helicopter Aerodynamics	3	0	0	3
15.	AE32B6	Air Transportation and Aircraft Maintenance	3	0	0	3
16.	AE32B7	Aircraft Design	3	0	0	3
17.	AE32B8	Aircraft Production Planning and Control	3	0	0	3
18.	AE32B9	Hypersonic Aerodynamics	3	0	0	3
19.	AE32C1	Rocket Propulsion	3	0	0	3
20.	AE32C2	Aerodynamics of Drones	3	0	0	3
21.	AE32C3	Boundary Layer Theory	3	0	0	3
22.	AE32C4	Avionics	3	0	0	3
23.	AE32C5	Fatigue and Fracture Mechanics	3	0	0	3
24.	AE32C6	Computer Integrated Manufacturing	3	0	0	3
25.	AE32C7	Optimization Techniques	3	0	0	3
26.	AE32C8	Sustainable Manufacturing	3	0	0	3
27.	AE32C9	Electric and Hybrid Vehicles	3	0	0	3
28.	AE32E1	Air Traffic Control	3	0	0	3
29.	AE32E2	Aircraft Rules and Regulations	3	0	0	3
30.	AE32E3	Aerospace Materials	3	0	0	3
31.	AE32E4	Wind Engineering	3	0	0	3
32.	AE32E5	Cryogenics	3	0	0	3
33.	AE32E6	Advanced Vehicle Engineering	3	0	0	3

LIST OF OPEN ELECTIVES

SI. NO	Course Code	Course Title	L	T	P	C
1.	AE32D1	Reverse Engineering	3	0	0	3
2.	AE32D2	Additive Manufacturing	3	0	0	3

LIST OF COMMON SUBJECTS

SI. NO	Course Code	Course Title	L	T	P	C
1.	MS3201	Professional and Business Ethics	3	0	0	2
2.	AI32D1	Fundamentals of Artificial Intelligence	3	0	0	3

Syllabus

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 – I

EG3101	TECHNICAL ENGLISH	L	T	P	C
		3	**1**	**0**	**4**

OBJECTIVES

- To develop the linguistic, communicative and critical thinking competencies of First Year Engineering students
- To enhance the understanding of the complex grammatical structures of the English language to students
- To improve the language proficiency of students in English with emphasis on
- Vocabulary, Grammar, Listening, Speaking, Reading, and Writing skills
- 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

Course Outcome - COs		Cognitive Skill
CO-01	The students will be able to improve their vocabulary relating to Engineering and Technology, and use articles and prepositions effectively in sentences.	R

CO-02	The students will be able to learn grammatical items like tense, voice, compound nouns etc. and thereby enhance their linguistic competence.	U
CO-03	The students will be able to learn definitions of technical terms, relative pronouns etc. which will develop their language competence.	A
CO-04	The students will be able to acquire the essentials of writing skills relating to CV, Resume, Formal and Business Letters.	U
CO-05	The students will be able to learn English phonemes such as Vowels, Diphthongs and Consonants which will be instrumental in improving their pronunciation and speaking skills.	R

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

Mapping of Course Outcomes with Programme Outcomes

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

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

EXTENSIVE READING:

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.

TEXT BOOK

1. Khaleel Rahuman A., Deepa P., Sheila J., Mathi Vathani J. , *Technical English*, R. K. Publishers, 2023.

REFERENCES

1. Nagarajan S., Senthil C. S., *Engineering English I & II*, Sri Krishna Publications, 2004.
2. Jewelcy Jawahar , Rathna P., *English Work Book for First Year B.E./ B.Tech.*, VRB Publishers, Chennai, 2008.

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

OBJECTIVE

The course objective is to develop the required skill of the students in the area of Engineering Mathematics with special mph as is 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 – COs Students able to		**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	PO-M
CO-01	S	M	S	M	S	S	S	S	M	S	S	M	N
CO-02	S	M	M	M	S	S	M	S	M	M	M	M	N
CO-03	S	M	M	M	S	S	M	M	M	S	S	M	L
CO-04	S	M	S	M	S	M	S	S	M	S	S	M	M
CO-05	S	M	S	M	S	M	S	S	M	S	S	M	N

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 curvature, 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

OUTCOMES:
At the end of the course, the students will be familiar with various concepts of calculus which are essential for engineering. They also become acquainted with the basic ideas of multiple integrals and their usage.

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	**0**	**0**	**3**

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.

Course Outcome–Cos		**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 nano materials 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	PO-M
CO-01	S	S	S	M	S	M	M	N	M	N	L	L	M
CO-02	S	S	S	M	S	S	M	N	N	N	M	M	M
CO-03	S	S	S	S	M	S	S	N	M	N	L	M	N
CO-04	S	M	S	S	M	S	S	N	M	N	L	N	N
CO-05	S	S	M	M	M	M	M	N	M	N	M	N	N

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 tunneling microscope.

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), Nano materials, Biomaterials.

TOTAL: 45 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 - COs		**Cognitive Skill**
CO-01	Students will understand the basic concept of Estimations of entropy and free energies. Free energy and emf.	U
CO-02	Students will study disinfection by chlorination, ozone and UV treatments.	R
CO-03	Students will know the Effective nuclear charge, penetration of orbitals, variations of s, p, d	U
CO-04	Principles of spectroscopy and selection rules. Electronic spectroscopy.	A
CO-05	Student will study Introduction to reactions involving substitution, addition, elimination,	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	L	S	L	M	M	L	M	S	S	S	L
CO-02	S	L	S	L	M	M	L	M	S	S	S	L
CO-03	S	M	S	M	S	M	L	S	S	S	S	L

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

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.

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

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 call them.
- To use Python data structures: lists, tuples, dictionaries.
- To do input/output with files in Python.

Course Outcome – COs		Cognitive Skill
CO-01	Understand the basics of algorithmic problem solving.	R,U
CO-02	Ability to analyze various techniques for read and write simple Python programs.	A
CO-03	Introduce Python programs with conditionals and loops.	An
CO-04	Evaluate and Define Python functions, call them and use Python data structures – lists, tuples, dictionaries.	E
CO-05	Apply input/output with files in Python.	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
CO-01	N	M	S	L	M	M	L
CO-02	N	S	L	L	M	S	S
CO-03	M	L	S	M	L	L	M
CO-04	M	L	L	S	M	M	L
CO-05	M	L	L	L	M	S	L

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, tuple as return 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 (http://greenteapress.com/wp/thinkpython/)
2. 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,20 12. Charles Dierbach, ―Introduction to Computer Science using Python: A Computational ProblemSolving 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.

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

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's method.
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)

AIM

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.

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.

Course Outcome – COs		Cognitive Skill
CO-01	Understand the basic syntax of python	U

CO-02	Understand the problem solving techniques	An, U
CO-03	Analyze data structure concept in python	U
CO-04	Understand all tools of python	An
CO-05	Understand pygame with simulation	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
CO-01	M	L	S	M	L	L	S
CO-02	L	L	M	M	S	M	L
CO-03	M	M	L	L	M	S	L
CO-04	S	L	L	M	M	M	L
CO-05	L	L	L	S	L	L	S

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

LIST OF PROGRAMS:

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

PLATFORM NEEDED: Python 3 interpreter for Windows/Linux

TOTAL: 45 HOURS

Syllabus

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.	AE3101	Aircraft Production Technology	3	0	0	3
6.	ME3101	Engineering Graphics	3	0	2	4
PRACTICALS						
7.	BE3173	Manufacturing Practices Laboratory	0	0	2	1
8.	BE3171	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1
TOTAL			**18**	**1**	**6**	**22**

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 Outcomes		Cognitive Skill
CO-01	The students will be able to understand the basic vocabulary items, sentence structures and error detection and correction which, in turn, will expand their knowledge of the English language.	R
CO-02	The students will be able to grasp the LSRW Skills and gain exposure to absorb Comprehension and Note-making.	U

CO-03	The students will get real time practice in speaking through Oral Presentation, Small Talk, Role Play, Debate , Group Discussion etc.	A
CO-04	The students will be able to improve their writing skills through exposure to Report Writing and Letter Writing.	U
CO-05	The students will be able to learn the Theory of Communication , the Importance of Communication, and be introduced to the various facets of Verbal and Non verbal Communication.	R

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

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO-A	PO-B	PO-C	PO-D	PO-E	PO-F	PO-G	PO-H
CO-01	S	M	M	S	S	M	S	S
CO-02	M	S	M	M	S	S	M	S
CO-03	S	M	M	S	M	M	S	M
CO-04	M	S	M	M	S	M	S	M
CO-05	S	M	S	S	M	S	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).

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

EXTENSIVE READING :

Can Field 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.

REFERENCES

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

OBJECTIVE

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 - COs		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	PO-M
CO-01	M	S	M	S	S	N	M	M	S	S	M	M	M

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

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.

L: 45 + T: 15 = TOTAL 60 HOURS

TEXT BOOK

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

REFERENCES

1. M.Immaculate Mary , K.Uma Samundesvari, Engineering Mathematics – II" First Edition, Anuradha Publications, ,2013.
2. Erwin Kreyszig, " Advanced engineering Mathematics", Seventh Edition, Wiley India, 2007.

3. Veerarajan T, " Engineering Mathematics (for first year)", Tata McGraw- Hill Publishing Company Ltd.,New Delhi,2007.
4. P.Kandasamy , K.Thilagavathy , K.Gunavathy" Engineering Mathematics" S.Chand & Company Ltd.2002.
5. 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

OBJECTIVE

To understand the basic concepts of AC and DC circuits, measuring instruments, electronic devices and Communication system.

Course Outcome - COs		Cognitive Skill
CO-01	To study the basic principle and operation of AC and DC machines.	U
CO-02	To study the fundamental operations of measuring instruments.	R
CO-03	To understand the fundamental operation and characteristics of Electron devices	U, A
CO-04	To understand the implementation of Boolean expression using logic gates.	R
CO-05	To become familiar with basic concepts of Communication system.	U,R

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

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 and 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

OBJECTIVE

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 - COs		Cognitive Skill
CO-01	Calculate Resultant force for different force systems	R,U,A,An,E

CO-02	Carryout equilibrium analysis of truss	R,U,A,An,E
CO-03	Calculate C.G &centre of mass for simple and composite figures	R,U,A,An,E
CO-04	Apply Newton's law & conservation law to elastic collision & motion of rigid bodies	R,U,A,An,E
CO-05	Apply the principles of dynamics to solve engineering problem	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	M	M	L	L	L	L	L	L	L	S	L
CO-02	S	M	M	L	L	L	L	L	L	L	S	L
CO-03	S	M	M	L	L	L	L	L	L	L	S	L
CO-04	S	M	L	L	L	L	L	L	L	L	S	L
CO-05	S	M	L	L	L	L	L	L	L	L	S	L

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

UNIT I: STATICS OF PARTICLES 10

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 8

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 8

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 **10**

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*.

AE3101	AIRCRAFT PRODUCTION TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVE

To impart the knowledge about the various production processes and to expose the students on the principles and applications of production processes.

Course Outcome – COs		Cognitive Skill
CO-01	Understanding the concepts of aircraft part casing	R
CO-02	Apply the concept in metal forming process.	A
CO-03	Understanding the basics of aircraft part machining	U
CO-04	Analyze the working principles of various welding processes.	An

CO-05	Analyze additive manufacturing and composite 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	PO-M
CO-01	S	S	M	S	M	N	N	N	M	N	M	M	S
CO-02	S	S	M	N	N	M	N	N	L	N	L	M	M
CO-03	M	M	S	S	L	N	N	M	M	N	L	L	S
CO-04	M	L	M	M	N	L	N	N	M	N	M	M	L
CO-05	L	M	M	N	L	L	N	N	M	N	M	L	L

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

UNIT I: AIRCRAFT PARTS CASTING 9

Methods of production processes – comparison – sand casting – mould, pattern, and die – pattern allowances – materials – types –The lost wax process - Application, Construction and working of Permanent mold casting, Pressure die casting, and Aluminum castings - Aircraft designers estimate structural fatigue life - Application of Magnesium Alloy, Aluminium Alloy and Titanium Alloy in Aircraft Parts Casting, Significance of casting in the construction and repair of modern aircraft - Aerospace Investment Castings.

UNIT II: METAL FORMING PROCESSES 9

Definition and companion of hot and cold forming – Principle, construction, types, merits, demerits and application of forging, rolling, extrusion, spinning processes – sheet metal operations – Types of dies used – Principle of powder metallurgy – steps involved – merits, demerits and applications. Forming Process - Aircraft Metal Structural Repair - Forming Operations and Terms,Specialized Procedures for the Aircraft Industry,Flow Forming of Aircraft Engine Components,Aircraft Sheet Metal Fabrication, Hydroforming.

UNIT III: AIRCRAFT PARTS MACHINING 9

Complex Aircraft Parts Machined to the Highest Standards, Manufacturing Custom Precision Aircraft Components, Machine and machine tool – construction, types operations in the following machines with block diagrams – Lathe, Milling, Drilling and Grinding – Concept of NC/CNC machines – Comparison of CNC with conventional machines – sample manual part programming for CNC Lathe and milling. Precision CNC Machining, Swiss Machining, n-axis Machining, Wire EDM Services, Ultra-Precise Micro Machining.

UNIT IV: AIRCRAFT WELDING 9

Types of joining – soldering, brazing, welding, Chemical and mechanical – Fusion welding process – Gas welding – flame types – applications - Arc welding – types of joint – electrode – power supply – edge preparation – weld symbol – filler material – flux/ shielding gases – arc theory – Construction and applications of types of Arc welding – Manual, Gas Tungsten Arc Welding (GTAW), Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW or MIG). Electric resistance welding (ERW), Spot and Seam welding, Plasma arc welding (PAW), Aircraft Welder job description.

UNIT V: ADDITIVE MANUFACTURING AND COMPOSITE MATERIALS 9

Designing parts with advanced materials and unique geometries– lattice structures-Powder-bed laser printing systems, Fused deposition modeling, laser metal deposition with wire (LMD-w), Advanced robotic controls. Composites in Aerospace Applications - Fibrous composites - Particulate composites. Composite Production techniques - Filament Winding – Pultrusion - Resin Transfer Molding - Hand Laying - Mechanized Tape Laying - Fully Automatic Tape Laying - Press Molding.

TOTAL: 45 HOURS

TEXT BOOKS

1. HarijaChoudry, Elements of workshop Technology, Vol. I and II, Media promoters and publishers pvt; Ltd; Mumbai, 2001.
2. P.C. Sharma, "A Text Book of Production Technology", S.Chand and Co. Ltd., New Delhi, 2010. 31

REFERENCES

1. R.K Jain and S.C Gupta, Production Technology, Khanna Publishers. 16th Edition ,2001
2. H.M.T Production Technology- Hand Book, Tata Mc Graw- Hill, 2000.
3. P.N.Rao, "Manufacturing Technology – I and II", Tata McGraw Hill Publishing Co., New Delhi – 2013.
4. Amitabha Ghosh, Asok Kumar Mallik, Manufacturing Science, EWP Pvt. Ltd, 2007

ME3101	ENGINEERING GRAPHICS	L	T	P	C
		3	0	2	4

OBJECTIVE

- 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 – Cos		Cognitive Skill
CO-01	Students should able to understand the Use of drafting instruments, BIS conventions and specifications – Size, layout and folding of drawing sheets	U
CO-02	Students should able to Projection of points, Projection of straight lines located in the first quadrant. Determination of true lengths and true inclinations.	A
CO-03	Students should able to understand the Prisms, pyramids, cylinder and cone, axis perpendicular to any one reference plane. Axis parallel to both the planes	U
CO-04	Students should able to Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone, Isometric view,	E
CO-05	Students should able to understand the Fundamental of projection along with classification, Projections from the pictorial view of the object	R

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

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).

L: 45+P:15 = TOTAL: 60 HOURS

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

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

OBJECTIVE

To impart the knowledge about the preparation of products in various production processes such as foundry, welding and special machining processes.

Course Outcome – Cos		Cognitive Skill
CO-01	To Prepare the mould using single piece pattern	R
CO-02	Apply the concept in gas cutting and gas welding.	A
CO-03	Remember the basics of Arc Welding with use of appropriate fixtures for welding	R
CO-04	Prepare Square / Hexagonal Head Bolt in forging.	S
CO-05	To make Plane turning, taper turning, drilling and thread cutting and knurling	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	L	S	M	S	L	N	M	M	N	L	M	S
CO-02	M	L	S	N	S	M	N	M	L	N	M	M	L
CO-03	L	M	S	N	S	N	N	M	M	N	M	L	S
CO-04	L	L	S	M	M	L	N	S	M	N	L	M	M
CO-05	L	M	M	N	S	L	N	L	M	N	L	L	N

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

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: 30 HOURS

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

OBJECTIVES

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

Course Outcome - COs		Cognitive Skill
CO-01	To study the basic symbols for electrical circuits	U
CO-02	To make basic electrical connection	R
CO-03	To measure the electrical parameters	U,A
CO-04	To obtain the characteristics of Electron devices	R
CO-05	To verify the operation of logic gates.	U,R

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

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

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA3201	Engineering Mathematics - III	3	1	0	4
2.	AE3201	Aero Engineering Thermodynamics	3	0	0	3
3.	AE3202	Fundamental of Aeronautics	3	0	0	3
4.	AE3203	Introduction to Aircraft Structures	3	0	0	3
5.	AE3204	Solid Mechanics	3	0	0	3
6.	ME3204	Fluid Mechanics and Machinery	3	0	0	3
PRACTICALS						
7.	AE3271	Aero Thermodynamics Lab	0	0	2	1
8.	AE3272	Solid Mechanics Lab	0	0	2	1
9.	ME3272	Fluid Mechanics and Machinery Lab	0	0	2	1
TOTAL			**18**	**1**	**6**	**22**

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

OBJECTIVE

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 Outcomes		Cognitive Skills
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.	R,U,A,An, E, S
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.	R,U,A,An, E, S
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,A,An, E, S
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.	R,U,A,An, 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.	R,U,A,An, E, 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	S	L	M	S	M	N	N	N	N	N	M	M	M
CO-02	S	M	L	S	L	M	N	N	N	N	L	M	L

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

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

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

TEXT BOOK

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

REFERENCES

1. Erwin Kreyszig, "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

AE3201	AERO ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVE

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 – Cos		Cognitive Skill
CO-01	Analyzing the basic laws of thermodynamics	An
CO-02	Apply the concept of Air cycles phenomena	A
CO-03	Understanding the working principles of jet propulsion systems	U
CO-04	Remembering the working principles of Refrigeration and Air conditioning	R
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

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

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

UNIT I: FIRST AND SECOND LAW OF 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 : THERMODYNAMIC CYCLES AND IC ENGINES 11

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

UNIT III : HEAT TRANSFER AND BASICS OF JET PROPULSION 9

Basic modes of heat transfer – conduction – convection – radiation – heat exchangers – parallel flow and counter flow heat exchangers – Jet propulsion – air breathing engines – Working principle - turbo jet engine – turbo fan engine – turbo fan engine – rocket engine - Properties of steam and use of steam tables.

UNIT IV: REFRIGERATION AND AIR CONDITIONING 8

Principles of refrigeration – Psychrometry - Heat pumps - Vapour compression - Vapour absorption types - Coefficient of performance, Properties of refrigerants -Air conditioning

UNIT V: AIR COMPRESSORS 8

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 – working of vane blower, roots blower, centrifugal compressor and reciprocating compressor (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 Edition, 1993.
3. V.Ganesan, "Gas turbines", McGraw Hill Education, Third Edition, 2017.

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

AE3202	FUNDAMENTAL OF AERONAUTICS	L	T	P	C
		3	0	0	3

OBJECTIVE

To introduce the basic concepts on structures, aerodynamics, materials and propulsion and their developments in aeronautics.

Course Outcome – Cos		Cognitive Skill
CO-01	Remembering the historical evolution of aircraft.	R

CO-02	Apply the concept in various types of flight vehicles.	A
CO-03	Understanding the basics of aerodynamics.	U
CO-04	Analyze the working principles of various air-breathing engines.	An
CO-05	Understanding various types of aircraft structures and their materials.	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	PO-M
CO-01	M	L	M	S	M	N	N	M	M	N	M	M	M
CO-02	M	S	M	N	N	M	N	L	L	N	L	M	S
CO-03	M	M	S	S	L	N	N	M	M	N	L	L	M
CO-04	S	L	M	M	N	L	N	S	M	N	M	M	S
CO-05	M	M	M	N	L	L	N	M	M	N	M	L	S

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

UNIT I: HISTORICAL EVOLUTION OF AIRCRAFT 10

Early airplanes, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years - Basis of Helicopter.

UNIT II: AIRCRAFT CONFIGURATIONS 8

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

UNIT III: BASICS OF AERODYNAMICS 9

Physical properties and structure of the atmosphere, Temperature, pressure and altitude relationships, lift, drag and moment. Aerofoils, Mach number, High lift devices, Simple propeller aerodynamics.

UNIT IV: BASICS OF PROPULSION 9

Basic ideas about piston, ramjet, pulse jet, turbojet, turbo prop, turbo fan engines, Use of propeller and jets for thrust production. Comparative merits, Principles of operation of rocket, types of rockets and typical applications.

UNIT V: BASICS OF AIRCRAFT STRUCTURES 9

General types of construction, Monocoque, semi-monocoque and geodesic construction, typical wing and fuselage structure. Metallic and non-metallic materials, Use of aluminum alloy, titanium, stainless steel and composite materials – Introduction to high temperature materials.

TOTAL: 45 HOURS

TEXT BOOK

1. Anderson, J.D., "Introduction to Flight", McGraw-Hill, 1995.

REFERENCE

1. Kermode, A.C., "Flight without Formulae", McGraw-Hill, 1997.
2. Kermode, A.C., "Mechanics of Flight", Pearson Education, 2006.

AE3203	INTRODUCTION TO AIRCRAFT STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the concept on the linear static analysis of statically determinate aircraft structural components.
- To understand the concept on thin and thick cylinders and their failures.

Course Outcome - COs		Cognitive Skill
CO-01	Students should able to understand types of structures and statically determinate structures.	U
CO-02	Students should able to design various energy methods and their applications in beams, frames, rings & trusses.	A
CO-03	Students should able to evaluate principal stresses and strains with Mohr's circle.	E
CO-04	Students should able to understand the concept of thin and thick cylinders.	U
CO-05	Students should able to understand the various theories of failures and analyze the stresses in beams,	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	M	N	L	N	N	M	N	N	S	M	S
CO-02	M	M	S	M	L	L	N	L	N	N	L	L	L
CO-03	M	M	M	S	M	M	N	M	N	N	M	L	S
CO-04	S	M	S	N	L	L	N	S	N	N	L	M	L
C0-05	M	S	L	L	M	L	N	N	N	N	M	M	L

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

UNIT I: STATICALLY DETERMINATE STRUCTURES 10

Types of structures – Perfect, efficient and redundant structures - Plane truss analysis – method of joints– 3D trusses – principle of super position.

