NOORUL ISLAM CENTRE FOR HIGHER EDUCATION

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

DEPARTMENT OF AERONAUTICAL ENGINEERING

M.E. AERONAUTICAL ENGINEERING

CURRICULUM AND SYLLABI

REGULATION 2021

NOORUL ISLAM CENTRE FOR HIGHER EDUCATION, Kumaracoil

Regulation : 2021

Curriculum and Syllabi

M.E Programme
DEPARTMENT OF AERONAUTICAL ENGINEERING

M.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
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 ME Programme: 2 Years
Total Credit: 67

Curriculum

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA3503	Applied Mathematics	3	0	0	4
2.	AE3501	Aerodynamics	3	0	0	3
3.	AE3502	Aircraft Structural Mechanics	3	0	0	3
4.	AE3503	Aerospace Propulsion	3	0	0	3
5.	XXXX1	Department Elective-I	3	0	0	3
6.	XXXX2	Department Elective-II	3	0	0	3
PRACTICAL						
7.	AE3571	Aircraft Structures and Engine Lab	0	0	3	1
TOTAL			**18**	**0**	**3**	**20**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	AE3504	Flight Dynamics	3	0	0	3
2.	AE3505	Finite Element Methods	3	0	0	3
3.	AE3506	Computational Fluid Dynamics	3	0	0	3
4.	AE3507	Aero Elasticity	3	0	0	3
5.	XXXX3	Department Elective-III	3	0	0	3
6.	XXXX4	Department Elective-IV	3	0	0	3
PRACTICAL						
7.	AE3572	Computational Fluid Dynamics Laboratory	0	0	3	1
TOTAL			**18**	**0**	**3**	**19**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	AE****	Department Elective-V	3	0	0	