UNIT II: ENERGY METHODS **9**

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

UNIT III: PRINCIPAL STRESSESAND STRAINS **9**

Concept of principal planes -principal stresses and principal strain-Normal and shear stresses on any oblique planes and principal stresses and principal strainby analytical and graphical methods -Mohr's circle of 2-D stresses and strains.

UNIT IV: THIN AND THICK CYLINDERS **8**

Stresses in thin cylindrical shell due to internal pressure - circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theorem.

UNIT V: STRESS ANALYSIS AND FAILURE THEORY **9**

Loads on aircraft - procedure for solving aircraft structural problems, fail safe and safe life, Shear and bending moment distribution for semi cantilever and other types of wings and fuselage - Ductile and brittle materials – maximum principal stress theory - maximum principal strain theory - maximum shear stress theory - distortion energy theory – octahedral shear stress theory.

TOTAL: 45 HOURS

TEXT BOOKS

1. Timoshenko and Gere, "Mechanics of Materials", Tata McGraw Hill, 1993.
2. Megson T M G, "Aircraft Structures for Engineering students" Elsevier Science and Technology, 2007 3. Peery and Azar, "Aircraft Structures".

REFERENCES

1. Donaldson, B.K., "Analysis of Aircraft Structures - An Introduction", McGraw Hill, 1993.
2. Bruhn E F, "Analysis and Design of Flight Vehicle Structures", Tri-State Off- set Company, USA, 1985
3. Peery, D.J. and Azar,J.J., "Aircraft Structures", 2nd Edition, McGraw – Hill, N.Y, 1999.
4. Dr.R.K.Bansal, "Streength of Materials", Laxmi Publications (P) Ltd, 2014.

AE3204	SOLID MECHANICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To gain knowledge of simple stresses, strains and deformation in components due to external loads.
- To assess stresses and deformations through mathematical models of beams, twisting bars or combinations of both.
- Effect of component dimensions and shape on stresses and deformations are to be understood.
- To study the linear static analysis of indeterminate structural components.

Course Outcome - COs		Cognitive Skill
CO-01	Students should able to understand the basic of stress, strain and various sLoads.	U
CO-02	Students should able to design various types of beams.	A
CO-03	Students should able to analyse bending stresses in beams and statically indeterminate structures.	A
CO-04	Students should able to calculate the B-M, slope and deflection by various methods.	E
CO-05	Students should able to understand the theory of torsion of shaft.	R

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

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

UNIT I: AXIAL LOADING **9**

Stress and strain due to axial force, elastic limit, Hooke's law-factor of safety - stepped bars, uniformly varying sections, stresses in composite bar due to axial force - Elastic Constants - thermal stresses.

UNIT II: TRANSVERSE LOADING ON BEAMS **10**

Types of beams – types of transverse loading on beams – Shear force and bending moment in beams with point load, uniformly distributed and uniformly varying loads – Cantilevers – Simply supported beams.

UNIT III: STATICALLY INDETERMINATE STRUCTURES **9**

Theory of simple bending - Bending stresses in beams - Shear force and bending moment in fixed beams - Clapeyron’s three moment equation and moment distribution method for indeterminate beams.

UNIT IV: DEFLECTION OF BEAMS **9**

Relation between bending moment, slope and deflection - Slope and deflection by double integration method - McCauley’s method - Moment Area method - conjugate beam method. Euler’s & Rankine’s Formula.

UNIT V: TORSION OF CIRCULAR SHAFT **8**

Theory of torsion of shafts of circular cross section - assumptions, Derivation of torsion equation, stresses strains and deformation in determinate and indeterminate shafts of hollow, solid, homogeneous and composite circular cross section subjected to twisting moments, stresses due to combine torsion, bending and axial force on shafts.

TOTAL: 45 HOURS

TEXT BOOKS

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2007
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2007

REFERENCES

1. Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2001
2. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series
3. NPTEL courses, http://nptel.iitm.ac.in/courses.php, web and video courses on Strength of Materials by Prof. Sharma, S. C., and Prof. Harsha, S. P.

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 - COs		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 hydraulic pumps and their classification	U,R

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 incomp ressible 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 BOOKS

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.

AE3271	AERO THERMODYNAMICS LAB	L	T	P	C
		0	0	2	1

OBJECTIVE

To enhance the basic knowledge in applied thermodynamics

Course Outcome – Cos		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	PO-M
CO-01	S	M	S	S	S	N	N	M	S	L	M	M	M
CO-02	M	S	L	N	L	M	S	L	L	S	S	M	S
CO-03	M	L	S	S	L	L	S	S	M	M	S	S	M
CO-04	M	L	M	M	N	L	S	S	M	S	M	M	S
CO-05	M	L	M	L	M	L	N	S	L	M	M	M	L

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

LIST OF EXPERIMENTS (Any 6)

1. Performance test on a 4-stroke diesel engine
2. Valve timing of a 4 – stroke petrol engine

3. Valve timing of a 4 – stroke diesel engine
4. Port timing of a 2 stroke petrol engine
5. Determination of effectiveness of a parallel flow heat exchanger
6. Determination of effectiveness of a counter flow heat exchanger
7. Determination of the viscosity of a given liquid.
8. COP test on a vapour compression refrigeration test rig
9. COP test on a vapour compression air-conditioning test rig
10. Determination of Transfer Coefficient in Natural Convection
11. Determination of Transfer Coefficient in Forced Convection
12. Determination of Thermal Resistance of a Composite wall.

TOTAL: 30 HOURS

LIST OF EQUIPMENTS

(For a batch of 30 students)

Sl.No	Details of Equipments	Qty Req.	Experiment No.
1.	4 stroke twin cylinder diesel engine	1	1
2.	Cut section model of 4 stroke petrol engine	1	2
3	Cut section model of 4 stroke diesel engine	1	3
4	Cut section model of 2 stroke petrol engine	1	4
5.	Parallel and counter flow heat exchanger test rig	1	5,6
6.	Red wood viscometer	1	7
7	Vapour compression refrigeration test rig	1	8
8.	Vapour compression air-conditioning test rig	1	9
9.	Conductive Heat Transfer set up	1	10, 11
10	Composite wall	1	12

AE3272	SOLID MECHANICS LAB	L	T	P	C
		0	0	2	1

OBJECTIVES

- To impart practical training on simple machines like screw jack, worm wheel, etc.,
- To understand the theoretical and practical aspects of elasticity and plasticity of the materials through a variety of experiments

Course Outcome - COs		Cognitive Skill
CO-01	Tension test on metals-stress strain characteristics, ductility, resilience, toughness.	An
CO-02	Cupping test on metal sheets-load deformation characteristics, cupping load, cupping number.	A
CO-03	Hardness test on metals - Brinell, Vicker and Rockwell Hardness tests.	An
CO-04	Impact test on metals - Charpy, Izod impact tests.	U
CO-05	Shear test on metals-direct shear strength, single shear, double shear.	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	PO-M
CO-01	S	L	M	M	L	M	N	M	L	L	S	L	S
CO-02	S	S	S	L	L	M	N	S	L	M	S	L	M
CO-03	S	S	S	M	L	S	N	M	L	M	S	L	M
CO-04	S	S	M	L	S	M	N	S	L	M	S	L	S
CO-05	S	S	S	L	S	M	N	S	L	M	S	L	M

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

LIST OF EXPERIMENTS (Any 6)

1. Tension test on metals-stress strain characteristics, ductility, resilience, toughness.
2. Cupping test on metal sheets-load deformation characteristics, cupping load, cupping number.
3. Hardness test on metals-Brinell, Vickers and Rockwell Hardness tests.
4. Impact test on metals-Charpy, Izod impact tests.
5. Shear test on metals-direct shear strength, single shear, double shear.
6. Tests on helical springs-compression, tension springs-load deformation characteristics, stiffness, shear stress, modulus of rigidity, energy.
7. Torsion test on beams-torque and angle of twist characteristics, shear stress, modulus of rigidity, energy.
8. Tests on wood-tension, compression and bending-load deformation characteristics, Young's modulus, modulus of rupture.

TOTAL: 30 HOURS

LIST OF EQUIPMENTS

(For a batch of 30 students)

Sl.No	Details of Equipments	Qty Req.	Experiment No.
1.	Universal Testing Machine	1	1
2.	Vickers Hardness testing Machine.	1	3
3	Brinell Hardness testing Machine.	1	3
4	Rockwell Hardness testing Machine.	1	3
5.	Izod Impact Testing Machine	1	4
6.	Charpy Impact Testing Machine	1	4
7	Dial Gauge	1	7
8.	Beam Test Setup with various end conditions	1	7

ME3272	FLUID MECHANICS AND MACHINERY LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES:

Upon Completion of this subject, the students can able to have hands on experience in

flow measurements using different devices and also perform calculation related to losses in pipes and also perform characteristic study of pumps, turbines etc.,

Course Outcome - COs		Cognitive Skill
CO-01	To determine coefficient of discharge of orificemeter and venturimeter	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

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA3203	Numerical Methods	2	1	0	3
2.	BS3201	Environmental Studies	3	0	0	2
3.	AE3205	Aircraft Structures	3	0	0	3
4.	AE3206	Aircraft Systems and Instrumentation	3	0	0	3
5.	AE3207	Low speed Aerodynamics	3	0	0	3
6.	AE3208	Mechanics of Machines	3	0	0	3
PRACTICALS						
7.	AE3273	Aerodynamics Lab	0	0	2	1
8.	AE3274	Aircraft Structures Lab	0	0	2	1
9.	AE3275	Aircraft Systems Lab	0	0	2	1
10.	AE32P1	Summer Internship-I	0	0	0	2
TOTAL			**17**	**1**	**6**	**22**

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

OBJECTIVE

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 Outcomes At the end of the course students should be able to		**Cognitive Skills**
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.	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.	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.	E
CO-04	Understand the first order differential equation. To solve the first order differential equation by using single step method. To apply	A

	multi step method to find the solution of first order differential equation.	
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 poison equations.	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	M	N	L	L	N	N	L	L	N	S	L	L
CO-02	S	S	N	L	L	N	N	S	L	N	S	L	L
CO-03	S	M	N	N	L	N	N	M	L	N	S	L	M
CO-04	M	M	N	N	M	M	N	S	L	N	S	L	L
CO-05	S	S	N	L	L	M	N	N	L	N	S	L	S

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: 30L+15T = 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.

BS3201	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 - COs		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	PO-M
CO-01	S	M	S	M	M	S	S	S	M	S	S	M	S

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

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 systemforest 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

AE3205	AIRCRAFT STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide the behavior of loads experience of aircraft indigenous components.
- To provide conception design of major aircraft structural components.
- To provide the students an understanding on buckling of columns and plates.
- To provide the better understate the low weight structures.

Course Outcome – Cos		Cognitive Skill
CO-01	Ability to solve complex problems on symmetric and un symmetric beams	E
CO-02	To apply the knowledge of mathematics and engineering to solve shear flow in open section.	A
CO-03	To analyzecomplex structural problems on shear flow in closed section.	An
CO-04	Ability to understand the various classifications ofcolumns and their buckling under bending loads.	U
CO-05	To analyze the buckling of plates and their failures due to loads.	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	S	M	L	S	M	M	N	S	L	N	N	M	L
CO-02	M	S	L	M	L	L	N	N	S	N	M	M	M
CO-03	S	S	N	M	L	L	N	N	S	N	L	S	S
CO-04	S	M	M	L	M	L	N	N	L	N	M	L	M
CO-05	M	S	M	S	M	M	N	S	L	N	L	S	M

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

UNIT I: UNSYMMETRICAL BENDING **10**

Bending of symmetric beams subject to skew loads - bending stresses in beams of unsymmetrical sections – generalized k-method, neutral axis method, principal axis method, Advantages and Disadvantages of three methods.

UNIT II: SHEAR FLOW IN OPEN SECTIONS **9**

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

idealization – shear flow variation in idealized sections - Applications of shear flow calculations.

UNIT III: SHEAR FLOW IN CLOSED SECTIONS 9

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

UNIT IV: BUCKLING OF COLUMNS 8

Failure of Columns – Long, medium and short columns - Assumptions made in Euler's column theory – inelastic buckling – columns with different end conditions, the South-well plot – basics of beam columns.

UNIT V: BUCKLING OF PLATES 9

Bending of thin plates – rectangular sheets under compression - local buckling stress of thin walled sections – crippling strength estimation – Needham's and Gerard's methods - thin-walled column strength – load carrying capacity of sheet stiffener panels.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Megson T M G , "Aircraft Structures for Engineering Students", Elsevier Ltd, 2007
2. Peery, D.J., and Azar, J.J., "Aircraft Structures", 2nd edition, McGraw – Hill, N.Y., 1999
3. Bruhn. E.H., "Analysis and Design of Flight Vehicles Structures", Tri-state off-set Company, USA, 1985.

REFERENCES:

1. Rivello, R.M., "Theory and Analysis of Flight Structures", McGraw Hill, 1993.
2. Dr.R.K.Bansal, "Streength of Materials", Laxmi Publications (P) Ltd, 2014.
3. Howard D Curtis, "Fundamentals of Aircraft Structural Analysis", WCB-McGraw Hill, 1997

AE3206	AIRCRAFT SYSTEMS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVE:

To give a brief background of airplane control systems, engine systems, auxiliary systems and instruments.

Course Outcome – Cos		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	PO-M
CO-01	S	L	M	M	M	L	S	M	N	L	S	M	L
CO-02	M	L	L	M	M	M	L	S	L	M	N	M	L
CO-03	S	L	L	M	L	L	M	N	S	L	M	M	N
CO-04	M	M	M	L	L	L	M	N	L	L	M	L	L
CO-05	M	L	L	L	M	M	L	S	L	M	L	L	L

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

UNIT I: AIRPLANE 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, VOR - CCV case studies, Morse code.

UNIT II: AIRCRAFT SYSTEMS **9**

Hydraulic systems - Study of typical workable system - components - Hydraulic system controllers - Modes of operation - Pneumatic systems - Advantages - Working principles - Typical Air pressure system – Brake system - Typical Pneumatic power system - Components, Landing Gear systems - Classification – Shock absorbers – Retractive 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: AUXILIARY 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, De-icing and anti icing systems.

UNIT V: AIRCRAFT 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 Power plant Mechanics", U.S. Dept. of Transportation, Federal Aviation Administration, The English Book Store, New Delhi1995.

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.

AE3207	LOW SPEED AERODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVE

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

Course Outcome – Cos		Cognitive Skill
CO-01	Apply the basic knowledge of engineering to basic aerodynamic and fluid mechanics	A
CO-02	Ability to understand the subsonic flows for engineering concepts	U
CO-03	To evaluate conformal transformation and fluid flow problems	E
CO-04	To apply the knowledge of engineering to understand airfoil and wing characteristics.	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	PO-M
CO-01	M	S	S	S	M	L	N	M	L	L	M	M	L
CO-02	S	S	L	N	L	S	N	L	L	N	S	L	S
CO-03	M	M	S	M	L	N	N	N	N	M	S	L	M
CO-04	S	L	S	S	L	N	N	N	N	M	S	N	M
CO-05	S	L	M	M	M	L	N	S	N	L	M	M	L

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

UNIT I: BASIC AERODYNAMICS AND FLUID MECHANICS 9

Aerodynamic forces and moments centre of pressure, dimensional analysis, flow similarity, buoyancy forces, types of flows, substantial derivative, conservation of mass, momentum and energy equations.

UNIT II: INCOMPRESSIBLE AND INVISCID FLOWS 10

Velocity potential and stream function, angular velocity, vorticity and strain, Elementary flows – uniform, source & sink, vortex and doublets flows. Superposition of elementary flows - pressure and velocity distributions on bodies with and without circulation in ideal fluid flow.

UNIT III: CONFORMAL TRANSFORMATION 8

Kutta-Joukowski's theorem, Joukowski transformation and its application to fluid flow problems, Joukowski and Karman - Treftz profiles, Kutta condition, Blasius solution.

UNIT IV: AIRFOIL AND WING THEORY 9

Airfoil and wing geometry parameters, wing of finite span, thin air foil theory, vortex system, Biot-Savart law, Horse shoe vortex, trailing vortices and downwash, lift on wing, vortex induced drag, Prandtl's lifting line theory and its limitations.

UNIT V: VISCOUS FLOW 9

Navier-Stokes equations, boundary layer properties - boundary layer - displacement, momentum, energy thickness, the boundary layer equations, boundary conditions, incompressible boundary layer, flow over a flat plate.

TOTAL: 45 HOURS

TEXT BOOKS

1. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw-Hill Book Co., New York, 1985.
2. Clancey, L.J., "Aerodynamics", Pitman, 1986.

REFERENCES

1. Houghton, E.L., and Carpenters, N.B., "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989.
2. Bertin, J. J., Aerodynamics for Engineers, Pearson Education, Fourth Edition, 2002.

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

OBJECTIVE

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

Course Outcome - COs		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	PO-M
CO-01	S	M	S	M	M	N	N	L	M	L	L	N	L
CO-02	M	S	S	L	M	N	N	M	L	N	M	N	M
CO-03	M	S	M	M	N	N	N	M	L	N	M	N	M
CO-04	M	M	S	L	N	N	N	L	L	N	M	N	S
CO-05	S	M	M	S	M	N	N	M	M	M	M	N	S

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.

AE3273	AERODYNAMICS LAB	L	T	P	C
		0	0	2	1

OBJECTIVE

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

Course Outcome – Cos		Cognitive Skill
CO-01	To study experimentally the aerodynamic forces on different bodies at low speeds.	A
CO-02	Ability of Flow visualization studies in low speed flows over airfoil with different angle of incidence	S
CO-03	Analyze the Coefficient of Lift and Drag for Symmetrical aero-foil	E
CO-04	Evaluate the Pressure distribution over symmetrical airfoils	An
CO-05	Study and Calibration of subsonic wind tunnel	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	PO-M
CO-01	S	S	M	S	S	M	N	N	L	N	M	L	S
CO-02	M	S	M	S	S	S	L	N	L	N	M	L	M
CO-03	M	S	M	S	S	L	N	N	L	N	S	L	M
CO-04	S	M	S	S	S	L	L	N	L	N	S	L	S
CO-05	M	M	S	S	S	L	L	N	L	N	S	L	L

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

LIST OF EXPERIMENTS

1. Study of Wind Tunnel
2. Calibration of subsonic wind tunnel.
3. Pressure distribution over smooth and rough cylinder.
4. Pressure distribution over symmetrical airfoils during positive angle of attack.
5. Pressure distribution over symmetrical airfoils during negative angle of attack.
6. Pressure distribution over unsymmetrical airfoil.
7. Determination of Coefficient of Lift and Drag for Symmetrical aerofoil during Takeoff.
8. Determination of Coefficient of Lift and Drag for Symmetrical aerofoil during Landing.
9. Flow over a flat plate at different angles of incidence
10. Flow visualization studies in low speed flows over cylinders
11. Flow visualization studies in low speed flows over airfoil with different angle of incidence

TOTAL: 30 HOURS

LIST OF EQUIPMENT

(For a batch of 30 students)

Sl. No.	Items	Quantity
1.	Wind Tunnel test section size around 300 x 300 mm with test section flow speed of 70 m/s.	1 No.
2.	Symmetrical sections	1 Nos.
3.	Unsymmetrical sections	1 Nos.
4.	Angle of incidence changing mechanism	1 No.
5.	Multiple Manometer stands with 20 – 30 manometer tubes	4 Nos.
6.	U-Tube Manometer	1 No.
7.	Static Pressure Probes	4 Nos.
8.	Total Pressure Probest	4 Nos.
9.	Pitot-Static Tubes	4 Nos.
10.	Wooden Models of Three Dimensional bodies (eg. Cylinder etc.,)	2 Nos. each

AE3274	AIRCRAFT STRUCTURES LAB	L	T	P	C
		0	0	2	1

OBJECTIVE

To enhance the students with practical knowledge on the unsymmetrical bending of beams, shear centre, stresses in circular discs and beams using photo-elastic techniques, and vibration of beams.

Course Outcome - COs		Cognitive Skill
CO-01	Compare the theoretical and experimental results of beam with various conditions.	E
CO-02	To determine the elastic constant of photo elastic materials.	A
CO-03	Investigate shear centre of closed and open section.	An
CO-04	Analyze the theoretical and experimental result for axial loading on column member.	E
CO-05	Describe and apply the fundamental concepts for analysis of thin wall aircraft structure.	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	PO-M
CO-01	S	S	S	M	S	L	N	L	L	N	M	M	M
CO-02	L	S	S	L	S	M	L	L	L	N	S	M	S
CO-03	M	S	S	M	S	M	L	L	L	N	M	M	M
CO-04	M	S	S	L	S	M	L	L	L	N	S	M	S
CO-05	M	S	S	M	S	L	N	L	L	N	S	M	S

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

LIST OF EXPERIMENTS (Any 6)

1. Calibration of Strain Gauge
2. Unsymmetrical bending of beams
3. Shear centre location for open sections
4. Shear centre location for closed sections
5. Constant strength beam
6. Flexibility matrix for cantilever beam
7. Beam with combined loading
8. Calibration of Photo- elastic materials
9. Stresses in circular discs and beams using photo-elastic techniques
10. Vibrations of beams
11. Wagner beam – Tension field beam

12. Column – Testing

TOTAL: 30 HOURS

LIST OF EQUIPMENT

(for a batch of 30 students)

Sl. No.	Name of the Equipment	Qty	Experiments Number
1	Beam Test set –up	2	1, 2, 3,4
2	Unsymmetrical sections like 'Z' sections	2	1, 2, 3
3	Channel section and angle section	2	1, 2, 3
4	Dial gauges	12	1, 2, 3
5	Weights 1Kg	10	1, 2, 3
6	Weights 2 Kg	10	1, 2, 3
7	Beam Test Set – up	2	3, 4
8	Strain indicator and strain gauges	One set	4,5,6
9	Photo – elastic apparatus	1	7,8
10	Amplifier	2	9
11	Exciter	2	9
12	Pick – up	2	9
13	Oscilloscope	2	9
14	Wagner beam	1	10
15.	Hydraulic Jack	1	10

AE3275	AIRCRAFT SYSTEMS LAB	L	T	P	C
		0	0	2	1

OBJECTIVE

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

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

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

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: 30 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

AE32P1	SUMMER INTERNSHIP I	L	T	P	C
		0	0	0	2

Course Outcome - COs		Cognitive Skill
CO-01	Get exposure to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry	A

CO-02	Get possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job(s)	An
CO-03	Gain experience in writing Technical reports / projects and presentation of it.	An
CO-04	Learn and gain exposure to the engineer's responsibilities and ethics.	E
CO-05	Understand the social, economic and administrative considerations that influence the working environment of industrial organizations	R

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

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

General Guidelines for Summer Internship

Step 1: Request Letter/ Email from the Institute should go to industry to allot multiple slots of 2 weeks during summer vacation as Summer Internship period for the students. Students request letter/profile/ interest areas may be submitted to industries for their willingness for providing the internship.

Step 2: Industry will confirm the internship slots and the number of seats allocated for internships via Confirmation Letter/ Email. In case the students arrange the internship themselves the confirmation letter will be submitted by the students in the office Institute through respective department. Based on the number of slots agreed to by the Industry, institute will allocate the students to the Industry.

Step 3: Students, after joining the Training at the concerned Industry / Organization, has to submit the Joining Report/ Letters / Email.

Step 4: Students are undergoing for Summer Internship at the concerned Industry / Organization. In between Faculty Member(s) has to evaluate(s) the performance of students once by visiting the Industry/Organization and Evaluation Report of the students needs to be submit in department office with the consent of Industry persons/ Trainers.

Step 5: Students will submit a training report after completion of internship.

Step 6: Training Certificate to be obtained from industry.

Step7: List of students who have completed their internship successfully will be issued / maintained by Training and Placement Cell of the Institute.

SEMESTER V

SL. No.	Course Code	Course Title	L	T	P	C
THEORY						
1.	MS3201	Professional and Business Ethics	3	0	0	2
2.	AE3209	Aircraft Composite Materials and Structures	3	0	0	3
3.	AE3210	Air Breathing Propulsion	3	0	0	3
4.	AE3211	High Speed Aerodynamics	3	0	0	3
5.	AE3212	Flight Dynamics	3	0	0	3
6.	AE32XX	Department Elective	3	0	0	3
PRACTICAL						
7.	AE3276	Part Design and Assembly Lab	0	0	3	1
8.	AE3277	UAV & Aero modeling Lab	0	0	3	1
9.	AE3278	Airframe & Composite Materials Lab	0	0	3	1
TOTAL			**18**	**0**	**9**	**21**

AE3209	AIRCRAFT COMPOSITE MATERIALS AND STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVE

To understand the fabrication, analysis and design of composite materials & structures.

Course Outcome - COs		Cognitive Skill
CO-01	Remember and Understand the basic of composites and their properties	U
CO-02	Evaluate the micro and macro mechanics	E
CO-03	Analysis of various laminated plates and sandwich construction	An

CO-04	Understand and evaluate the fabrication process and repair methods	E
CO-05	Analyze various mechanical properties and characterization	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	S	S	S	L	S	S	N	L	L	L	S	N	S
CO-02	M	S	M	S	S	M	N	M	L	L	S	M	S
CO-03	N	M	S	L	L	S	M	M	L	L	M	L	S
CO-04	L	L	S	M	M	N	N	L	L	L	M	L	S
CO-05	N	L	N	M	S	S	N	L	L	L	S	L	S

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

UNIT I: INTRODUCTION TO COMPOSITES 8

Composites – need for composites – enhancement of properties – classification of composites – Matrix – Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – Particle reinforced composites, Fibre reinforced composites. Applications of various types of composites.

UNIT II: MICRO AND MACRO MECHANICS 10

Micro mechanical analysis aspects of volume and weight fraction – Longitudinal strength and stiffness – Transverse modulus – Stress strain relationship of a thin lamina – Experimental characterization of a lamina – Elastic behavior longitudinal loading, Transverse loading.

UNIT III: LAMINATED PLATES & SANDWICH CONSTRUCTIONS 10

Introduction to general laminate, angle ply and cross ply laminates - Basic design concepts of sandwich construction -Materials used for sandwich construction - Failure modes of sandwich panels.

UNIT IV: FABRICATION PROCESS AND REPAIR METHODS 8

Various Open and closed mould processes. Manufacture of fibers – Types of resins and properties and applications, importance of repair and different types of repair techniques in composites – autoclave and non-autoclave methods – Failure criteria of composites

UNIT V: MECHANICAL PROPERTIES AND CHARACTERIZATION 8

Mechanism of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads –Thermal effect.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Noastrand Reinhold Company, New York 1998.
2. Jones, R.M., "Mechanics of Composite Materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1985.
3. Autar K. Kaw, "Mechanics of Composite Materials", Second Edition, 2006.
4. P.K. Mallick; "Fiber- Reinforced Composites: Materials, Manufacturing and Design", CRC Press Taylors & Francis Group, Boca Raton, London. Third Edition.

REFERENCES:

1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995.
2. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989.

AE3210	AIR BREATHING PROPULSION	L	T	P	C
		3	0	0	3

OBJECTIVE

To establish fundamental approach and application of jet engine components and learn about the analysis of flow phenomenon and estimation of thrust developed by jet engine.

Course Outcome - COs		Cognitive Skill
CO-01	Analyze the knowledge of engineering to understand the basics of aircraft gas turbines.	An
CO-02	Ability to synthesize the concepts of intakes and exhaust nozzles.	S
CO-03	Apply the knowledge of engineering to understand the fundamentals and working of combustion chamber	A
CO-04	Understand about various advanced propulsion compressor.	U
CO-05	Remember about various advanced propulsion Air breathing turbines	R

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	S	S	S	M	M	M	M	L	L	S	S	S	N

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

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

UNIT I: PRINCIPLES OF AIR BREATHING ENGINES 9

Review of thermodynamic cycles – Carnot cycle, Otto cycle, Diesel cycle and Brayton cycle - Illustration of working of gas turbine engines – Turbo jet, Turbo fan and Turbo prop engines – factors affecting thrust – methods of thrust augmentation – performance parameters of jet engines.

UNIT II: JET ENGINE INTAKES AND EXHAUST NOZZLES 10

Ram effect, Internal flow and Stall in subsonic inlets – relation between minimum area ratio and eternal deceleration ratio – diffuser performance – modes of operation - supersonic inlets – starting problem on supersonic inlets – Aircraft Anti-icing and De-icing - shock swallowing by area variation – real flow through nozzles and nozzle efficiency – losses in nozzles – ejector and variable area nozzles -thrust reversal.

UNIT III: JET ENGINE COMBUSTION CHAMBERS 8

Chemistry of combustion, Combustion equations, Combustion process, classification of combustion chambers – combustion chamber performance – effect of operating variables on performance – flame stabilization, Cooling process.

UNIT IV: JET ENGINE COMPRESSORS 9

Principle operation of centrifugal compressor, Principle operation of axial flow compressor– Work done and pressure rise – velocity diagrams – degree of reaction – free vortex and constant reaction designs of axial flow compressor – performance parameters axial flow compressors– stage efficiency.

UNIT V: JET ENGINE TURBINES 9

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

TOTAL: 45 HOURS

TEXT BOOKS:

1. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Pearson education (2009)
2. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 2nd edition 2014.

REFERENCES:

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. "Gas Turbine Theory", Pearson Education Canada; 6th edition, 2008.
2. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 2003.
3. "Rolls Royce Jet Engine", Rolls Royce; paperback, 2015.

AE3211	HIGH SPEED AERODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVE

To arrive at the shock wave and expansion wave relations and to get exposure on potential equation for Two-dimensional compressible flow and knowledge on high speed flow over airfoils, wings and airplane configuration.

Course Outcome – COs		Cognitive Skill
CO-01	To understand the fundamentals of compressible flow.	U
CO-02	Evaluate the fundamentals of normal, oblique and expansion wave	E
CO-03	Analyze the computation of steady compressible flow	An
CO-04	Apply high speed flow over airfoils, wings and airplane configuration	A
CO-05	Evaluate high speed flows and wind tunnel performance	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	PO-M
CO-01	S	M	M	L	S	M	L	N	L	N	S	L	S
CO-02	L	S	M	S	M	S	L	N	L	S	M	L	S
CO-03	S	S	M	S	S	L	L	N	M	N	S	L	S
CO-04	L	M	S	M	S	L	L	N	L	N	S	L	M
CO-05	M	M	S	S	S	L	L	N	L	S	S	L	S

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

UNIT I: FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW 10

Compressibility, Continuity, Momentum and energy equation for steady one dimensional flow- compressible Bernoulli's equation-Calorically perfect gas, Mach Number, Speed of sound, Area – Mach number – Velocity relation, Mach cone, Mach angle, One dimensional Isentropic flow through variable area duct, Static and Stagnation properties, Critical conditions, Characteristic Mach number, Area-Mach number relation, Maximum discharge velocity.

UNIT II: SHOCK AND EXPANSION WAVES 10

Normal shock relations, Prandtl's relation-Hugoniot equation, Raleigh Supersonic Pitot tube equation-Moving normal shock waves, Oblique shocks, θ-β-M relation, Shock Polar, Reflection of oblique shocks, Interaction of oblique shock waves, slip line, Rayleigh flow, Fanno flow, Expansion waves, Prandtl-Meyer expansion, Maximum turning angle, Simple and non-simple regions, operating characteristics of Nozzles, under expansion, over expansion.

UNIT III: TWO DIMENSIONAL COMPRESSIBLE FLOW 8

Potential equation for 2-dimensional compressible flow, Linearization of potential equation, perturbation potential, Linearized Pressure Coefficient, Linearized subsonic flow, Prandtl-Glauert rule, Linearized supersonic flow, Method of characteristics.

UNIT IV: HIGH SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANE CONFIGURATION 8

Critical Mach number, Drag divergence Mach number, Shock Stall, Supercritical Airfoil Sections, Transonic area rule, Swept wing, Airfoils for supersonic flows, Lift, drag, Pitching moment and Centre of pressure for supersonic profiles, Shock expansion theory, wave drag, supersonic wings, Design considerations for supersonic aircrafts.

UNIT V: CHARACTERIZATION OF HIGH SPEED FLOWS 9

Wind tunnels for Supersonic flows, Classifications – Blow down, indraft and induction tunnel layouts, shock tubes, Flow visualization techniques - Optical Methods-Shadow Graph method, Schlieren method and interferometer.

TOTAL: 45 HOURS

TEXT BOOKS

1. Anderson, J. D, Modern Compressible Flow: With Historical Perspective McGraw-Hill Education; 3rd edition, 2003.
2. Rathakrishnan. E, Gas Dynamics, Prentice-Hall of India Pvt., Ltd, 2008.

REFERENCES

1. Oosthuizen,P.H., & Carscallen,W.E., Compressible Fluid Flow, CRC Press; 2nd edition (July 22, 2013)
2. Shapiro, A. H., Dynamics and Thermodynamics of Compressible Fluid Flow, Ronald Press, 2022.
3. Zucrow, M. J. and Anderson, J. D., Elements of Gas Dynamics, McGraw- Hill &Co.,2nd edition 2002.

AE3212	FLIGHT DYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVE

To study the performance of airplanes under various operating conditions and the static and dynamic response of aircraft in flight conditions

Course Outcome – COs		Cognitive Skill
CO-01	To study the performance of airplanes under various operating conditions and forces and moments acting on a flight vehicle	U, A
CO-02	Evaluate maneuvering flight performance	E
CO-03	Analyze the Degree of freedom of rigid bodies in space	An
CO-04	Evaluating the dihedral and adverse yaw effect	E
CO-05	Interpret the mechanical properties and testing of dynamic longitudinal stability.	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	L	S	M	S	N	M	S	N	S	N	S	M	S
CO-02	M	S	M	S	S	S	L	N	L	N	S	L	S
CO-03	M	S	M	M	S	L	L	N	L	N	L	L	S
CO-04	S	S	S	S	M	L	M	N	M	N	S	L	S
CO-05	M	M	S	S	S	L	L	N	L	N	S	M	S

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 9

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) – Takeoff and landing - Turning performance (Turning rate turn radius). Bank angle and load factor – limitations on turn - V-n diagram and load factor.

UNIT III: STATIC LONGITUDINAL STABILITY 9

Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes -Inherently stable and marginal stable airplanes – Static, Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion - Effects of fuselage and nacelle - Influence of CG location - Power effects - Stick fixed neutral point - Stick free stability-Hinge moment coefficient - Stick free neutral points- Symmetric maneuvers - Stick force gradients - Stick force per 'g' - Aerodynamic balancing.

UNIT IV: LATERAL AND DIRECTIONAL STABILITY 9

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

UNIT V: DYNAMIC STABILITY 9

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

TOTAL: 45 HOURS

TEXT BOOKS:

1. Perkins, C.D., and Hage, R.E., “Airplane Performance stability and Control”, John Wiley & Son:, Inc, New York, 1988.
2. Anderson J.D, “Introduction to Flight Dynamics”, McGraw-Hill Inc.,US; 3rd edition edition, 1989.
3. Anderson J.D, “Aircraft Performance and Design”, McGraw-Hill Inc.,US; 5thd edition edition, 1989.

REFERENCES:

1. Etkin, B., “Dynamics of Flight Stability and Control”, Edn. 3, John Wiley, New York, 1.
2. Babister, A.W., “Aircraft Dynamic Stability and Response”, Pergamon Press, Oxford, 2013.
3. Dommasch, D.O., Shelby, S.S., and Connolly, T.F., “Aeroplane Aero dynamics”, Third Edition, Issac Pitman, London, 1981.
4. Nelson, R.C. “Flight Stability and Automatic Control”, McGraw-Hill Book Co., 2nd edition paperback 2017

AE3276	PART DESIGN AND ASSEMBLY LAB	L	T	P	C
		0	0	3	1

OBJECTIVE:

Ability to design and draw different joints and components using manual drafting method.

Course Outcome – COs		Cognitive Skill
CO-01	To study the AUTO CAD commands	R
CO-02	Evaluate the modeling compressor blade	E
CO-03	Analyze the typical aircraft wing with structural members and fuselage.	An
CO-04	Modeling the landing gear.	S
CO-05	Analyze the typical turbo jet engine	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	L	M	S	S	L	M	S	M	S	N	S	M	M
CO-02	M	L	M	S	S	S	L	M	L	N	S	L	L
CO-03	M	L	S	M	S	S	L	L	L	N	L	L	L
CO-04	L	L	S	S	M	S	M	M	M	N	S	L	M
CO-05	M	M	S	S	S	S	L	M	L	N	S	M	L

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

LIST OF EXPERIMENTS

1. Study of AUTOCAD commands.
2. Design and Modeling of a compressor blade.
3. Design and Modeling of a Converging-diverging nozzle.
4. Design and Modeling of typical aircraft wing with structural members.
5. Design and Modeling of typical fuselage with structural members.
6. Design and Modeling and assembly of landing gear.
7. Design and Modeling of an Empennage.
8. Design and Modeling of typical Turbojet engine.

TOTAL: 30 HOURS

AE3277	UAV & AERO MODELING LAB	L	T	P	C
		0	0	3	1

OBJECTIVE:

The objective of this laboratory is to learn and understand the UAV systems and Aircraft models.

Course Outcome – COs		Cognitive Skill
CO-01	To study the Study on basics of UAV & Flight path planning	R
CO-02	Evaluate the materials such as balsa wood, Coro plast and foam	E
CO-03	Analyze the power systems and command and control system procedure.	An
CO-04	Modeling the UAV with controls and circuits.	S
CO-05	Understand auto pilot system and hands on training in flying an 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	PO-M
CO-01	M	L	M	S	L	M	S	L	S	N	S	M	S
CO-02	M	L	M	S	S	S	L	M	L	N	S	L	M
CO-03	M	S	S	M	S	S	L	L	L	N	L	L	M
CO-04	L	L	S	S	M	S	M	M	M	N	S	L	S
CO-05	M	M	S	M	S	S	L	M	L	N	S	M	N

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

LIST OF EXPERIMENTS:

1. Study on basics of UAV & Flight path planning.
2. Study on UAV Aerodynamics.
3. Working with materials such as balsa wood, Coro plast and foam.
4. Study on Power system integration.
5. Study on Command and control system procedure.
6. Simple flight stabilization system integration.
7. Basic RF Experiments.
8. Quad rotor stabilization (rotary).
9. Build an UAV airframe of own design.
10. Building UAV with controls and circuits.
11. Study on Auto pilot system &Hands on training in flying an UAV.

TOTAL: 30 HOURS

LIST OF EQUIPMENTS:

S. No.	Name of the Equipment	Quantity
1	Balsa wood	**-**
2	Tools for working with Balsa wood	**1 set**
3	Electric motor with propeller	**1**
4	Lipo Battery & charger	**1**
5	Transmitter & Receiver	**1**

		L	T	P	C
AE3278	**AIRFRAME & COMPOSITE MATERIALS LAB**	**0**	**0**	**3**	**1**

OBJECTIVE:

To fabricate and testing of airframes and composite materials and structures.

Course Outcome - COs		Cognitive Skill
CO-01	To make the students understand the methods of composite repair such as riveting	U
CO-02	To demonstrate the Glass fiber composite Laminates and Specimens as per ASTM standards.	A,
CO-03	To understand and evaluate the various types of damages and repair in the composite materials	An
CO-04	To demonstrate the various advanced welding processes such as MIG,TIG and Plasma Arc welding	A
CO-05	To demonstrate metal and wood repair processes such as sheet metal forming and wood gluing	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	PO-M
CO-01	L	M	S	L	S	L	N	L	N	L	S	L	S

CO-02	M	S	S	M	S	L	N	L	N	L	S	L	S
CO-03	L	M	S	L	S	L	N	L	N	L	S	L	S
CO-04	M	M	S	M	S	L	N	L	N	L	S	L	S
CO-05	M	M	S	M	S	L	N	L	N	L	S	L	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. Butt joints.
5. Riveted Joints with different sizes
6. Riveted patch repairs.
7. Fabric Patch repair
8. Preparation of Epoxy/Glass fiber composite Laminates and Specimens as per ASTM standards.
9. Preparation of hybrid composites by hand layup.
10. Preparation of Sandwich panel and Specimens as per ASTM standards.
11. Determination of Elastic constants of Composite Specimens
12. Repair of composites

TOTAL: 30 HOURS

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

SEMESTER VI

SL. No.	Course Code	Course Title	L	T	P	C
THEORY						
1.	AI32D1	Fundamentals of Artificial Intelligence	3	0	0	3
2.	AE3213	Finite Element Analysis for Aircraft Structures	3	0	0	3
3.	AE3214	Advanced Propulsion Systems	3	0	0	3
4.	AE32**	Department Elective	3	0	0	3
5.	AE32**	Department Elective	3	0	0	3
6.	AE32**	Department Elective	3	0	0	3
PRACTICAL						
7.	AE3279	Aero Engines Lab	0	0	3	1
8.	AE3280	Aircraft Design Project I	0	0	3	1
9.	AE3282	Finite Element Analysis Lab	0	0	3	1
10.	AE32P2	Summer Internship II	0	0	0	2
TOTAL			**18**	**0**	**9**	**23**

AE3213	FINITE ELEMENT ANALYSIS FOR AIRCRAFT STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVE:

To introduce the concept of discrete, continuum, iso-parametric elements and heat transfer analysis.

Course Outcome – COs		Cognitive Skill
CO-01	To analyze basic approximate methods.	An
CO-02	To understand the use of basic finite elements for structural applications using truss, beam, frame and plane elements.	A

CO-03	Apply the plane stress, plane strain and Axisymmetric problems	A
CO-04	To demonstrate the ability to understand element stiffness matrix for 4-noded and higher-noded and isoparametric quadrilateral element	U
CO-05	To understand the application and use of Finite element method for heat transfer problems and vibration problems.	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	M	M	M	N	M	L	S	S	S	L
CO-02	S	S	S	M	L	N	N	L	M	M	M	L	M
CO-03	M	M	S	S	L	L	N	N	M	S	S	L	M
CO-04	L	S	S	M	N	L	N	L	N	M	M	M	M
CO-05	L	L	M	N	L	N	N	N	L	N	M	L	M

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

UNIT I: INTRODUCTION **4**

Basic approximate methods and analysis – weighted residual methods– Rayleigh Ritz – Stiffness and Flexibility matrix for simple cases – Governing equation and convergence criteria of finite element method-Gaussian coordinates.

UNIT II: DISCRETE ELEMENTS **12**

Bar elements - Stiffness matrix of the bar elements in local coordinates - Stiffness matrix of frame or truss, beam elements, Governing equation of bending of beam, Application to static, dynamic and stability analysis.

UNIT III: CONTINUUM ELEMENTS **10**

Various types of 2-D-elements, Stiffness matrix for constant strength, Triangular elements, Application to plane stress, plane strain and Axisymmetric problems, stress- strain relationship, stiffness matrix for axisymmetric elements.

UNIT IV: ISOPARAMETRIC ELEMENTS **10**

Element stiffness matrix for 4-noded and higher-noded isoparametric quadrilateral lement. Jacobian transformation – Lagrangian interpolation function, applications to two and three-dimensional problems- solution techniques.

UNIT V: HEAT TRANSFER & VIBRATION PROBLEMS **9**

One Dimensional Heat Transfer Analysis – Formulation of the Governing Equations in Finite Element Form – Equivalent Load Vector – Solution & Temperature Distribution – Finite Element Formulation & Solution for Sample Problems involving vibration

TOTAL: 45 HOURS

TEXT BOOK

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

REFERENCES

1. Reddy J.N. "An Introduction to Finite Element Method", McGraw-Hill, 2006.
2. Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw-Hill, 2000.
3. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis",Prentice Hall of India, 1985.

AE3214	ADVANCED PROPULSION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVE

To study the detail about working and performance of gas turbine engines, ramjet and advanced rocket techniques.

Course Outcome - COs		Cognitive Skill
CO-01	To Analyze the rocket propulsion systems	An
CO-02	Analyze the concepts of chemical rockets	A
CO-03	Understand the ramjet and scramjet propulsion system.	E
CO-04	Analyze the electric and ion propulsion systems.	U
CO-05	To analyze the nuclear and solar propulsion systems.	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	S	S	M	M	S	L	S	N	N	L	S	L	L
CO-02	L	S	L	L	M	M	L	N	N	L	N	L	L
CO-03	L	L	S	L	M	L	L	N	N	L	N	L	N
CO-04	N	M	M	L	S	L	M	N	N	L	M	L	L
CO-05	M	S	S	L	M	M	L	N	N	M	L	L	M

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

UNIT I: ROCKET PROPULSION **8**

Operating principle – Thrust equation of rockets - Specific impulse of a rocket – internal ballistics- Rocket nozzle contour optimization, Rocket performance considerations – Numerical problems

UNIT II: CHEMICAL ROCKETS **10**

Solid propellant rockets – Selection criteria of solid propellants – Important hardware components of solid rockets – Propellant grain design considerations – Liquid propellant rockets – Cryogenic and semi cryogenic rockets -Selection of liquid propellants – Cooling in liquid rockets – Limitations of hybrid rockets – Relative advantages of liquid rockets over solid rockets-Propellant Combustion-Combustion Instability.

UNIT III: RAMJETS AND SCRAMJET ENGINES **10**

Working or Ramjet engine and its performance – Efficiencies - Preliminary performance calculations – Typical modes of inlet operation– air augmented rockets - Introduction to scramjet – Preliminary concepts in supersonic combustion – Problems encountered for designing scramjet engine - Various types of supersonic combustors.

UNIT IV: ELECTRIC AND ION PROPULSION **8**

Basic concepts in electric propulsion– Classification of electric rockets - Arc plasma rocket engine – Magneto plasma rocket engine - power requirements and rocket efficiency – thermal thrusters – electrostatic thrusters – plasma thruster - Ion rocket engine.

UNIT V: NUCLEAR AND SOLAR ROCKETS **9**

Working of Nuclear rocket engine– nuclear rocket nozzles – nuclear rocket thrust control – Nuclear thermal rocket - Working of solar rocket engine - Solar sail – Concept of nozzle less propulsion - Pulsed inductive thruster - radioisotope propulsion.

TOTAL: 45 HOURS

TEXT BOOKS

1. G.P. Sutton, “Rocket Propulsion Elements”, John Wiley & Sons Inc., Ninth Edition, 2017.
2. William H. Heiser and David T. Pratt, Hypersonic Air breathing propulsion, AIAA Education Series, 2001.
3. HS Mukunda, “Understanding Aerospace Chemical Propulsion”, I.K. International Publishing House Pvt. Limited, 2017.

REFERENCES

1. Fortescue and Stark, Spacecraft Systems Engineering, 1999.
2. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Addison – Wesley Longman INC, 1999.
3. Cumpsty, Jet propulsion, Cambridge University Press, 2003.

AE3279	AERO ENGINES LAB	L	T	P	C
		0	0	3	1

OBJECTIVE:

To learn Study of Lubricating oils used in aircraft engines and Aircraft Engine preservation procedure.

Course Outcome - COs		Cognitive Skill
CO-01	To familiarize the students with various engines used in aircrafts.	U
CO-02	Dismantling and assembling of aircraft piston engine.	A
CO-03	Familiarization of Aviation fuels.	U
CO-04	Study of Lubricating oils used in aircraft engines.	U
CO-05	Aircraft Engine preservation procedure	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	PO-M
CO-01	L	S	S	L	S	S	N	L	L	L	S	N	S
CO-02	M	S	M	S	S	M	N	M	S	L	S	M	S
CO-03	N	M	S	L	L	S	M	M	L	L	M	L	M
CO-04	L	L	S	M	M	N	N	L	L	L	M	L	S
CO-05	N	L	N	M	S	S	N	L	L	L	S	L	S

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

LIST OF EXPERIMENTS

1. Safety precautions followed while working with aircraft engines.
2. Dismantling and assembling of aircraft piston engine.
3. Study of aircraft jet engine
4. Study of rocket engine.
5. Study of aircraft propellers
6. Familiarization of Aviation fuels.
7. Familiarization of basic tools used for aircraft engine maintenance
8. Aircraft Engine starting procedure.

9. Study of Lubricating oils used in aircraft engines.
10. Aircraft Engine servicing procedure.
11. Aircraft Engine preservation procedure

TOTAL: 30 HOURS

LIST OF EQUIPMENTS

(for a batch of 30 students)

Sl. No	Equipment	Qty	Experiments No.
1	Piston engines	2	2
2	Jet Engine /Engine model	1	3,8,9,10,11
3	Rocket engine	1	4
4	Propellers	4	5
5	Aircraft Maintenance tools.	1	7

AE3280	AIRCRAFT DESIGN PROJECT – I	L	T	P	C
		0	0	3	1

OBJECTIVE

Each student is assigned with the design of an Airplane (or Helicopter or any other flight vehicle), for given preliminary specifications. The following are the assignments to be carried out.

Course Outcome – Cos		Cognitive Skill
CO-01	Understand and implement the design and development process for aero vehicles.	U
CO-02	Perform open-ended iterative tasks related to aircraft engine design and airframe−engine integration.	A
CO-03	Integrate a variety of systems and sub-systems with in aircraft to demonstrate design feasibility.	E
CO-04	Demonstrate design viability through testing and verification.	An
CO-05	Prioritize design requirements and organize project schedules; use formal structured design methods to develop aircraft	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	PO-M
CO-01	M	S	S	M	M	M	N	N	N	S	S	S	M
CO-02	S	S	S	M	L	N	N	N	N	M	M	L	M
CO-03	M	M	S	S	L	L	N	N	N	S	S	L	S
CO-04	L	S	S	M	N	L	N	N	N	M	M	M	S
CO-05	L	S	M	N	L	N	N	N	N	N	M	L	L

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

EXPERIMENTS

1. Comparative configuration study of different types of airplanes
2. Comparative study on specification and performance details of aircraft
3. Preparation of comparative data sheets
4. Work sheet 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 mass balance diagram.
9. Drag estimation
10. Detailed performance calculations and stability estimates

TOTAL: 30 HOURS

LIST OF EQUIPMENTS

(for a batch of 30 students)

Sl.No.	Name of the Equipment	Quantity	Experiments Number
1	Engineering Drawing Board	30	3
2	Engineering Drawing Instruments	30	3

AE3282	FINITE ELEMENT ANALYSIS LAB	L	T	P	C
		0	0	3	1

OBJECTIVE:

To train the students in the lab about the design and drafting of aero components.

Course Outcome - COs		Cognitive Skill
CO-01	To study FEA and general steps.	R
CO-02	Evaluate the Simply Supported Beam with uniformly distributed load and uniformly varying load	E
CO-03	Analyze the Bars of Constant Cross-section Area	An
CO-04	Apply Finite Element to a rectangular plate with a circular hole	A
CO-05	Analyze constant strength beam, Truss analysis and Thermo structural analysis	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	M	S	L	M	S	N	L	L	L	S	N	S
CO-02	M	S	M	S	S	M	N	M	S	L	S	M	S
CO-03	L	M	S	L	M	S	M	M	L	L	M	L	M
CO-04	M	L	S	M	M	N	N	L	L	L	M	L	S
CO-05	S	L	S	M	S	S	N	L	M	L	S	L	S

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

LIST OF EXPERIMENTS

1) Introduction to FEA and general steps.
2) Stress analysis of a beams with load end conditions
3) Stress analysis of a Simply Supported Beam with Uniformly distributed load.
4) Stress analysis of a Simply Supported Beam with Uniformly varying load
5) Stress analysis of a Bars of Constant Cross-section Area
6) Stress analysis of a rectangular plate with a circular hole
7) Analysis of constant strength beam
8) Truss analysis
9) Thermo structural analysis

TOTAL: 30 HOURS

LIST OF EQUIPMENT

(for a batch of 30 students)

Sl. No.	Equipment	Quantity	Experiment No.
1	Computer nodes	30	1 to 10
2	2002 – CAD Packages	30 licenses	1 to 3, 8 to 10
3	ANSYS- 7	30 licenses	4 to 7
4	UPS	1	1 to 10

AE32P2	SUMMER INTERNSHIP II	L	T	P	C
		0	0	0	2

Course Outcome - COs		Cognitive Skill
CO-01	Get exposure to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.	R
CO-02	Get possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job	E
CO-03	Gain experience in writing Technical reports / projects and presentation of	An
CO-04	Learn and gain exposure to the engineer's responsibilities and ethics	A
CO-05	Understand the social, economic and administrative considerations that influence the working environment of industrial organizations	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	L	S	M	M	S	M	L	N	L	N	M	M	S
CO-02	L	S	S	S	M	S	N	N	L	N	S	L	S
CO-03	M	S	M	S	S	L	N	N	L	N	S	M	S
CO-04	M	M	S	M	M	L	N	N	L	N	S	L	S
CO-05	M	M	S	S	S	L	L	N	L	N	M	M	S

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

General Guidelines for Summer Internship

Step 1: Request Letter/ Email from the Institute should go to industry to allot multiple slots of 2 weeks during summer vacation as Summer Internship period for the students. Students

request letter/profile/ interest areas may be submitted to industries for their willingness for providing the internship.

Step 2: Industry will confirm the internship slots and the number of seats allocated for internships via Confirmation Letter/ Email. In case the students arrange the internship themselves the confirmation letter will be submitted by the students in the office Institute through respective department. Based on the number of slots agreed to by the Industry, institute will allocate the students to the Industry.

Step 3: Students, after joining the Training at the concerned Industry / Organization, has to submit the Joining Report/ Letters / Email.

Step 4: Students are undergoing for Summer Internship at the concerned Industry / Organization. In between Faculty Member(s) has to evaluate(s) the performance of students once by visiting the Industry/Organization and Evaluation Report of the students needs to be submit in department office with the consent of Industry persons/ Trainers.

Step 5: Students will submit a training report after completion of internship.

Step 6: Training Certificate to be obtained from industry.

Step 7: List of students who have completed their internship successfully will be issued/maintained by Training and Placement Cell of the Institute.

SEMESTERVII

SL. No.	Course Code	Course Title	L	T	P	C
THEORY						
1.	AE3215	Grid Generation Techniques	3	0	0	3
2.	MS3202	Principle of Management	3	0	0	2
3.	AE****	Department Elective	3	0	0	3
4.	AE****	Department Elective	3	0	0	3
5.	XXXX	Open Elective	3	0	0	3
PRACTICAL						
6.	AE3283	Computational Fluid Dynamics Lab	0	0	2	1
7.	AE3284	Aircraft Design Project - II	0	0	2	1
8.	AE32P3	Project Work Phase - I	0	0	6	3
TOTAL			**15**	**0**	**10**	**19**

AE3215	GRID GENERATION TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVE

To study about basic aspects, structured and unstructured grid generation techniques and panel methods.

Course Outcome – COs		Cognitive Skill
CO-01	To remember the importance of Methodology of grid generation and the classification of grid generation techniques.	R
CO-02	To analyse concepts of algebraic methods for structured grid generation and data structure in unstructured grid generation.	An
CO-03	To understand elementary concepts in dynamic meshing and mesh motion and the role of adaptive meshing.	U
CO-04	To apply the best practices for grid quality and grid control.	A
CO-05	To apply the concept of panel methods to incompressible, compressible, subsonic and supersonic flows.	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	PO-M
CO-01	M	S	S	L	M	S	N	M	L	N	M	N	S
CO-02	S	M	M	M	S	M	N	M	L	N	L	M	S
CO-03	M	S	N	S	M	S	N	M	L	N	M	L	S
CO-04	S	S	M	S	L	N	N	S	L	N	M	L	M
CO-05	M	N	S	S	M	S	N	M	L	N	S	L	L

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

UNIT I: BASIC ASPECTS IN GRID GENERATION 9

Methodology of grid generation- classification of grid generation techniques – Structured, Unstructured and Hybrid grids and their characteristic features – Areas of application – Geometry related issues for grid generation – Grid or mesh topology – Conformal Mapping- Domain decomposition with multi blocking.

UNITII: STRUCTURED AND UNSTRUCTURED GRID GENERATION 9

Algebraic methods for structured grid generation – Use of blending functions for grid generation- Use of partial differential equations for structured grid - Implementation of boundary conditions – Variational methods - Use of triangular, quadrilateral and tetrahedral grids/meshes – Concept of dual mesh – Connectivity Information and data structure in unstructured grid generation – Hierarchy in unstructured grid Generation – Applications.

UNIT III: ADAPTIVE MESHING **9**

Description of adaptive mesh refinement – Adaption control – Strategies for mesh adaption- Solution gradient based adaption – Discretization error and Recovery based adaption - r adaption, h adaption and p adaption methods – Elementary concepts in dynamic meshing and mesh motion – Role of adaptive meshing in solution accuracy and convergence.

UNIT IV: GRID INDEPENDENCY STUDIES **9**

A brief description of metrics for grid quality – Aspect ratio – Orthogonality – Skewness – Warpage- Jacobian- Best practices for grid quality and grid control – mesh/grid quality aspects in surface meshing – Volume meshing and quality check – Grid quality aspects in boundary layer flows – Prismatic layers – Quality control in hybrid mesh transition.

UNIT V: PANEL METHODS **9**

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

TOTAL: 45 HOURS

TEXT BOOK

1. Fletcher C.A.J. , "Computational Techniques for Fluid Dynamics 1" Springer Verlag, 1996.

REFERENCES

1. Liseikin V. D., "Grid Generation Methods:, Springer-Verlag Berlin and Heidelberg GmbH &Co. KG 1st edition 1999.
2. Chung T. J., "Computational Fluid Dynamics", Cambridge University Press; 2nd edition, 2010.
3. John D. Anderson, "Computational Fluid Dynamics, The Basics with Applications"", McGraw-Hill, Inc., New York – Second Edition, 1995.
4. Dr.R.K. Bansal, "A text book of Fluid mechanics and hydraulic machines", revised ninth edition, Laxmi Publications, New Delhi – 2017.
5. Patrick Knupp& Stanly Steinberg, "Fundamentals of Grid Generation" CRC Press 1st edition 1993.
6. Versteeg H.K. and Malalsekera W. "An Introduction to Computational Fluid Dynamics, The Finite Volume Method", PHI; 2nd edition 2007.
7. John F Wendt , "Computational Fluid Dynamics – An Introduction", 3rd Edition, Springer- Verlag, Berlin Heidelberg, 2009.

MS3202	PRINCIPLE OF MANAGEMENT	L	T	P	C
		3	0	0	2

Course Description

This course provides an introduction to the fundamental principles of management. It covers the essential concepts and practices involved in planning, organizing, leading, and controlling

within an organizational context. The course is designed to equip engineering students with the management skills necessary to lead teams and projects effectively.

Course Objectives

- To introduce students to the basic concepts and functions of management.
- To understand the role and responsibilities of managers in various organizational settings.
- To develop an understanding of the planning, organizing, leading, and controlling functions of management.
- To examine the impact of management theories and practices on organizational performance.
- To equip students with the skills necessary to manage people and processes effectively in a technical environment.

Course Outcome – COs		Cognitive Skill
CO-01	To define and explain the key concepts and functions of management.	R
CO-02	To analyse the roles and responsibilities of managers in different organizational contexts.	An
CO-03	To apply planning, organizing, leading, and controlling principles to real-world scenarios.	A
CO-04	To evaluate the effectiveness of different management theories and practices.	E
CO-05	To demonstrate management skills necessary for leading teams and projects in a technical environment.	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	PO-M
CO-01	L	N	M	L	M	S	M	S	L	S	L	S	M
CO-02	L	N	S	M	S	M	M	M	L	M	S	M	S
CO-03	M	N	S	M	M	S	S	M	L	S	M	S	S
CO-04	M	N	M	M	L	N	S	S	L	S	M	S	M
CO-05	L	N	L	S	M	S	S	L	L	S	S	S	M

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

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: 30 HOURS

TEXT BOOKS

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

AE3283	COMPUTATIONAL FLUID DYNAMICS LAB	L	T	P	C
		0	0	2	1

OBJECTIVES:

1. To familiarize the students with the working of CFD codes.
2. To familiarize the students with actual setting up of the problem and solution procedure.
3. To extract the required data, post process and compare with available data.

Course Outcome - COs		Cognitive Skill
CO-01	To understand the principles of fluid dynamics and algorithms of CFD modeling.	U
CO-02	To employ commercial codes to develop CFD models and interpret the results into the physical process.	An
CO-03	To Understand the underlying principles of CFD analysis and finite difference methods	An
CO-04	Understand the numerical models in flow modeling.	U
CO-05	To demonstrate the ability to use modern CFD software tools to get accurate solution.	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	L	M	M	M	S	S	N	L	L	N	S	N	S
CO-02	M	S	M	S	S	L	N	M	L	L	S	M	M
CO-03	N	M	S	S	L	S	N	L	M	N	M	L	M
CO-04	L	S	S	S	M	N	N	L	L	N	M	L	S
CO-05	N	S	M	S	S	N	N	L	L	L	S	L	M

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

LIST OF EXPERIMENTS

1. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=0.1, a=0^o
2. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=0.1, a=10^o
3. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=0.8, a=0^o
4. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=0.8, a=10^o
5. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=01.2, a=0^o
6. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=01.2, a=10^o
7. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=2.0, a=0^o
8. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=2.0, a=10^o
9. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=3.0, a=0^o

10. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=3.0, a=10^o
11. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=5.0, a=0^o
12. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=5.0, a=10^o
13. Aerodynamic Analysis for 2D NACA 0010 airfoil
14. Aerodynamic Analysis for 2D SELIG 1210 airfoil
15. Aerodynamic Analysis for 2D wing
16. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=0.1, a=0^o
17. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=0.1, a=10^o
18. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=0.8, a=0^o
19. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=0.8, a=10^o
20. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=01.2, a=0^o
21. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=01.2, a=10^o
22. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=2.0, a=0^o
23. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=2.0, a=10^o
24. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=3.0, a=0^o
25. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=3.0, a=10^o
26. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=5.0, a=0^o
27. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=5.0, a=10^o

(Any 6 experiments can be offered)

TOTAL: 30 HOURS

LIST OF EQUIPMENT
(For a batch of 20 students)

Sl. No.	Name of the Equipment	Quantity	Experiment No.
1	Computer nodes	40	1 to 27
2	ANSYS- 19 (CFD Version)	10 licenses	1 to 27
3	UPS	1	1 to 27
4	XFRL5	10	13 to 15

AE3284	AIRCRAFT DESIGN PROJECT – II	L	T	P	C
		0	0	2	1

OBJECTIVE

To enhance the knowledge in continuation of the design project given in project–I Each student is assigned with work in continuation of the design project – I. The following assignments are to be carried out.

Course Outcome - COs		Cognitive Skill
CO-01	To understand the basic concepts, Gust and maneuverability envelopes and the design study of V-n diagram.	U

CO-02	To apply the knowledge of structural layouts, and structural design study of the aircrafts.	A
CO-03	Ability to analyze the load estimation of wings and fuselage.	An
CO-04	Understanding the concepts of balancing and maneuvering loads on tail plane, aileron and rudder.	U
CO-05	Understand the basic design concepts of wings, fuselage, and some components of aircraft and preparing the detailed design report using the software analysis.	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	PO-M
CO-01	L	S	S	L	S	S	N	L	L	L	S	N	M
CO-02	S	S	M	S	S	M	N	M	L	L	S	M	S
CO-03	N	M	S	L	L	S	M	M	L	L	M	L	M
CO-04	L	L	S	M	M	N	N	L	L	L	M	L	M
CO-05	N	L	N	M	S	S	N	L	L	L	S	L	S

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

LIST OF EXPERIMENTS

1.V-n diagram for the design study
2.Gust and maneuverability envelopes
3.Critical loading performance and final V-n graph calculation
4.Structural design study – Theory approach
5.Load estimation of wings
6.Load estimation of fuselage.
7.Balancing and Maneuvering loads on tail plane, Aileron and Rudder loads.
8.Detailed structural layouts
9.Design of some components of wings, fuselage
10. Preparation of a detailed design report with CAD drawings.

TOTAL: 30 HOURS

LIST OF EQUIPMENTS

(for a batch of 30 students)

S.No.	**Items**	**Quantity**	**Experiment No.**
1.	Drawing Board	30	4 and 5
2.	Drawing Instrument	20	4 and 5

AE32P3	PROJECT WORK PHASE I	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 – COs		Cognitive Skill
CO-01	Demonstrate a sound technical knowledge of their selected project topic.	S
CO-02	Undertake problem identification, formulation and solution.	S
CO-03	Design engineering solutions to complex problems utilising a systems approach.	S
CO-04	Conduct an engineering project	S
CO-05	Demonstrate the knowledge, skills and attitudes of a professional engineer.	S

SEMESTER VIII

SL. No.	Course Code	Course Title	L	T	P	C
THEORY						
1.	AE****	Department Elective	3	0	0	3
2.	AE****	Department Elective	3	0	0	3
PRACTICAL						
3.	AE32P5	Project Work Phase - II	0	0	24	8
TOTAL			**6**	**0**	**24**	**14**

AE32P5	PROJECT WORK PHASE II	L	T	P	C
		0	0	24	8

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. There are 24 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 – COs		Cognitive Skill
CO-01	Demonstrate a sound technical knowledge of their selected project topic.	S
CO-02	Undertake problem identification, formulation and solution.	S
CO-03	Design engineering solutions to complex problems utilising a systems approach.	S
CO-04	Conduct an engineering project	S
CO-05	Demonstrate the knowledge, skills and attitudes of a professional engineer.	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	S	S	S	L	S	S	N	N	N	L	S	N	M
CO-02	M	S	M	S	S	M	N	N	N	L	S	M	S
CO-03	L	M	L	L	L	S	N	N	N	L	L	L	S
CO-04	S	L	S	M	M	N	N	N	N	L	M	L	M
CO-05	L	L	N	M	S	S	N	N	N	L	S	L	S

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

LIST OF DEPARTMENT ELECTIVES

SI. NO	Course Code	Course Title	L	T	P	C
1.	AE32A1	Renewable Energy Technologies	3	0	0	3
2.	AE32A2	Industrial Aerodynamics	3	0	0	3
3.	AE32A3	Heat Transfer in Space Applications	3	0	0	3
4.	AE32A4	Computational Fluid Dynamics	3	0	0	3
5.	AE32A5	Aero Engine Maintenance and Repair	3	0	0	3
6.	AE32A6	Design of Gas Turbine Engine Components	3	0	0	3
7.	AE32A7	Space Mechanics	3	0	0	3
8.	AE32A8	Theory of Vibration	3	0	0	3
9.	AE32A9	Rockets and Missiles	3	0	0	3
10.	AE32B1	Theory of Elasticity	3	0	0	3
11.	AE32B2	Wind Tunnel Techniques	3	0	0	3
12.	AE32B3	UAV Design	3	0	0	3
13.	AE32B4	Non Destructive Testing and Evaluation	3	0	0	3
14.	AE32B5	Helicopter Aerodynamics	3	0	0	3
15.	AE32B6	Air Transportation and Aircraft Maintenance	3	0	0	3
16.	AE32B7	Aircraft Design	3	0	0	3
17.	AE32B8	Aircraft Production Planning and Control	3	0	0	3
18.	AE32B9	Hypersonic Aerodynamics	3	0	0	3
19.	AE32C1	Rocket Propulsion	3	0	0	3
20.	AE32C2	Aerodynamics of Drones	3	0	0	3
21.	AE32C3	Boundary Layer Theory	3	0	0	3
22.	AE32C4	Avionics	3	0	0	3
23.	AE32C5	Fatigue and Fracture Mechanics	3	0	0	3
24.	AE32C6	Computer Integrated Manufacturing	3	0	0	3
25.	AE32C7	Optimization Techniques	3	0	0	3
26.	AE32C8	Sustainable Manufacturing	3	0	0	3
27.	AE32C9	Electric and Hybrid Vehicles	3	0	0	3

28.	AE32E1	Air Traffic Control	3	0	0	3
29.	AE32E2	Aircraft Rules and Regulations	3	0	0	3
30.	AE32E3	Aerospace Materials	3	0	0	3
31.	AE32E4	Wind Engineering	3	0	0	3
32.	AE32E5	Cryogenics	3	0	0	3
33.	AE32E6	Advanced Vehicle Engineering	3	0	0	3

LIST OF OPEN ELECTIVES

SI. NO	Course Code	Course Title	L	T	P	C
1.	AE32D1	Reverse Engineering	3	0	0	3
2.	AE32D2	Additive Manufacturing	3	0	0	3

LIST OF COMMON SUBJECTS

SI. NO	Course Code	Course Title	L	T	P	C
1.	MS3201	Professional and Business Ethics	3	0	0	2
2.	AI32D1	Fundamentals of Artificial Intelligence	3	0	0	3

Syllabus

LIST OF DEPARTMENT ELECTIVES

SI. NO	Course Code	Course Title	L	T	P	C
1.	AE32A1	Renewable Energy Technologies	3	0	0	3
2.	AE32A2	Industrial Aerodynamics	3	0	0	3
3.	AE32A3	Heat Transfer in Space Applications	3	0	0	3
4.	AE32A4	Computational Fluid Dynamics	3	0	0	3
5.	AE32A5	Aero Engine Maintenance and Repair	3	0	0	3
6.	AE32A6	Design of Gas Turbine Engine Components	3	0	0	3

7.	AE32A7	Space Mechanics	3	0	0	3
8.	AE32A8	Theory of Vibration	3	0	0	3
9.	AE32A9	Rockets and Missiles	3	0	0	3
10.	AE32B1	Theory of Elasticity	3	0	0	3
11.	AE32B2	Wind Tunnel Techniques	3	0	0	3
12.	AE32B3	UAV Design	3	0	0	3
13.	AE32B4	Non Destructive Testing and Evaluation	3	0	0	3
14.	AE32B5	Helicopter Aerodynamics	3	0	0	3
15.	AE32B6	Air Transportation and Aircraft Maintenance	3	0	0	3
16.	AE32B7	Aircraft Design	3	0	0	3
17.	AE32B8	Aircraft Production Planning and Control	3	0	0	3
18.	AE32B9	Hypersonic Aerodynamics	3	0	0	3
19.	AE32C1	Rocket Propulsion	3	0	0	3
20.	AE32C2	Aerodynamics of Drones	3	0	0	3
21.	AE32C3	Boundary Layer Theory	3	0	0	3
22.	AE32C4	Avionics	3	0	0	3
23.	AE32C5	Fatigue and Fracture Mechanics	3	0	0	3
24.	AE32C6	Computer Integrated Manufacturing	3	0	0	3
25.	AE32C7	Optimization Techniques	3	0	0	3
26.	AE32C8	Sustainable Manufacturing	3	0	0	3
27.	AE32C9	Electric and Hybrid Vehicles	3	0	0	3
28.	AE32E1	Air Traffic Control	3	0	0	3
29.	AE32E2	Aircraft Rules and Regulations	3	0	0	3
30.	AE32E3	Aerospace Materials	3	0	0	3
31.	AE32E4	Wind Engineering	3	0	0	3
32.	AE32E5	Cryogenics	3	0	0	3
33.	AE32E6	Advanced Vehicle Engineering	3	0	0	3

AE32A1	RENEWABLE ENERGY TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVE:

To impart knowledge on energy scenario, solar energy, wind energy, bio energy, ocean and geothermal energy.

Course Outcome – COs		Cognitive Skill
CO-01	To know the Indian and global energy scenario	U
CO-02	To learn the various solar energy technologies and its applications.	R
CO-03	To educate the various wind energy technologies.	E
CO-04	To explore the various bio-energy technologies.	S
CO-05	To study the ocean and geothermal technologies.	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	PO-M
CO-01	M	M	M	L	S	M	L	N	L	N	S	L	M
CO-02	L	L	M	S	M	S	L	N	L	S	N	L	M
CO-03	N	L	M	S	S	L	L	N	M	N	S	L	M
CO-04	L	N	S	M	S	L	L	N	L	L	S	L	L
CO-05	L	N	S	S	S	L	L	N	L	S	S	L	L

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

UNIT I: ENERGY SCENARIO **9**

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status- Potential of various renewable energy sources-Global energy status-Per capita energy consumption- Future energy plans.

UNIT II: SOLAR ENERGY **9**

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications –

Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems–Solar PV applications.

UNIT III: WIND ENERGY 9

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

UNIT IV: BIO-ENERGY 9

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion- mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

UNIT V: OCEAN AND GEOTHERMAL ENERGY 9

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
2. Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

REFERENCES:

1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press,U.K., 2012.
2. Rai.G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.
3. Sukhatme.S.P., “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw HillPublishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., “Solar Energy – Fundamentals Design, Modelling and applications”, Alpha ScienceIntl Ltd, 2015.

AE32A2	INDUSTRIAL AERODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVE:

The students will learn the fundamentals of Pressure distribution on low rise buildings, wind forces on buildings, environmental winds in city blocks, Special problems of tall buildings, Building codes, Building ventilation and architectural aerodynamics.

Course Outcome - COs		Cognitive Skill
CO-01	The students will be able to grasp the basics of winds types, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows.	U
CO-02	The students will be able to expand the given Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.	A
CO-03	The students will be able to frame questions using Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft.	An
CO-04	The students will learn the fundamentals of Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, Building codes, Building ventilation and architectural aerodynamics.	A
CO-05	The students will gain knowledge of Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.	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	PO-M
CO-01	L	M	L	M	L	L	L	M	M	S	S	M	S
CO-02	M	M	M	L	M	M	L	M	S	L	S	M	S
CO-03	S	M	L	M	L	L	M	M	S	S	M	L	L
CO-04	L	N	N	L	L	M	L	L	S	S	M	M	S
CO-05	S	M	L	S	M	M	S	S	S	S	S	M	M

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

UNIT I: ATMOSPHERE **9**

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

UNIT II: WIND ENERGY COLLECTORS **9**

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

UNIT III: VEHICLE AERODYNAMICS **9**

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

UNIT IV: BUILDING AERODYNAMICS **9**

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

UNIT V: FLOW INDUCED VIBRATIONS **9**

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

TOTAL: 45 HOURS

TEXT BOOK

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

REFERENCES

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

AE32A3	HEAT TRANSFER IN SPACE APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVE:

The students will learn the fundamentals of conduction, convection and radiation. Also learn heat transfer in aerospace applications and numerical methods in heat transfer.

Course Outcome – COs		Cognitive Skill
CO-01	To apply the knowledge of science and engineering in Heat conduction.	U
CO-02	To formulate engineering problems in convection	E
CO-03	To apply the knowledge of mathematics, engineering and science in radiation	R
CO-04	Apply appropriate techniques in heat transfer in aerospace applications	A
CO-05	Design the solutions for numerical methods in heat transfer	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	PO-M
CO-01	S	M	M	M	M	L	L	N	N	N	L	L	M
CO-02	M	S	M	M	M	L	L	N	N	N	L	L	M
CO-03	S	M	M	M	L	L	L	N	N	N	L	L	S
CO-04	M	M	M	S	M	L	L	N	N	N	L	L	M

CO-05	L	S	S	N	S	L	N	L	N	N	N	N	S

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

UNIT I: HEAT CONDUCTION 10

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

UNIT II: CONVECTIVE HEAT TRANSFER 10

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

UNIT III: RADIATIVE HEAT TRANSFER 8

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

UNIT IV: HEAT TRANSFER PROBLEMS IN AEROSPACE ENGINEERING 8

High-Speed flow Heat Transfer, Heat Transfer problems in gas turbine combustion chambers Rocket thrust chambers Aerodynamic heating Ablative heat transfer- Heat Transfer problem in turbine and nozzle blades.

UNIT V: NUMERICAL METHODS IN HEAT TRANSFER 9

1-D and 2-D steady and unsteady state heat conduction – composite walls-heat generation-variable thermal conductivity- extended surfaces analysis using finite difference method-Convective heat transfer- Stream function - vorticity method- creeping flow analysis-convection-diffusion 1-D, 2-D analysis using finite difference approximation. Numerical methods applicable to radiation heat transfer.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Yunus A. Cengel., Heat Transfer A practical approach, Second Edition, Tata McGraw-Hill, 2002.
2. Incropera. F.P.and Dewitt.D.P. Introduction to Heat Transfer, John Wiley and Sons 2002.

REFERENCES:

1. Lienhard, J.H., A Heat Transfer Text Book, Prentice Hall Inc., 1981.
2. Holman, J.P. Heat Transfer, McGraw-Hill Book Co., Inc., New York, 6th Edn., 1991.
3. Sachdeva, S.C., Fundamentals of Engineering Heat & Mass Transfer, Wiley Eastern Ltd., New Delhi, 1981.
4. Mathur, M. and Sharma, R.P. Gas Turbine and Jet and Rocket Propulsion, Standard Publishers, New Delhi 1988.
5. C.P.Kothandaraman, Mathur Sharma Fundamentals of Heat Transfer.

AE32A4	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVE:

To know the fundamental aspects of finite volume methods and their application to fluid dynamics problem and numerical grid generation and having knowledge about mapping techniques.

Course Outcome – COs		Cognitive Skill
CO-01	Describe the flow phenomena in a flow field with correspondence with elliptic, parabolic and hyperbolic.	E
CO-02	Able to do numerical grid generation and having knowledge about mapping techniques.	R
CO-03	To understand the eelements of two and three-dimensional panels, panel singularities	U
CO-04	To analyze the approximate factorization scheme, Unsteady transonic flow around aerofoils.	An
CO-05	Knowledge about the fundamental aspects of finite volume methods and their application to fluid dynamics problem.	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	PO-M
CO-01	S	S	S	L	S	S	N	N	N	L	S	N	M
CO-02	M	S	M	S	S	M	N	N	N	L	S	M	S
CO-03	S	M	S	L	M	S	M	N	M	L	M	L	S
CO-04	L	L	S	M	M	N	N	N	N	L	M	L	M
CO-05	S	L	N	M	S	S	N	N	N	L	S	L	M

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

UNIT I: FUNDAMENTAL CONCEPTS **10**

Introduction – Basic Equations of Fluid Dynamics, Panel, methods – lifting flows over arbitrary bodies - Mathematical properties of Fluid Dynamics Equations – Elliptic, Parabolic

and Hyperbolic equations, Discretization of Partial Differential Equations - Finite Difference Methods of subsonic, supersonic and viscous flows.

UNIT II: GRID GENERATION **7**

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

UNIT III: PANEL METHODS **9**

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

UNIT IV: TIME DEPENDENT METHODS **9**

Stability of solution – Explicit methods – Time split methods – Approximate factorization scheme – Unsteady transonic flow around aerofoils – Sometime dependent solutions of gas dynamic problems – Numerical solution of unsteady 2D heat conduction problems using SLOR methods.

UNIT V: FINITE VOLUME TECHNIQUES **12**

Finite Volume Techniques – Cell centred and Cell Vertex Formulation – Lax-Wend or off 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 HOURS

TEXT BOOK:

1. Fletcher, C. A. J., "Computational Techniques for Fluid Dynamics", Vols. I and II, Springer - Verlag, Berlin, 1988.

REFERENCES

1. John F. Wendt (Editor), 'Computational Fluid Dynamics: An Introduction', Third Edition, Springer-Verlag, Berlin, 2008.
2. Charles Hirsch, 'Numerical Computation of Internal and External Flows', Vols. I and II, Second Edition, John Wiley and Sons, New York, 2007.
3. Klaus A. Hoffmann and Steve T. Chiang, 'Computational Fluid Dynamics', Vol. & II Engineering Education System, P.O. Box 20078, W.Wichita, K.S., 67208 – 1078 USA, 1993.
4. Anderson Jr.D., "Fundamentals of Aerodynamics", McGraw-Hill, 2000.
5. John D. Anderson: "Computational Fluid Dynamics", McGraw-Hill, 2000.

AE32A5	AERO ENGINE MAINTENANCE AND REPAIR	L	T	P	C
		3	0	0	3

OBJECTIVE:

To make the students to analyze various inspections of piston engines and jet engines.

Course Outcome – COs		Cognitive Skill
CO-01	To study the basic concepts of the maintenance and repair of both piston and jet aero engines and the procedures followed for overhaul of aero engines.	U
CO-02	Ability to analysis of various inspections of piston engines	An
CO-03	Ability to integrate classification of jet engine components	A
CO-04	Understanding various maintenance procedure of jet engine components	U
CO-05	To apply the knowledge of Engine Overhaul procedures	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	M	L	M	L	L	M	M	M	M	M	L	L
CO-02	S	L	M	M	M	L	L	L	M	M	M	N	L
CO-03	M	M	M	L	L	S	L	L	M	M	L	M	M
CO-04	L	L	M	L	L	M	M	L	L	L	L	L	L
CO-05	L	M	L	M	L	L	L	M	M	M	N	L	L

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

UNIT I: CLASSIFICATION OF PISTON ENGINE COMPONENTS 5

Types of piston engines – Principles of operation – Function of components – Materials used – Details of starting the engines – Details of carburetion and injection systems for small and large engines – Ignition system components – Spark plug details – Engine operating conditions at various altitudes – Maintenance and inspection check to be carried out.

NIT II: INSPECTIONS OF PISTON ENGINES 8

Inspection and maintenance and troubleshooting – Inspection of all engine components – Daily and routine checks – Overhaul procedures – Compression testing of cylinders – Special inspection schedules – Engine fuel, control and exhaust systems – Engine mount and super charger – Checks and inspection procedures. Methods and instruments for non-destructive testing techniques – Equipment for replacement of part and their repair. Engine testing: Engine testing procedures and schedule preparation – Online maintenance.

UNIT III: CLASSIFICATION OF JET ENGINE COMPONENTS 12

Types of jet engines – Principles of operation – Functions of components – Materials used – Details of starting and operating procedures – Gas turbine engine inspection & checks – Use of instruments for online maintenance – Special inspection procedures : Foreign Object Damage – Blade damage – etc.

UNIT IV: MAINTENANCE PROCEDURE OF JET ENGINES 10

Maintenance procedures of gas turbine engines – Trouble shooting and rectification procedures – Component maintenance procedures – Systems maintenance procedures- Gas turbine testing procedures – test schedule preparation – Storage of Engines – Preservation and de-preservation procedures.

UNIT V: OVERHAUL PROCEDURES 10

Engine Overhaul procedures – Inspections and cleaning of components – Repairs schedules for overhaul – Balancing of Gas turbine components. Trouble Shooting - Procedures for rectification – Condition monitoring of the engine on ground and at altitude – engine health monitoring and corrective methods, Drone, UAV and Learjet inspections.

TOTAL: 45 HOURS

TEXT BOOK:

1. KROES & WILD, "Aircraft Power plants", 7th Edition – McGraw Hill, New York, 1994.

REFERENCES

1. TURBOMECA, "Gas Turbine Engines", The English Book Store, New Delhi, 1993.
2. UNITED TECHNOLOGIES PRATT & WHITNEY, "The Aircraft Gas turbine Engine and its Operation", (latest edition) The English Book Store, New Delhi.

AE32A6	DESIGN OF GAS TURBINE ENGINE COMPONENTS	L	T	P	C
		3	0	0	3

OBJECTIVE:

To make the students to understand the on design and off design parametric analysis and design various rotating components and inlet and nozzle.

Course Outcome – COs		Cognitive Skill
CO-01	To introduce basic design concepts of jet engine and estimation of requiredthrust to students.	U
CO-02	To make students familiarize with the design parameter and off designcalculations.	An
CO-03	To give the students adequate exposure to design procedure to the rotating components of engine such as compressor and turbine along with staging.	R
CO-04	To make the students learn the aspects of combustion processes, flame stabilization issue, igniters design and NOx controls.	U
CO-05	To make students familiarize with the concept of design inlet and nozzle forvarious on - off design conditions.	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	M	M	M	L	N	L	N	N	L	L	S
CO-02	L	S	M	L	M	L	N	M	N	N	L	L	M
CO-03	S	S	M	L	L	L	N	S	N	N	L	L	S
CO-04	M	S	M	L	M	L	N	S	N	N	L	L	M
CO-05	L	S	S	M	S	L	N	S	N	N	N	N	S

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

UNIT I: GAS TURBINE ENGINE DESIGN FUNDAMENTALS 9

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

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

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

UNIT III: DESIGN OF ROTATING COMPONENTS 9

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

UNIT IV: COMBUSTION CHAMBER DESIGN 9

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

UNIT V: INLET AND NOZZLE DESIGN 9

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

TOTAL: 45 HOURS

TEXT BOOKS:

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

REFERNCES:

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

AE32A7	SPACE MECHANICS	L	T	P	C
		3	0	0	3

OBJECTIVE:

To make the students to learn understanding Kepler's Laws and the connection to Newtonian mechanics and provide the student with the ability to analyze an orbit in three dimensions using orbital elements.

Course Outcome – COs		Cognitive Skill
CO-01	To develop the student's understanding references frames and coordinate systems and the celestial sphere	An
CO-02	To develop student's skills in analyzing relative motion in the N-body problem	An
CO-03	To provide the student with an understanding of the satellite injection and satellite orbit perturbations	U
CO-04	To provide the student with the ability to analyze interplanetary trajectories	An
CO-05	To evaluate an effect of space environment on the selection of spacecraft material	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	PO-M
CO-01	M	L	M	M	M	L	N	M	N	L	S	M	S

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

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

UNIT I: BASIC CONCEPTS 4

The Solar System – References Frames and Coordinate Systems – The Celestial Sphere– The Ecliptic – Motion of Vernal Equinox – Sidereal Time – Solar Time – Standard Time –The Earth's Atmosphere.

UNIT II: THE GENERAL N-BODY PROBLEM 10

The many body Problem – Lagrange – Jacobian Identity –The Circular Restricted Three Body Problem – Libration Points- Relative Motion in the N-body Problem –Two –Body Problem – Satellite Orbits – Relations Between Position and Time – Orbital Elements.

UNIT III: SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS 12

General Aspects of satellite Injections – Satellite Orbit Transfer –Various Cases – Orbit Deviations Due to Injection Errors – Special and General Perturbations – Cowell's Method– Encke's Method – Method of vibrations of Orbital Elements – General Perturbations Approach.

UNIT IV: INTERPLANETARY TRAJECTORIES 7

Two Dimensional Interplanetary Trajectories –Fast Interplanetary Trajectories – Three Dimensional Interplanetary Trajectories – Launch if Interplanetary Spacecraft – Trajectoryabout the Target Planet.

UNIT V: BALLISTIC MISSILE TRAJECTORIES AND MATERIALS 12

The Boost Phase – The Ballistic Phase –Trajectory Geometry- Optimal Flights – Time of Flight – Re-entry Phase – The Position of the Impact Point – Influence Coefficients - Space Environment – Peculiarities – Effect of Space Environment on the Selection of Spacecraft Material.

TOTAL: 45 HOURS

TEXT BOOK:

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamic", W.H. Freeman & Co.,1984.

REFERENCES:

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley, 1993.
2. Van de Kamp, P., "Elements of Astro-mechanics", Pitman, 1979.
3. Parker E.R., "Materials for Missiles and Spacecraft", McGraw-Hill Book Co. Inc.,1982.

AE32A8	THEORY OF VIBRATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the solving methods of multi degree of freedom systems.
- To introduce the approximates method to solve vibration problems.
- To make the student to understand the solving techniques of vibration of continuous system
- To study the aero elastic effects of aircraft wings.

Course Outcome – COs		Cognitive Skill
CO-01	Solve single and multi-degree vibrating systems	E
CO-02	Distinguish types of vibrations according to dampness and particle motion	An
CO-03	Solve the different numerical methods to solve continuous system.	E
CO-04	Solve approximate methods to find natural frequency of a system	E
CO-05	Examine Collars Triangle and Aero Elastic Problems	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	PO-M
CO-01	L	M	M	S	M	M	N	L	N	M	L	L	M
CO-02	M	S	M	L	M	N	N	M	N	N	N	L	M
CO-03	S	S	M	L	L	N	N	S	N	N	L	L	L
CO-04	M	M	M	L	M	M	N	S	N	N	L	L	M
CO-05	L	M	S	M	S	S	N	S	N	N	N	N	S

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

UNIT I: INTRODUCTION **9**

Introduction to simple harmonic motion, D'Alembert's principle, methods of vibration analysis- Energy method, Rayleigh's method and Equilibrium method - vibration measuring instruments.

UNIT II: SINGLE DEGREE OF FREEDOM SYSTEMS **9**

Free vibrations, with and without damping vibrations – forced vibrations, with and without damping vibration– support excitation – transmissibility.

UNIT III: MULTI DEGREE OF FREEDOM SYSTEMS **9**

Two degrees of freedom systems - static and dynamic couplings - vibration absorber- Multi degree of freedom systems - principal co-ordinates - principal modes and orthogonal conditions - Eigen value problems - Hamilton's principle - Lagrangean equations and application

UNIT IV: CONTINUOUS SYSTEMS **9**

Vibration of elastic bodies – lateral Vibration of string – torsional vibrations of uniform shaft, longitudinal vibration of bar, transverse vibration of beam.

UNIT V: APPROXIMATE METHODS **9**

Approximate methods - Rayleigh's method - Dunkerley's method – Rayleigh-Ritz method- Holzer method - Matrix iteration method

TOTAL: 45 HOURS

TEXT BOOKS:

1. Grover. G.K., "Mechanical Vibrations", 7th Edition, Nem Chand Brothers, Roorkee, India, 2003
2. Leonard Meirovitch, "Elements of Vibration Analysis". McGraw Hill International Edition,2007
3. Thomson W T, 'Theory of Vibration with Application' - CBS Publishers, 1990.

REFERENCES:

1. Bisplinghoff R.L., Ashely H and Hogman R.L., "Aeroelasticity", Addision Wesley Publication, New Tork, 1983.
2. Den Hartog, "Mechanical Vibrations" Crastre Press, 2008.
3. TSE. F.S., Morse, I.F., Hinkle, R.T., "Mechanical Vibrations" – Prentice Hall, New York, 1984.
4. William W Seto, "Mechanical Vibrations" – McGraw Hill, Schaum Series.
5. William Weaver, Stephen P. Timoshenko, Donovan H. Yound, Donovan H. Young. 'Vibration Problems in Engineering' – John Wiley and Sons, New York, 2001

AE32A9	ROCKETS AND MISSILES	L	T	P	C
		3	0	0	3

OBJECTIVE:

To make the students to learn the working of rockets and missiles. Also learn staging, controlling and materials in rockets.

Course Outcome - COs		Cognitive Skill
CO-01	Remembering the basics in general rocket Ignition and feed systems	R

CO-02	Understanding the basics in general rocket Injection systems .	U
CO-03	Analyse the aerodynamics of rockets and missiles .	An
CO-04	Understand the working principle of rocket motion in free space and gravitational field	U
CO-05	Evaluate the staging, control and materials of rockets and missiles	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	PO-M
CO-01	M	S	S	L	S	S	N	L	N	L	S	N	S
CO-02	M	S	S	M	S	L	N	M	N	L	S	M	S
CO-03	L	M	L	L	L	S	N	M	N	L	L	L	S
CO-04	L	M	S	M	M	N	N	S	N	L	M	L	S
CO-05	M	L	N	M	S	S	N	N	N	L	S	L	S

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

UNIT I: ROCKET IGNITION & FEED SYSTEMS 8

Review of solid, liquid propellant rockets – Hybrid propellant rockets – Working principle- Ignition system in rockets – types of igniters and igniter design considerations –Propellant feed systems of liquid rockets and their design considerations

UNIT II: ROCKET INJECTION & CHAMBER SYSTEMS 8

Working principle of injection system – Classification and design considerations - Solid propellant combustion – Liquid propellant combustion– combustion mechanisms – design considerations of liquid rocket thrust chambers and solid propellant combustion process

UNIT III: AERODYNAMICS OF ROCKETS AND MISSILES 10

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 up wash and body downwash in missiles – rocket dispersion.

UNIT IV: 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 V: STAGING, CONTROL AND MATERIALS FOR ROCKETS AND MISSILES 10

Design philosophy behind multi staging of launch vehicles - stage separation techniques in atmosphere and in space – stage separation dynamics and lateral separation characteristics — numerical problems on stage separation and multi staging - various types of thrust vector control methods including secondary injection thrust vector control

Materials: 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.
2. Mathur, M.L., and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion",Standard Publishers and Distributors, Delhi, 1988.

AE32B1	THEORY OF ELASTICITY	L	T	P	C
		3	0	0	3

OBJECTIVE

To understand the concepts of developing Bi-harmonic equations, Polynomial solutions and apply the theory of elasticity to problems of practical interest.

Course Outcome – COs		Cognitive Skill
CO-01	Apply concept of equations of equilibrium and compatibility equations	A
CO-02	Analyze plane stress and plane strain problems	An
CO-03	Develop strain displacement relations and Boussinesque problems.	E
CO-04	Utilize equilateral triangular and rectangular sections	E
CO-05	Apply the theory of plates and shells and Levy's method of solution for rectangular plates under different boundary condition	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	PO-M
CO-01	S	L	M	M	M	L	N	M	N	L	S	M	M
CO-02	M	L	L	M	M	M	N	S	L	M	N	M	M
CO-03	M	L	L	M	L	L	N	N	S	L	M	M	M
CO-04	M	M	M	L	L	L	N	N	L	L	M	S	S
CO-05	M	L	L	L	M	M	N	S	L	M	L	L	M

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

UNIT I: BASIC EQUATIONS OF ELASTICITY 9

Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant's principle - Principal Stresses, Stress Ellipsoid - Stress invariants.

UNIT II: PLANE STRESS AND PLANE STRAIN PROBLEMS 9

Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams, etc.

UNIT III: POLAR COORDINATES 9

Equations of equilibrium, Strain displacement relations, Stress – strain relations, Axi – symmetric problems, Kirsch, Michell's and Boussinesque problems.

UNIT IV: TORSION 9

Navier's theory, St. Venant's theory, Prandtl's theory on torsion, The semi- inverse methodand applications to shafts of circular, elliptical, equilateral triangular and rectangular sections.

UNIT V: INTRODUCTION TO THEORY OF PLATES AND SHELLS 9

Classical plate theory – Assumptions – Governing equations – Boundary conditions – Navier's method of solution for simply supported rectangular plates – Levy's method of solution for rectangular plates under different boundary conditions.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Ansel C Ugural and Saul K Fenster, 'Advanced Strength and Applied Elasticity', 4th Edition, Prentice Hall, New Jersey,4th edition 2003.
2. Bhaskar, K., and Varadan, T. K., Theory of Isotropic/Orthotropic Elasticity, CRC Press USA, 2009.
3. Timoshenko, S., and Goodier, T.N., "Theory of Elasticity", McGraw–Hill Ltd., Tokyo,1990.

REFERENCES

1. Enrico Volterra& J.H. Caines, "Advanced Strength of Materials", Prentice Hall NewJersey, 1991.
2. Wang, C.T., "Applied Elasticity", McGraw–Hill Co., New York, 1993.
3. Sokolnikoff, I.S., "Mathematical Theory of Elasticity", McGraw–Hill New York, 1978.
4. Barber, J. R., Elasticity (Solid Mechanics and Its Applications), Springer publishers, 3rd edition, 2010.
5. Volterra& J.H. Caines, Advanced Strength of Materials, Prentice Hall, New Jersey, 1991.

AE32B2	WIND TUNNEL TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVE:

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

Course Outcome – COs		Cognitive Skill
CO-01	Understand the concepts of aerodynamics and basics of wind tunnels	U
CO-02	Understand the high speed wind tunnels.	R
CO-03	Analyze the different approaches of wind tunnel calibration and measurements	An
CO-04	Apply the concept of Hot wire anemometer and laser Doppler anemometer for turbulence and velocity measurements	U
CO-05	To Know the Knowledge about the flow visualization and non-intrusive flow diagnostics	R

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	L	S	M	M	L	S	L	N	M	S	S	N	S
CO-02	L	S	M	S	S	M	L	N	M	S	S	M	M

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

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

UNIT I: BASICS OF WIND TUNNELS 9

Buckingham Pi Theorem –non-dimensional numbers - Scale effect - types of similarities- Layout of open circuit and closed circuit subsonic wind tunnels.

UNIT II: HIGH SPEED WIND TUNNELS 9

Classifications – Blow down, indraft and induction tunnel layouts and their design features, Transonic, supersonic and hypersonic tunnels, Shock tubes - design parameters.

UNIT III: WIND TUNNEL CALIBRATION AND MEASUREMENTS 9

Pressure, velocity and temperature measurements – Force measurements – types of Balances- Three component and six component balances – calibration of measuring instruments.

UNIT IV: TEMPERATURE MEASUREMENT TECHNIQUES 9

Hot wire anemometer and laser Doppler anemometer for turbulence and velocity measurements-Use of thermocouples and pyrometers for measurement of static and total temperatures-Use of pressure transducers, Rotameters and ultrasonic flow meters.

UNIT V: FLOW VISUALIZATION AND NON-INTRUSIVE FLOW DIAGNOSTICS 9

Smoke and Tuft grid techniques – Dye injection special techniques – Optical Methods- Shadow Graph method, Schlieren method and interferometer - Particle image velocimetry - Laser induced fluorescence.

TOTAL: 45 HOURS

TEXT BOOKS

1. Rae, W.H. and Pope, A. “Low Speed Wind Tunnel Testing”, John Wiley Publication,1984.
2. Pope, A., and Goin, L., “High Speed Wind Tunnel Testing”, John Wiley, 1985.
3. Short term course on Flow visualization techniques, NAL , 2009.

REFERENCES

1. E. Rathakrishnan, "Instrumentation, Measurements and Experimentation in Fluids”, Boca Raton, - 2016.
2. Bradsaw "Experimental Fluid Mechanics", Lecture course on Advanced Flow diagnostic techniques 17-19 September 2008 NAL, Bangalore
3. Dr.R.K. Bansal, “A text book of Fluid mechanics and hydraulic machines”, revised ninth edition, Laxmi Publications, New Delhi – 2017.

AE32B3	UAV DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVE:

To introduce the basic concepts of UAV, the basics of airframe, avionics hardware, communication payloads, controls, design considerations, path planning, Micro aerial vehicles and UAV certification standards.

Course Outcome – COs		Cognitive Skill
CO-01	To study the history of UAV systems	R
CO-02	To understand the basics of airframe.	U
CO-03	To evaluate the concepts of avionics hardware	E
CO-04	To understand communication payloads and control.	U
CO-05	To know about the fundamental aspects of path planning and MAV	R

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

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

UNIT I: INTRODUCTION TO UAV **8**

History of UAV – Classification – Basic Terminology – Models and prototypes – Applications

UNIT II: BASICS OF AIRFRAME **9**

Airframe – Dynamics – Modeling – Structures – Wing design – Engine types – Equipment maintenance and management – Control surfaces – Specifications.

UNIT III: AVIONICS HARDWARE **9**

Autopilot – AGL-pressure sensors – Servos – Accelerometers – Gyros – Actuators – Power Supply processors, integration, installation, configuration and testing.

UNIT IV: COMMUNICATION PAYLOADS AND CONTROLS **10**

Payloads – terminology – Tracking – Aerial photography – Controls – PID feedback – radio control frequency range – SAS – flight director – commands and videos – elements of control loops – flight computer sensors – displays – parameter settings – modems – memory systems – simulations – ground test – analysis trouble shooting.

UNIT V: PATH PLANNING AND MAV **8**

Waypoints navigation – ground control software – recent trends in UAV – Case Studies.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Introduction to UAV systems-Paul G Fashlstrom, Thomas J Gleason, INC 1998.
2. Jane's, Unmanned Aerial Vehicles and Targets- Jane's information group, ASSIN: 0710612575, 1999.
3. Power Supply System for UAV, R.Said & H.Chayeb, KTH, 2002.

REFERENCES:

1. Flight stability and automatic control, Robert C Nelson, Mc.Graw Hill, INC 1998.
2. Ground studies for pilots fight planning – P.J Swatton, 6th edition, 2002.
3. Design of Unmanned Aerial vehicle systems – Dr.Armand J Chaput, Lockheed Martin Aeronautics Company, 2001.

AE32B4	NON DESTRUCTIVE TESTING AND EVALUATION	L	T	P	C
		3	0	0	3

OBJECTIVE:

To introduce the basic concepts of surface NDE methods, thermography, eddy current testing, ultrasonic testing and radiography.

Course Outcome – COs		Cognitive Skill
CO-01	To remember the overview of the Non Destructive Testing methods for the detection of manufacturing defects as well as material characterization.	R
CO-02	To develop student's skills in analyzing principles, types and properties of liquid penetrants	An
CO-03	To know about the thermography and eddy current testing	R
CO-04	To understand ultrasonic testing and acoustic emission	U
CO-05	To evaluate an effect of radiography	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	PO-M
CO-01	S	S	M	S	M	M	N	M	N	N	S	L	M
CO-02	L	L	L	M	M	M	N	S	L	N	N	N	S
CO-03	S	S	M	M	L	L	M	N	S	N	M	M	L
CO-04	S	M	S	L	N	L	M	N	L	N	M	L	M
CO-05	S	M	M	S	M	M	N	S	L	N	L	L	N

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

UNIT I: INTRODUCTION **9**

NDT Versus Mechanical testing - Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT- Visual inspection – Unaided and aided.

UNIT II: SURFACE NDE METHODS **9**

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT III: THERMOGRAPHY AND EDDY CURRENT TESTING (ET) **9**

Thermography- Principles, Contact and noncontact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations,
Interpretation / Evaluation.

UNIT IV: ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) **9**

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications.

UNIT V: RADIOGRAPHY (RT) **9**

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrometers, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

TOTAL: 45 HOURS

TEXT BOOKS:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2014.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010

REFERENCES:

1. "Non destructive Testing Handbook", Vol. 1-10, 3rd Edition, American Society for NonDestructive Testing., 2010. ISBN: 978-1-57117-186-3.
2. Hellier C., "Handbook of Non destructive Evaluation", 1st edition, McGraw-Hill Professional., United States, 2001. ISBN: 0070281211, 978-0070281219.
3. Paipetis A.S, Matikas T. E., and Aggelis D. G., "Emerging Technologies in Non-Destructive Testing",1st edition, CRC Press., United States, 2012. ISBN :9780415621311.
4. Ravi Prakash, "Non destructive Testing Techniques", 1st Edition, New Age Science., India, 2009. ISBN: 1906574065, 978-1906574062.
5. Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing
6. Charles, J. Hellier," Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.
7. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005

AE32B5	HELICOPTER AERODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVE:

To get basic knowledge about Types, Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machines, Drag of hovercraft on land and also develop awareness and usage of Configurations based on torque reaction, Jet rotors and compound helicopters, Methods of control, collective and cyclic pitches changes, Lead, lag and flapping hinges.

Course Outcome - COs		Cognitive Skill
CO-01	Students will be able to access the Various configurations of propeller, rotor, ducted fan and jet lift, tilt wing and vectored thrust, performance of VTOL and STOL aircraft in hover, transition and forward motion.	A,U
CO-02	To develop awareness and usage of Configurations based on torque reaction, Jet rotors and compound helicopters, Methods of control, collective and cyclic pitches changes, Lead, lag and flapping hinges.	A,R,S
CO-03	To understand the uses of Hovering performance, Momentum and simple blade element theories, Figure of merit, Profile and induced power estimation, Constant chord and ideal twist rotors.	A
CO-04	To identify the Induced, profile and parasite power requirements in forward flight, performance curves with effects of altitude, Preliminary ideas on helicopter stability.	R

CO-05	To get basic knowledge about Types, Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machines, Drag of hovercraft on land and water, Applications of hovercraft.	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	PO-M
CO-01	L	L	M	M	L	L	L	M	M	S	S	L	S
CO-02	S	M	L	M	M	M	M	M	S	S	S	M	S
CO-03	L	M	L	M	M	L	M	M	S	S	M	L	M
CO-04	L	N	N	M	L	M	L	L	S	M	M	M	M
CO-05	S	M	S	S	M	M	S	S	L	S	S	M	M

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

UNIT I: LIFT, PROPULSION AND CONTROL OF V/STOL AIRCRAFT 9

Various configurations – propeller, rotor, ducted fan and jet lift-Tilt wing and vectored thrust – performance of VTOL and STOL aircraft in hover, transition and forward motion.

UNIT II: ELEMENTS OF HELICOPTER AERODYNAMICS 9

Configurations based on torque reaction – Jet rotors and compound helicopters – Methods of control – collective and cyclic pitches changes – Lead – lag and flapping hinges.

UNIT III: IDEAL ROTOR THEORY 9

Hovering performance – Momentum and simple blade element theories – Figure of merit – Profile and induced power estimation – Constant chord and ideal twist rotors.

UNIT IV: POWER ESTIMATES 9

Induced, profile and parasite power requirements in forward flight – performance curves with effects of altitude – Preliminary ideas on helicopter stability.

UNIT V: GROUND EFFECT MACHINES 9

Types – Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machines – Drag of hovercraft on land and water. Applications of hovercraft.

TOTAL: 45 HOURS

REFERENCES:

1. B.W. McCormic, “Aerodynamics of V/STOL Flight”, Academic Press, New York, 1978.
2. A. Gessow and G.C.Meyers, “Aerodynamics of the Helicopter”, Macmillan and Co., New York, 1982.
3. G.H. Elsley and A.J. Devereux, “Hovercraft Design and Construction, David Charies, London, 1982.
4. Anderson J.D. “Aerodynamics”, John Wiley, 1995.

AE32B6	AIR TRANSPORTAION AND AIRCRAFT MAINTENANCE	L	T	P	C
		3	0	0	3

OBJECTIVE

To understand fleet, tariffs, routes and cost analysis and study the bodies of aircraft operations their architecture and their principles of management.

Course Outcome – COs		Cognitive Skill
CO-01	To study the bodies of aircraft operations their architecture and their principles of management	R
CO-02	Ability to understand fleet, tariffs, routes and cost analysis	An
CO-03	Ability to understand aircraft scheduling their advantages and limitations	A
CO-04	To study the reliability of aircraft in maintenance operations and ageing.	E
CO-05	To study the use of technologies in aircraft maintenance	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	PO-M
CO-01	S	L	M	M	M	L	S	M	N	L	S	M	L
CO-02	M	L	L	M	M	M	L	S	L	M	N	M	L
CO-03	S	L	L	M	L	L	M	N	S	L	M	M	N
CO-04	M	M	M	L	L	L	M	N	L	L	M	L	L
CO-05	M	L	L	L	M	M	L	S	L	M	L	L	L

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

UNIT I: INTRODUCTION **8**

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 organisation – levels of management, functions of management, Principles of organisation planning the organisation – chart, staff departments & line departments.

UNIT II: AIRLINE ECONOMICS **10**

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 10

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 8

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".
4. "Indian Aircraft manual" – DGCA Pub.
5. ALEXANDER T WELLS, "Air Transportation", Wadsworth Publishing Company, California, 1993.

AE32B7	AIRCRAFT DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVE

To introduce and develop the basic concept of aircraft design.

Course Outcome – COs		Cognitive Skill
CO-01	To understand the overview of power plant types and characteristics	U
CO-02	To develop student's skills in analyzing Weight estimation of an aircraft and balance diagram	An
CO-03	To know about static and dynamic stability detailed study	U

CO-04	To analyze the optimization of wing loading	An
CO-05	To evaluate an airplane structural design and 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	PO-M
CO-01	S	N	M	S	M	M	N	M	N	N	S	L	S
CO-02	L	S	L	M	M	M	N	S	L	N	N	N	S
CO-03	S	L	M	M	L	L	M	N	S	N	M	M	M
CO-04	S	S	S	L	N	L	M	N	L	N	M	L	M
CO-05	S	M	M	S	M	M	N	S	L	N	L	L	S

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

UNIT I: POWER PLANT TYPES AND CHARACTERISTICS 9

Classification 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 of an aircraft and balance diagram – Drag estimation of complete aircraft – Level flight, climb – climbing flight, time to climb, take – off and landing performance derivation – range and endurance.

UNIT III: STABILITY DESIGN 9

Introduction to stability - Static and dynamic stability detailed study – 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 – landing gear design requirements and design flowchart.

UNIT V: AIRPLANE STRUCTURAL DESIGN AND MATERIALS 9

General types of construction, Monocoque, semi-monocoque and geodesic construction, Typical wing and fuselage structure. Metallic and non-metallic materials, Use of aluminium alloy, titanium, stainless steel and composite materials – Introduction to high temperature materials. Materials for modern aircraft – Methods of analysis, testing and fabrication.

TOTAL: 45 HOURS

TEXT BOOKS

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.

REFERENCES

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.

AE32B8	AIRCRAFT PRODUCTION PLANNING AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVE:

To study the basic knowledge on forecast of components & other elements and study about the materials, machines, their process & testing.

Course Outcome – COs		Cognitive Skill
CO-01	To have the basic knowledge on forecast of components and other elements	R
CO-02	To study about the materials, machines, their process and testing.	An
CO-03	To understand the use of special tools in maintenance and overhaul	A
CO-04	To study the production planning, Queuing theory, balancing-Charts and graphs	E
CO-05	To study about production control charts and their statistics	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	PO-M
CO-01	M	S	M	S	S	M	N	M	N	L	S	M	S
CO-02	M	L	L	S	M	M	N	S	L	M	N	M	S
CO-03	S	M	M	S	N	L	N	S	S	L	M	M	M
CO-04	M	M	M	L	N	L	N	S	L	L	M	L	M

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

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

UNIT I: INTRODUCTION **8**

Factors affecting planning-Forecasting information necessary for pre-planning-sources of information-Methods of forecasting-aircraft components requiring overhaul-repair modifications - premature-failures-project planning-estimates of plant, machinery, buildings, manpower, materials, spare parts, time, and cost estimates.

UNIT II: MATERIALS, MACHINES AND PROCESSES **9**

Production engineering knowledge necessary for Planning, machine tools and processes - Materials including aircraft materials and their processing-Spare parts required for overhaul and maintenance-Ground handling equipment-testing of components and aircraft overhaul-standards for acceptance after overhaul.

UNIT III: EQUIPMENT AND TOOLS **10**

Pre-planning required for provision of special tools, jigs, fixtures and test equipment required for overhaul and maintenance-types and description of major test equipment.

UNIT IV: PRODUCTION PLANNING **10**

Production planning function of routing, estimating and scheduling –LOB-CPM and PERT. Queuing theory, sequencing in jobs, shop scheduling, assembly line balancing-charts and graphs.

UNIT V: PRODUCTION CONTROL **8**

Production control functions of dispatching, progressing and evaluation-Activities of progressing-shop procedures-maintenance of critical data statistics of evaluation control charts.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Thomas. L. “Production planning and control” Mc Graw Hill, 1985.
2. Jain. K. C. and Aggarwal. L. N. “Production planning and control and Industrial Management, Khanna publishers, 1990.

REFERENCES:

1. Buffa. E. S. and Sarin. R. K. “Modern production / operations management ”8th ed, John Willey and sons, 2000.
2. MacNiece. E. H. “Production forecasting, planning and control”, John Willey, 1986.
3. Mages. J. F. “Production planning and Inventory control”, McGraw Hill, 1990.

AE32B9	**HYPERSONIC AERODYNAMICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVE:

To introduce fundamental concepts and features peculiar to hypersonic flow to students to familiarize them with the aerodynamic aspects of hypersonic vehicles and the general hypersonic flow theory.

Course Outcome – COs		Cognitive Skill
CO-01	To remember the basics of hypersonic aerodynamics	R
CO-02	To synthesize surface inclination methods for hypersonic in-viscid flows	S
CO-03	To know the approximate methods for in-viscid hypersonic flows	R
CO-04	To evaluate the viscous hypersonic flow theory	E
CO-05	To analyze viscous interactions in hypersonic flows	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	S	N	M	S	M	M	N	M	N	N	S	L	S
CO-02	S	S	L	M	M	M	N	S	L	N	N	N	S
CO-03	S	L	M	M	L	L	N	S	S	N	M	M	M
CO-04	L	S	S	L	N	L	N	S	L	N	M	L	M
CO-05	L	S	M	S	M	M	N	S	L	N	L	L	S

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

UNIT I: BASICS OF HYPERSONIC AERODYNAMICS 8

Thin shock layers – entropy layers – low density and high density flows – hypersonic flight paths hypersonic flight similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT II: SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS 9

Local surface inclination methods – modified Newtonian Law – Newtonian theory – tangent wedge or tangent cone and shock expansion methods – Calculation of surface flow properties.

UNIT III: APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS9

Approximate methods hypersonic small disturbance equation 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 10

Navier–Stokes equations – boundary layer equations for hypersonic flow – hypersonic boundary layer – hypersonic boundary layer theory and non similar hypersonic boundary layers – hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating.

UNIT V: VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9

Strong and weak viscous interactions – hypersonic shockwaves and boundary layer interactions – Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow.

TOTAL: 45 HOURS

TEXT BOOK:

1. John D. Anderson, Jr, Hypersonic and High Temperature Gas Dynamics, McGraw-Hill Series, New York, 1996.

REFERENCES:

1. John.D.Anderson, Jr., Modern Compressible Flow with Historical perspective Hypersonic Series.
2. William H. Heiser and David T. Pratt, Hypersonic Air Breathing propulsion, AIAA Education Series.
3. John T. Bertin, Hypersonic Aerothermodynamics, 1994 AIAA Inc., Washington D.C.

AE32C1	ROCKET PROPULSION	L	T	P	C
		3	0	0	3

OBJECTIVE:

To introduce fundamental concepts of solid, liquid, hybrid and staging of rockets.

Course Outcome – COs		Cognitive Skill
CO-01	To gain the basic knowledge on internal ballistics of rockets	U
CO-02	To study about the solid rocket propulsion and types of propellants	R
CO-03	To synthesize the application of the liquid rocket propulsion and its propellants	S
CO-04	To study about the hybrid rocket propulsion and its advantages	U
CO-05	To study and apply a staging and steering of rockets	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	PO-M
CO-01	S	M	M	S	S	M	N	M	N	N	S	M	S
CO-02	L	M	L	S	M	M	N	S	L	N	L	M	S
CO-03	S	M	M	S	N	L	N	S	S	L	M	M	M
CO-04	M	M	M	L	N	L	N	S	M	L	S	L	M
CO-05	S	S	M	M	M	M	N	S	M	N	S	S	S

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

UNIT I: INTERNAL BALLISTICS OF ROCKETS 9

Reaction principle – Rocket performance parameters – specific impulse – Schematic diagrams of solid, liquid and hybrid rocket propulsion systems – Equilibrium chamber pressure – Thrust equation –Characteristic velocity and thrust coefficient – Rocket performance assessment.

UNIT II: SOLID ROCKET PROPULSION 9

Selection criteria of solid propellants – Types of solid propellants – Propellant ingredients – Solid propellant regression rate and factors influencing the regression rate – Solid propellant grain configurations – Progressive, regressive and neutral burning of grains- Solid rocket igniters – Basics of solid propellant combustion and combustion instability – Erosive burning – Pressure and regression rate relationship.

UNIT III: LIQUID ROCKET PROPULSION 9

Types of liquid propellant combinations – Gas pressure and turbopump fed pressurization systems for liquid propellant rockets – Liquid rocket injectors and water testing – Liquid rocket cooling methods – Basic aspects of thrust chamber design - Thrust control – Advantages of liquid rockets over solid rockets – Combustion instability – Cryogenic rocket engines – Propellant slosh.

UNIT IV: HYBRID ROCKET PROPULSION 9

Standard and reverse hybrid systems – Combustion mechanism in hybrid rockets –Limitations and applications of hybrid rockets – Solid grain configurations in hybrid rockets-Solid grain regression rate behavior along the grain length - Local regression rate estimation – Material combinations for hybrid rocket propellants- Estimation of hybrid rocket performance – Performance comparison with solid and liquid rocket systems.

UNIT V: STAGING AND STEERING OF ROCKETS 9

Need for multi-staging of rocket vehicles – different types of multi-staging - staging optimization methods – estimation of staging performance – stage separation methods in atmosphere and in space -steering methods for rockets – aerodynamic control based steering – types – merits and limitations – jet control based steering – thrust vector control methods – merits and limitations of these methods.

TOTAL: 45 HOURS

TEXT BOOKS:

1. David H. Heiser and David T. Pratt., “Hypersonic Air breathing Propulsion”, AIAA Education Series, 1999.
2. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 2nd edition 2014.
3. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons; 8th Edition 2010

REFERENCES:

1. Martin J. Chiaverini and Kenneth K. Kuo, “Fundamentals of Hybrid Rocket Combustion and Propulsion”, Progress in Astronautics and Aeronautics, 2007.
2. Ramamurthi K, “Rocket Propulsion”, Macmillian publishers India Ltd, 1st edition, 2010.

AE32C2	AERODYNAMICS OF DRONES	L	T	P	C
		3	0	0	3

OBJECTIVE:

To introduce fundamental concepts and features peculiar to data fusion applications to multiple sensor systems, multiple sensor systems and influence of wavelength on atmospheric attenuation.

Course Outcome – COs		Cognitive Skill
CO-01	To remember the basics of radar imaging payloads and other non-dispensable payloads	R
CO-02	To understand the benefits of multiple sensor system	U
CO-03	To know the Data fusion processor functions and architecture	R
CO-04	To analyze the artificial neural networks	An
CO-05	To evaluate fuzzy logic and fuzzy neural networks	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	PO-M
CO-01	M	S	S	M	S	S	N	L	L	N	L	S	M
CO-02	L	S	M	L	L	L	N	S	M	N	N	N	M
CO-03	M	N	N	N	L	L	N	S	S	N	M	M	S
CO-04	M	S	S	M	N	L	N	S	L	N	M	L	S
CO-05	S	M	M	S	M	S	N	S	L	N	M	N	M

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

UNIT I: PAYLOAD FOR UAV **9**

Introduction – Types – Non-dispensable Payloads - Electro-optic Payload Systems - Electro-optic Systems Integration - Radar Imaging Payloads - Other Non-dispensable Payloads - Dispensable Payloads - Payload Development.

UNIT II: SENSOR **9**

Data fusion applications to multiple sensor systems - Selection of sensors - Benefits of multiple sensor systems - Influence of wavelength on atmospheric attenuation - Fog characterization - Effects of operating frequency on MMW sensor performance - Absorption of MMW energy in rain and fog - Backscatter of MMW energy from rain - Effects of operating wavelength on IR sensor performance - Visibility metrics - Atmospheric and sensor system computer simulation models.

UNIT III: DATA FUSION ALGORITHMS AND ARCHITECTURES 9

Definition of data fusion - Level 1 processing - Detection, classification, and identification algorithms for data fusion - State estimation and tracking algorithms for data fusion - Level 2, 3, and 4 processing - Data fusion processor functions - Definition of an architecture - Data fusion architectures - Sensor-level fusion - Central-level fusion - Hybrid fusion.

UNIT IV: ARTIFICIAL NEURAL NETWORKS 9

Applications of artificial neural networks - Adaptive linear combiner - Linear classifiers - Capacity of linear classifiers - Nonlinear classifiers - Madaline - Feedforward network - Capacity of nonlinear classifiers - Supervised and unsupervised learning - Supervised learning rules - Voting Logic Fusion.

UNIT V: FUZZY LOGIC AND FUZZY NEURAL NETWORKS 9

Conditions under which fuzzy logic provides an appropriate solution - Illustration of fuzzy logic in an automobile antilock braking system - Basic elements of a fuzzy system - Fuzzy logic processing -Fuzzy centroid calculation.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Reg Austin Aeronautical Consultant, AJohn "Unmanned aircraft systems UAVs design, development and deployment" Wiley and Sons, Ltd., Publication,2010
2. David L. Hall, Sonya A. H. McMullen "Mathematical Techniques in Multi-sensor Data Fusion", by Artech, 2004
3. Martin Liggins II David Hall, James "Handbook of Multisensor Data Fusion: Theory and Practice", Second Edition (Electrical Engineering & Applied Signal Processing Series), 2008.

REFERENCES:

1. Lawrence A. Klein, "Sensor and Data Fusion: A Tool for Information Assessment and Decision Making", Second Edition, SPIE Press, 2013.
2. Jitendra R. Raol, "Multi-Sensor Data Fusion with MATLAB", CRC Press, 2010.

AE32C3	BOUNDARY LAYER THEORY	L	T	P	C
		3	0	0	3

OBJECTIVE

To introduce the solution methods for boundary layer problems and enables the students to understand the importance of viscosity and boundary layer in fluid flow.

Course Outcome – COs		Cognitive Skill
CO-01	To acquire the knowledge the theory of viscous flow	U
CO-02	To evaluate the incompressible viscous flows and boundary layers	E
CO-03	To have the knowledge of laminar boundary layer theory	R

CO-04	To analyze the theory of turbulent boundary layer	An
CO-05	To study boundary layer transition and separation	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	PO-M
CO-01	M	S	M	M	M	S	N	S	N	N	S	M	M
CO-02	L	S	L	S	M	M	N	S	L	N	L	M	M
CO-03	M	M	M	S	N	L	N	S	S	L	M	M	L
CO-04	L	S	M	L	N	L	N	S	M	L	S	L	M
CO-05	M	S	M	M	M	M	N	S	M	N	S	S	M

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

UNIT I: THEORY OF VISCOUS FLOW 8

Fundamental equations of viscous flow, Conservation of mass, Conservation of Momentum-Navier-Stokes equations, Energy equation, Mathematical character of basic equations, Dimensional parameters in viscous flow, Non-dimensionalising the basic equations and boundary conditions, vorticity considerations, creeping flow, boundary layer flow.

UNIT II: INCOMPRESSIBLE VISCOUS FLOWS AND BOUNDARY LAYERS 10

Solutions of viscous flow equations, Couette flows, Hagen-Poisuelle flow, Flow between rotating concentric cylinders, Combined Couette-Poiseuille Flow between parallel plates, Creeping motion, Stokes solution for an immersed sphere, Development of boundary layer, Displacement thickness, momentum and energy thickness.

UNIT III: LAMINAR BOUNDARY LAYER THEORY 10

Laminar boundary layer equations, Flat plate Integral analysis of Karman – Integral analysis of energy equation – Laminar boundary layer equations – boundary layer over a curved body-Flow separation- similarity solutions, Blasius solution for flat-plate flow, Falkner–Skan wedge flows, Boundary layer temperature profiles for constant plate temperature –Reynold's analogy, Integral equation of Boundary layer – Pohlhausen method – Thermal boundary layer calculations.

UNIT IV: THEORY OF TURBULENT BOUNDARY LAYER 9

Turbulence-physical and mathematical description, Two-dimensional turbulent boundary layer equations — Velocity profiles – The law of the wall – The law of the wake – Turbulent flow in pipes and channels – Turbulent boundary layer on a flat plate – Boundary layers with pressure gradient, Eddy Viscosity, mixing length , Turbulence modelling.

UNIT V: BOUNDARY LAYER TRANSITION AND SEPARATION 8

Boundary layer control in laminar flow-Methods of Boundary layer control: Motion of the solid wall- Acceleration of the boundary layer-Suction- Injection of different gas-Prevention of transition- Cooling of the wall-Boundary layer suction-Injection of a different gas.

TOTAL: 45 HOURS

TEXT BOOK:

1. White, F. M., Viscous Fluid Flow, McGraw-Hill & Co., Inc., New York, 2008.

REFERENCES:

1. Schlicting, H., Boundary Layer Theory, McGraw-Hill, New York, 1979.
2. Reynolds, A, J., Turbulent Flows Engineering, John Wiley and Sons, 1980.

AE32C4	AVIONICS	L	T	P	C
		3	0	0	3

OBJECTIVE

To impart knowledge about the avionic architecture and various avionics data buses and gain more knowledge on various avionics subsystems, navigation systems and auto pilot system.

Course Outcome - COs		Cognitive Skill
CO-01	Recognize need for avionics in civil and military aircraft and space systems	U
CO-02	Remember data buses and digital avionics architecture	R
CO-03	Demonstrate all Control and display technologies	E
CO-04	Synthesize the various types of navigation systems	S
CO-05	Understand the various air data systems and auto pilot	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	PO-M
CO-01	S	M	S	L	S	S	N	L	L	L	S	N	N
CO-02	M	S	M	S	S	M	N	M	L	L	S	M	M
CO-03	N	M	S	L	L	S	M	M	L	L	M	L	L
CO-04	L	L	S	M	M	N	N	L	L	L	M	L	S
CO-05	N	L	N	M	S	S	N	S	L	L	S	L	S

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

UNIT I: INTRODUCTION TO AVIONICS **9**

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

UNIT II: DIGITAL AVIONICS ARCHITECTURE **9**

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

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

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

UNIT IV: INTRODUCTION TO NAVIGATION SYSTEMS **9**

Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS – Inertial Navigation Systems (INS) – Inertial sensors, INS block diagram – Satellite navigation systems – GPS.

UNIT V: AIR DATA SYSTEMS AND AUTO PILOT **9**

Air data quantities – Altitude, Air speed, Vertical speed, Mach Number, Total air temperature, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004
2. Collinson.R.P.G. "Introduction to Avionics", Chapman and Hall, 1996.

REFERENCES:

1. Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989.
2. Pallet.E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition 2011.
3. Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 1993.

		L	T	P	C
AE32C5	**FATIGUE AND FRACTURE MECHANICS**	**3**	**0**	**0**	**3**

OBJECTIVE

To introduce the basic of fatigue behavior and design and analysis of mechanisms of fatigue crack initiation and growth in metals.

Course Outcome – COs		**Cognitive Skill**
CO-01	Ability to apply mathematical knowledge to effect of mean stress, Goodman, Gerber and Soderberg relations	A
CO-02	Ability to perform statistical aspects of fatigue behavior	U
CO-03	Analyze the theory for analysis of crack initiation, crack growth and final fracture	An

CO-04	Analyze the effect of thickness on fracture toughness and stress intensity factors for typical geometries	An
CO-05	Evaluate the fatigue design and testing	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	PO-M
CO-01	M	L	M	S	S	M	N	M	N	N	S	M	S
CO-02	S	S	L	S	M	M	N	S	L	N	L	M	S
CO-03	L	M	M	S	N	L	N	M	S	N	M	M	M
CO-04	M	M	M	L	N	L	N	S	M	N	S	L	M
CO-05	M	S	M	M	M	M	N	M	M	N	S	S	S

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

UNIT I: FATIGUE OF STRUCTURES **7**

S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors - Plastic stress concentration factors - Notched S.N. curves.

UNIT II: STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR **10**

Low cycle and high cycle fatigue - Coffin - Manson's relation - Transition life - cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques -Cumulative damage - Miner's theory - Other theories.

UNIT III: PHYSICAL ASPECTS OF FATIGUE **10**

Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces.

UNIT IV: FRACTURE MECHANICS **10**

Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin – Or win extension of Griffith's theory to ductile materials - stress analysis of cracked bodies - Effect of thickness on fracture toughness - stress intensity factors for typical geometries.

UNIT V: FATIGUE DESIGN ANDTESTINIG **8**

Safe life and Fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Prasanth Kumar – "Elements of fracture mechanics" – Wheeter publication, 1999.
2. Barrois W, Ripely, E.L., "Fatigue of aircraft structure", Pe/gamon press. Oxford, 1983.

REFERENCES:

1. Sin, C.G., "Mechanics of fracture" Vol. I, Sijthoff and w Noordhoff International Publishing Co., Netherlands, 1989.
2. Knott, J.F., "Fundamentals of Fracture Mechanics", Buterworth& Co., Ltd., London, 1983.

AE32C6	COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVE

To understand the flexible manufacturing system and to handle the product data and various software used for manufacturing.

Course Outcome - COs		Cognitive Skill
CO-01	Outline the origin of computer integrated manufacturing and marketing engineering	U
CO-02	Determine the planning and control of production cost, Group technology and computer aided process planning.	A
CO-03	Construct the part family's classification and coding, shop floor control and flexible manufacturing.	An
CO-04	Apply the concepts of CIM open system, manufacturing and local area network management.	A
CO-05	Explain the development of manual part programming for CNC turning and machining centre	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	PO-M
CO-01	S	M	S	S	M	S	M	M	N	M	S	M	M
CO-02	M	S	M	M	S	L	M	N	N	N	L	M	S
CO-03	M	M	S	L	M	L	S	M	N	M	M	L	M
CO-04	S	M	M	L	M	S	M	M	N	M	S	M	S
CO-05	M	S	M	L	M	M	L	S	N	M	L	L	M

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

UNIT I: INTRODUCTION **8**

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 10

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 – 3D Printing.

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-&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: CNC PROGRAMMING 9

Structure of CNC program, Coordinate system, G& M codes, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, subroutines, do loop, mirroring features ,Manual part programming for CNC turning and machining centre, Generation of CNC program using popular CAM software

TOTAL: 45 HOURS

TEXT BOOKS:

1. Mikell.P.Groover “Automation, Production Systems and computer integrated manufacturing”, Pearson Education 2001.
2. Ranky, Paul G., “Computer Integrated Manufacturing”, Prentice Hall International, 1986.

REFERENCES:

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

AE32C7	OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVE

To make use of the above techniques while modeling and solving the engineering problems of different fields.

Course Outcome – COs		Cognitive Skill
CO-01	Understand importance of classification of optimization problems	U
CO-02	Apply basic concepts of mathematics to formulate an parametric linear programming	A
CO-03	Analyse and appreciate non linear programming	An
CO-04	Evaluate integer programming and dynamic programming and network techniques .	E
CO-05	Apply Solutions for advanced simulations and Neural Network and Fuzzy systems	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	PO-M
CO-01	S	M	S	L	S	S	N	L	L	L	S	N	S
CO-02	M	S	M	S	S	M	N	M	L	L	S	M	S
CO-03	N	M	S	L	L	S	N	M	L	L	M	L	M
CO-04	L	L	S	M	M	N	N	L	L	L	M	L	S
CO-05	N	L	N	M	S	S	N	L	L	L	S	L	M

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

UNIT I: INTRODUCTION **5**

Optimization – Historical Development – Engineering applications of optimization – Statement of an Optimization problem – classification of optimization problems.

UNIT II: CLASSIC OPTIMIZATION TECHNIQUES **10**

Linear programming - Graphical method – simplex method – dual simplex method –revised simplex method – duality in LP – Parametric Linear programming – Goal Programming.

UNIT III: NON-LINEAR PROGRAMMING **9**

Introduction – Lagrangeon Method – Kuhn-Tucker conditions – Quadratic programming- Separable programming – Stochastic programming – Geometric programming

UNIT IV: INTEGER PROGRAMMING AND DYNAMIC PROGRAMMING ANDNETWORK TECHNIQUES 12

Integer programming - Cutting plane algorithm, Branch and bound technique, Zero-oneimplicit enumeration – Dynamic Programming – Formulation, Various applications using Dynamic Programming. Network Techniques – Shortest Path Model – Minimum Spanning Tree Problem – Maximal flow problem.

UNIT V: ADVANCES IN SIMULATION 9

Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems

TOTAL: 45 HOURS

REFERENCES

1. R. Panneerselvam, "Operations Research", Prentice Hall of India Private Limited,New Delhi 1 – 2005
2. P.K. Guptha and Man-Mohan, Problems in Operations Research – Sultan chand&Sons, 1994
3. Ravindran, Philips and Solberg, Operations Research Principles and Practice, JohnWiley & Sons, Singapore, 1992
4. J.K.Sharma, Operations Research – Theory and Applications – Macmillan India Ltd.,1997
5. Hamdy A. Taha, Operations Research – An Introduction, Prentice Hall of India, 1997.

AE32C8	SUSTAINABLE MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVE

To learn globalization and international issues sustainability status and concepts of competitive strategy and manufacturing strategies and development of a strategic improvement program and Manufacturing strategy in business.

Course Outcome – COs		Cognitive Skill
CO-01	To know importance of economic sustainability and performance evaluation	E
CO-02	To apply basic concepts of social and environmental sustainability and processes that minimize negative environmental impacts	A
CO-03	Analyse measuring industry awareness and availability of sustainability indicators	An
CO-04	Evaluate the manufacturing strategy in business success strategy formation and formulation	E
CO-05	To understand the concept of Life cycle assessment manufacturing and service activities	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	PO-M
CO-01	M	L	S	L	S	S	N	S	M	L	S	N	M
CO-02	M	L	M	S	S	M	N	S	L	L	S	M	S
CO-03	L	M	N	L	L	S	N	M	M	L	M	L	M
CO-04	M	S	N	M	M	N	N	S	L	L	M	L	S
CO-05	N	L	N	M	S	S	N	N	M	L	S	L	M

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

UNIT I: ECONOMIC SUSTAINABILITY 9

Industrial Revolution-Economic sustainability: globalization and international issues Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability - Assessments of economic sustainability.

UNIT II: SOCIAL AND ENVIRONMENTAL SUSTAINABILITY 9

Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability.

UNIT III: SUSTAINABILITY PRACTICES 9

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements – Cost and time model.

UNIT IV: MANUFACTURING STRATEGY FOR SUSTAINABILITY 9

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

UNIT V: TRENDS IN SUSTAINABLE OPERATIONS 9

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - influence of product design on operations - Process analysis – Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Ibrahim Garbie, “Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0”, Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.

2. Davim J.P., “Sustainable Manufacturing”, John Wiley & Sons., United States, 2010,ISBN: 978-1-848-21212-1.

REFERENCES:

1.Jovane F, Ęmper, W.E. and Williams, D.J., “The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing”, Springer,2009, United States, ISBN 978-3-540-77011-4.
2.Kutz M., “Environmentally Conscious Mechanical Design”, John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
3.Seliger G., “Sustainable Manufacturing: Shaping Global Value Creation”, Springer, United States, 2012, ISBN 978-3-642-27289-9.

AE32C9	ELECTRIC AND HYBRID VEHICLES	L	T	P	C
		3	0	0	3

OBJECTIVE

To learn design consideration, energy sources, power converters, motor and drives of hybrid electric vehicles.

Course Outcome – COs		Cognitive Skill
CO-01	To know importance of design considerations for electric vehicles	An
CO-02	Apply basic concepts of energy sources and battery management system	A
CO-03	To know the working principles and needs of motors and drives	U
CO-04	To understand the concept of power converters and controllers	R
CO-05	To gain the knowledge of hybrid and electric vehicles	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	PO-M
CO-01	M	L	M	L	M	S	N	S	M	M	M	L	M
CO-02	M	S	M	S	S	M	N	M	L	M	S	M	S
CO-03	L	M	S	L	L	S	N	M	M	N	L	L	M
CO-04	M	L	S	M	M	N	N	L	N	N	L	L	S
CO-05	M	M	L	M	S	S	N	L	N	N	M	N	M

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

UNIT I: DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES 9

Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric

vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

UNIT II: ENERGY SOURCES **9**

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

UNIT III: MOTORS AND DRIVES **9**

Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.

UNIT IV: POWER CONVERTERS AND CONTROLLERS **9**

Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations – operating modes.

UNIT V: HYBRID AND ELECTRIC VEHICLES **9**

Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Iqbal Husain, " Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
2. Mehrdad Ehsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRCPress,2005.

REFERENCES:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003
2. Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005
3. Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005.

		L	T	P	C
AE32E1	**AIR TRAFFIC CONTROL**	**3**	**0**	**0**	**3**

OBJECTIVE

To study about the flight information alerting services, emergency procedures and visual aids in navigation.

Course Outcome – COs		Cognitive Skill
CO-01	To study the importance of objectives of air traffic control systems and establishment, designation and identification of units providing ATS	U
CO-02	To apply basic concepts of area control service, assignment of cruising levels	A
CO-03	To gain the knowledge in flight information and advisory service	R
CO-04	To know the aerodrome data, basic terminology and aerodrome reference code	U
CO-05	To analyse the concept of navigation and other services	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	S	M	L	M	S	S	N	M	L	N	S	N	L
CO-02	L	L	M	S	S	L	N	S	L	N	S	M	S
CO-03	M	M	N	L	L	S	N	M	L	N	M	L	N
CO-04	M	S	N	M	M	L	N	S	L	N	M	L	S
CO-05	L	L	N	M	S	S	N	N	L	N	S	L	L

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

UNIT I: BASIC CONCEPTS **9**

Objectives of air traffic control systems - Parts of ATC services – Scope and Provision of ATCs – VFR & IFR operations – Classification of ATS air spaces – Various kinds of separation – Altimeter setting procedures – Establishment, designation and identification of units providing ATS – Division of responsibility of control.

UNIT II: AIR TRAFFIC SYSTEMS **9**

Area control service, assignment of cruising levels - minimum flight altitude - ATS routes and significant points – RNAV and RNP – Vertical, lateral and longitudinal separations based on time / distance –ATC clearances – Flight plans – position report

UNIT III: FLIGHT INFORMATION SYSTEMS **9**

Radar service, Basic radar terminology – Identification procedures using primary / secondary radar–performance checks – use of radar in area and approach control services – assurance control and co-ordination between radar / non radar control – emergencies – Flight information and advisory service – Alerting service – Co-ordination and emergency procedures – Rules of the air.

UNIT IV: AERODROME DATA **9**

Aerodrome data - Basic terminology – Aerodrome reference code – Aerodrome reference point – Aerodrome elevation – Aerodrome reference temperature – Instrument runway,

physical Characteristics; length of primary / secondary runway – Width of runways – Minimum distance between parallel runways etc. – obstacles restriction.

UNIT V: NAVIGATION AND OTHER SERVICES **9**

Visual aids for navigation Wind direction indicator – Landing direction indicator – Location and characteristics of signal area – Markings, general requirements – Various markings – Lights, general requirements – Aerodrome beacon, identification beacon – Simple approach lighting system and various lighting systems – VASI & PAPI - Visual aids for denoting obstacles; object to be marked and lighter – Emergency and other services.

TOTAL: 45 HOURS

TEXT BOOKS:

1. AIP (India) Vol. I & II, "The English Book Store", 17-1, Connaught Circus, New Delhi.
2. Aircraft Manual (India) Volume I", Latest Edition – The English Book Store, 17-, ConnaughtPlace, New Delhi.

REFERENCES:

1. "PANS – RAC – ICAO DOC 4444", Latest Edition, The English Book Store, 17-1, ConnaughtPlace, New Delhi.
2. Michael S. Nolan., "Fundamentals of Air Traffic Control", Cengage Learning.
3. Wells .A-Airport Planning and Management, 4th Edition- McGraw-Hill, London-2000.
4. P S Senguttuvaan., "Fundamentals of Air Transport Management", McGraw-Hill, 2003.

AE32E2	AIRCRAFT RULES AND REGULATIONS	L	T	P	C
		3	0	0	3

OBJECTIVE

To teach Knowledge of procedure for holding examinations, proficiency checks etc. for defense personnel to fulfill the requirements for grant of civil licenses.

Course Outcome – COs		Cognitive Skill
CO-01	Knowledge of Airworthiness requirements for transport, military, gliders and micro light aircrafts.	U
CO-02	Understanding of Defect recording, reporting, investigation, rectification and analysis.	R
CO-03	Knowledge Procedure relating to registration of aircraft and revalidation of type certificate of aircraft and its engines	U
CO-04	Understanding of procedure relating to Issue of AME Licence and its classification and experience requirements	R
CO-05	Knowledge of approval of aircraft components and equipment including instruments	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	PO-M
CO-01	M	L	S	L	M	S	M	S	L	M	S	N	M
CO-02	M	L	M	S	M	M	N	S	L	N	S	M	S
CO-03	M	S	L	L	L	S	M	M	L	M	M	L	M
CO-04	L	L	M	M	L	N	N	S	L	N	M	L	S
CO-05	S	N	M	M	M	S	M	N	L	M	S	L	M

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

UNIT I: C.A.R. SERIES 'A' – PROCEDURE FOR CIVIL AIR WORTHINESS REQUIREMENTS AND RESPONSIBILITY OPERATORS Vis-à-vis AIR WORTHINESS DIRECTORATE 8

Responsibilities of operators / owners- Procedure of CAR issue, amendments etc., Objectives and targets of airworthiness directorate; Airworthiness regulations and safety oversight of engineering activities of operators.

C.A.R. SERIES 'B' – ISSUE APPROVAL OF COCKPIT CHECK LIST, MEL, CDL: Deficiency list (MEL & CDL); Preparation and use of cockpit checklist and emergency list.

UNIT II: C.A.R. SERIES 'C' – DEFECT RECORDING, MONITORING, INVESTIGATION AND REPORTING 7

Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-flight readings & recordings; Maintenance control by reliability Method.

C.A.R. SERIES 'D' – AND AIRCRAFT MAINTENANCE PROGRAMMES

Reliability Programmes (Engines); Aircraft maintenance programme& their approval; On condition maintenance of reciprocating engines; TBO – Revision programme; Maintenance of fuel and oil uplift and consumption records – Light aircraft engines; Fixing routine maintenance periods and component TBOs – Initial & revisions.

UNIT III: C.A.R. SERIES 'E' – APPROVAL OF ORGANISATIONS 10

Approval of organizations in categories A, B, C, D, E, F, & G - Requirements of infrastructure at stations other than parent base.

C.A.R. SERIES 'F' – AIR WORTHINESS AND CONTINUED AIR WORTHINESS: Procedure relating to registration of aircraft; Procedure for issue / revalidation of Type Certificate of aircraft and its engines / propeller; Issue / revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness.

UNIT IV: C.A.R. SERIES 'L'&'M' 8

Issue of AME Licence, its classification and experience requirements, Mandatory Modifications / Inspections.

UNIT V: C.A.R. SERIES 'T'&'X' 12

Flight testing of (Series) aircraft for issue of C of A; Flight testing of aircraft for which C of A had been previously issued. Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits & Physician's kit in an aircraft; Use furnishing materials

in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of tax permit; Procedure for issue of type approval of aircraft components and equipment including instruments.

TOTAL: 45 HOURS

TEXT BOOKS:

1. "Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness)" – Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi 2000.
2. Aeronautical Information Circulars (relating to Airworthiness) from DGCA 2000.

REFERENCES:

1. "Aircraft Manual (India) Volume" – Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.
2. Advisory Circulars from DGCA 2003.

AE32E3	AEROSPACE MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVE

To study the effect of structure on the melting and glass transition temperature.

Course Outcome – COs		Cognitive Skill
CO-01	To remember the elements of aerospace materials	R
CO-02	To apply basic concepts of mechanical behaviour of materials	A
CO-03	To analyse corrosion and heat treatment of metals and alloys	An
CO-04	To apply the behaviour of shape memory alloys and its applications in aerospace vehicle design	A
CO-05	To understand the concept of high temperature materials and characterization	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	PO-M
CO-01	M	M	S	L	M	S	N	S	M	N	S	N	S
CO-02	L	S	M	S	M	M	N	S	N	N	S	M	M
CO-03	M	S	M	L	S	S	N	M	S	N	M	L	M
CO-04	M	M	M	M	L	N	N	S	M	N	M	N	M
CO-05	M	N	M	M	S	S	N	S	M	N	M	N	S

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

UNIT I: ELEMENTS OF AEROSPACE MATERIALS 9

Structure of solid materials – Atomic structure of materials – Crystal structure – Miller indices – Density – Packing factor – Space lattices – X-ray diffraction – Imperfection in crystals – general requirements of materials for aerospace applications.

UNIT II: MECHANICAL BEHAVIOUR OF MATERIALS 9

Linear and non-linear elastic properties – Yielding, strain hardening, fracture, Bauchinger's effect – Notch effect testing and flaw detection of materials and components – Comparative study of metals, ceramics plastics and composites.

UNIT III: CORROSION & HEAT TREATMENT OF METALS AND ALLOYS 9

Types of corrosion – Effect of corrosion on mechanical properties – Stress corrosion cracking – Corrosion resistance materials used for space vehicles. Heat treatment of carbon steels – aluminium alloys, magnesium alloys and titanium alloys – Effect of alloying treatment, heat resistance alloys – tool and die steels, magnetic alloys, powder metallurgy.

UNIT IV: CERAMICS AND COMPOSITES 9

Introduction – physical metallurgy – modern ceramic materials – cermet - cutting tools – glass ceramic –production of semi-fabricated forms - Plastics and rubber – Carbon/Carbon composites, Fabrication processes involved in metal matrix composites - shape memory alloys – applications in aerospace vehicle design.

UNIT V: HIGH TEMPERATURE MATERIALS & CHARACTERIZATION 9

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

TOTAL: 45 HOURS

TEXT BOOKS:

1. Martin, J.W., "Engineering Materials, Their properties and Applications", Wykedham Publications (London) Ltd, 1987.
2. Titterton.G., "Aircraft Materials and Processes", 5th Ed., Pitman Publishing Co., 1998.

REFERENCES:

1. Raghavan.V., "Materials Science and Engineering", Prentice Hall of India, 5th Ed., 2011.
2. Van Vlack.L.H., "Materials Science for Engineers", Addison Wesley, 1985.

AE32E4	WIND ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVE

To study flow over the bluff body and the aerodynamics around it and concepts of aero elastic phenomena and flow around various types of bodies.

Course Outcome – COs		Cognitive Skill
CO-01	To remember the layer of atmosphere and effect of friction	R
CO-02	To know basic concepts of atmospheric boundary layer and roughness parameters simulation techniques in wind tunnels	U
CO-03	To analyse bluff body aerodynamics.	An
CO-04	To synthesize the loading coefficients, local and global coefficients pressure shear stress coefficients and force and moment coefficients	S
CO-05	To understand the concept of aero elastic phenomena and concept of launch vehicle	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	PO-M
CO-01	M	M	L	M	L	L	M	M	M	M	M	L	L
CO-02	S	L	M	M	M	L	L	L	M	M	M	N	L
CO-03	M	M	M	L	L	S	L	L	M	M	L	M	M
CO-04	L	L	M	L	L	M	M	L	L	L	L	L	L
CO-05	L	M	L	M	L	L	L	M	M	M	N	L	L

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

UNIT I: THE ATMOSPHERE: 6

Atmospheric Circulation – Stability of atmospheres – definitions & implications – Effects of friction – Atmospheric motion – Local winds, Building codes, Terrains different types.

UNIT II: ATMOSPHERIC BOUNDARY LAYER: 9

Governing Equations – Mean velocity profiles, Power law, logarithmic law wind speeds, Atmospheric turbulence profiles – Spectral density function – Length scale of turbulence, Roughness parameters simulation techniques in wind tunnels.

UNIT III: BLUFF BODY AERODYNAMICS: 10

Governing Equations – Boundary layers and separations – Wake and Vortex formation two dimensional – Strouhal Numbers, Reynolds numbers – Separation and Reattachments Oscillatory Flow patterns Vortex shedding flow switching – Time varying forces to wind velocity in turbulent flow – Structures in three dimensional

UNIT IV: WIND LOADING 10

Introduction, Analysis and synthesis loading coefficients, local & global coefficients pressure shear stress coefficients, force and moment coefficients – Assessment methods – Quasi steady method – Peak factor method – Extreme value method

UNIV V: AEROELASTIC PHENOMENA: 10

Vortex shedding and lock in phenomena in turbulent flows, across wind galloping wake galloping - Torsional divergence, along wind galloping of circular cables, cross wind galloping of circular cables, Wind loads & their effects on tall structures – Launch vehicles

TOTAL: 45 HOURS

TEXT BOOK:

1. Emil Simiu & Robert H Scanlan, Wind effects on structures - fundamentals and applications to design, John Wiley & Sons Inc New York, 1996.

REFERENCES:

1. Tom Lawson Building Aerodynamics Imperial College Press London, 2001.
2. N J Cook, Design Guides to wind loading of buildings structures Part I & II, Butterworths, London, 1985.

AE32E5	CRYOGENICS	L	T	P	C
		3	0	0	3

OBJECTIVE

To analyze the cryogenic refrigeration systems and understand the cryogenic storage and transfer systems

Course Outcome - COs		Cognitive Skill
CO-01	To gain knowledge on areas involving cryogenic engineering	U
CO-02	To understand the low temperature properties of engineering materials	U
CO-03	Ability to analyse the concepts of gas liquefaction systems	An
CO-04	Ability to analyse the cryogenic refrigeration systems	An
CO-05	To understand the cryogenic storage and transfer systems	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	PO-M
CO-01	M	S	S	L	S	S	N	N	N	L	S	N	S
CO-02	M	L	M	S	L	M	N	N	S	L	S	M	S
CO-03	S	M	L	L	L	S	N	N	N	L	L	M	S
CO-04	L	L	S	L	M	S	L	M	N	L	M	L	S
CO-05	S	L	N	M	S	S	N	N	L	N	M	L	S

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

UNIT I: INTRODUCTION **9**

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 Merit.

UNIT II: LOW TEMPERATURE PROPERTIES OF ENGINEERING MATERIALS 9

Mechanical properties – thermal Properties – electrical and magnetic properties. Properties of cryogenic fluids – materials of constructions for cryogenics applications.

UNIT III: GAS LIQUEFACTION SYSTEMS **9**

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

UNIT IV: CRYOGENIC REFRIGERATION SYSTEMS **9**

Ideal refrigeration systems – refrigerators using liquids and gases as refrigerants – refrigerators using solids as working media.

UNIT V: CRYOGENIC STORAGE AND TRANSFER SYSTEMS **9**

Cryogenic fluid storage vessels, cryogenic fluid transfer systems. Application of cryogenics – cryo pumping – 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.

AE32E6	ADVANCED VEHICLE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVE

To analyze the classification, applications in the vehicle, coupling of networks.

Course Outcome – COs		Cognitive Skill
CO-01	To know basic concepts of electric vehicles.	R
CO-02	To evaluate basic concepts of electric vehicle motors and their performance	E
CO-03	To know the concept of autonomous and connected vehicles	U
CO-04	To apply automotive networking to networked vehicles and buses	A
CO-05	To Integrate sensor Data to On-Board Control Systems	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	PO-M
CO-01	L	M	L	M	L	L	N	M	M	M	M	L	L
CO-02	M	L	M	M	M	L	N	L	M	M	M	N	L
CO-03	S	M	M	L	L	S	N	L	M	M	L	M	M
CO-04	M	L	M	L	L	M	N	L	L	L	L	L	L
CO-05	L	M	L	M	L	L	N	M	M	M	N	L	L

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

UNIT I: ELECTRIC VEHICLES **9**

EV architectures, advantages and disadvantages, Electrical and mechanical energy storage technologies, battery management. Performance of Electric Vehicles, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving.

UNIT II: ELECTRIC VEHICLE MOTORS **9**

Electric Propulsion basics, motor capacity determination, Induction motor, DC motor, Permanent Magnet Motor, Switch Reluctance Motor, Configuration, Characteristics, Performance and control of Drives.

UNIT III: AUTONOMOUS AND CONNECTED VEHICLES **9**

Vehicle-to-Vehicle Technology, Vehicle to Road and Vehicle to Vehicle Infrastructure, Basic Control System, Surroundings Sensing Systems, Role of Wireless Data Networks, Advanced Driver Assistance Systems, Basics of Radar System, Ultrasonic Sonar Systems, Lidar System, Camera Technology, Basics of Wireless Technology, Receiver System.

UNIT IV: AUTOMOTIVE NETWORKING **9**

Bus Systems – Classification, Applications in the vehicle, Coupling of networks, networked vehicles, Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces.

UNIT V: ON-BOARD TESTING **9**

Integration of Sensor Data to On-Board Control Systems (OBD), OBD requirements, certification, enforcement, systems, testing, Catalytic converter and Exhaust Gas Recirculation system monitoring, Introduction to Cyber-physical system.

TOTAL: 45 HOURS

TEXT BOOKS:

1 John G Hayes and G AbaasGoodarzi, Electric Powertrain -, 1st Edition, John Wiley & Sons Ltd., 2018

2 Hussain T Mouftah, Melike Erol-kantarci and Samesh Sorour, Connected and Autonomous Vehicles in Smart Cities,CRC Press, 1st Edition, 2020.

REFERENCES:

1. Dominique Paret, Multiplexed Networks for Embedded Systems, John Wiley & Sons Ltd., 2007.
2. Hong Cheng, ―Autonomous Intelligent Vehicles: Theory, Algorithms & Implementation‖, Springer, 2011.
3. Advanced Technology Vehicles Manufacturing (ATVM) Loan Program (Energy Science, Engineering and Technology: Congressional Policies, Practices and Procedures)by Andrew M Wright and Harrison R Scott: 5 September 2012.
4. Advanced Vehicle Technology by Heinz Heisler MSc BSc FIMI MIRTE MCIT | 17 July 2002.

LIST OF OPEN ELECTIVES

SI. NO	Course Code	Course Title	L	T	P	C
1.	AE32D1	Reverse Engineering	3	0	0	3
2.	AE32D2	Additive Manufacturing	3	0	0	3

AE32D1	REVERSE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVE

To introduce the basic of material characteristics and process identification, data processing, 3D scanning and modeling.

Course Outcome – COs		Cognitive Skill
CO-01	To apply mathematical knowledge to computer aided reverse engineering and surface and solid model reconstruction	A
CO-02	To evaluate material characteristics and process identification	E

CO-03	To analyze the theory of interference and data conformity and acceptance	An
CO-04	To study the effect of 3D scanning and modeling	U
CO-05	To apply reverse engineering in the automotive industry and medical industry	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	PO-M
CO-01	S	S	M	N	S	L	N	L	L	N	L	L	S
CO-02	S	S	L	M	M	M	N	S	L	N	L	M	S
CO-03	M	M	S	S	N	L	N	M	M	N	S	S	M
CO-04	S	S	M	L	N	L	N	S	S	N	L	L	M
CO-05	L	S	M	M	M	M	N	M	N	N	L	S	S

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

UNIT I: INTRODUCTION & GEOMETRIC FORM 9

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

UNIT II: MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION 9

Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

UNIT III: DATA PROCESSING 9

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

UNIT IV: 3D SCANNING AND MODELLING 9

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

UNIT V: INDUSTRIAL APPLICATIONS 9

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering. Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014
2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011.

REFERENCES:

1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022
2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001
3. Kathryn, A. Ingle, "Reverse Engineering", McGraw-Hill, 1994.
4. Linda Wills, "Reverse Engineering", Kluver Academic Publishers, 1996
5. Vinesh Raj and Kiran Fernandes, "Reverse Engineering: An Industrial Perspective", Springer- Verlag London Limited 2008.

AE32D2	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVE

To study about Development of Additive Manufacturing and vat polymerization and directed energy deposition.

Course Outcome – COs		Cognitive Skill
CO-01	To know importance of need and development of additive manufacturing	U
CO-02	To apply basic concepts of Topology Optimization	A
CO-03	To apply photo polymerization and continuous liquid interface production	A
CO-04	To understand the Powder Bed Fusion and material extrusion	R
CO-05	To understand the concept of Three-Dimensional Printing and applications	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	PO-M
CO-01	S	M	S	L	M	S	N	S	L	N	S	N	M
CO-02	S	M	M	S	M	M	N	S	L	N	S	M	S
CO-03	M	S	L	L	S	S	N	M	L	N	M	L	M
CO-04	S	L	M	M	L	N	N	S	L	N	M	L	S
CO-05	S	N	M	M	M	S	N	N	L	N	S	L	M

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

UNIT I: INTRODUCTION **9**

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing- Electronics Printing. Business Opportunities and Future Directions – Case studies: Automobile, Aerospace, Healthcare.

UNIT II: DESIGN FOR ADDITIVE MANUFACTURING (DfAM) **9**

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization- Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM.

UNIT III: VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION **6**

Photo polymerization: Stereo lithography Apparatus (SLA)- Materials -Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP)Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS)- Process - Material Delivery - Materials -Benefits -Applications.

UNIT IV: POWDER BED FUSION AND MATERIAL EXTRUSION **9**

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials- Process - Advantages and Applications - Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations.

UNIT V: OTHER ADDITIVE MANUFACTURING PROCESSES **9**

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations – Applications- Material Jetting: Multi-jet Modeling- Materials - Process - Benefits – Applications- Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding- Materials-Application and Limitation.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.

REFERENCES:

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN:9783446425521.

2. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.

LIST OF COMMON SUBJECTS

Sl. No	Course Code	Course Title	L	T	P	C
1.	MS3201	Professional and Business Ethics	3	0	0	2
2.	AI32D1	Fundamentals of Artificial Intelligence	3	0	0	3

MS3201	PROFESSIONAL AND BUSINESS ETHICS	L	T	P	C
		3	0	0	2

OBJECTIVES

- To recognize legal and ethical issues in business decision-making.
- To understand and apply ethical rules and constraints.
- To enhance analytical problem-solving skills and ethical decision-making abilities.

Course Outcome – COs		Cognitive Skill
CO-01	Explore the relationship between ethics and business across different cultural traditions.	R
CO-02	Explain the connection between ethics, morals, and values in the workplace.	U
CO-03	Formulate an ethical philosophy and relate it to current practices.	E
CO-04	Assess the ethical implications of business activities and competing demands on businesses.	An
CO-05	Critically analyze 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	PO-M
CO-01	L	N	L	M	M	S	S	M	S	N	S	M	L
CO-02	L	N	L	L	M	M	S	S	S	N	L	M	N
CO-03	M	N	L	L	N	S	S	M	M	L	M	M	L
CO-04	L	N	M	L	N	S	S	S	**S**	L	S	L	N
CO-05	M	N	M	M	M	M	S	S	S	N	S	S	N

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

UNIT IV: 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).

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

OBJECTIVES

- Understand the basic concepts of intelligent agents.
- Develop general-purpose problem-solving agents, logical reasoning agents, and agents that reason under uncertainty.
- Employ AI techniques to solve some of day's real world problems.

Course Outcome – COs At the end of the course students should be able to,		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
CO-01	L	L	L	M	L	M	M
CO-02	M	M	S	M	M	M	L
CO-03	M	M	M	M	M	S	S
CO-04	S	M	S	L	L	M	S
CO-05	M	M	L	L	M	M	S

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 – Problemsolvingagents–Searchalgorithms– Uninformedsearchstrategies.

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 on propositional logic. First-order logic – Syntax and semantics – Knowledge representation and engineering – Inferencesin first-order logic–Forward chaining– Backward chaining–Resolution.

UNIT V: KNOWLEDGE REPRESENTATION **9**

Ontological engineering–Objects and categories–Events–Mental objects and Modallogic– Reasoning systems for categories – Reasoning with default information. Classical planning– Algorithms for classical planning – Heuristics for planning – Hierarchical planning–Non-deterministic domains–Time, Schedule, and Resources–Analysis

TOTAL: 45 HOURS

TEXT BOOK

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, "Artificial Intelligence", Third edition, Pearson Edition, 2006.
4. Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education, 2013.
5. Artificial Intelligence by Example: Develop machine intelligence from scrat chusing real artificial intelligence use cases –by Dennis Rothman, 2018.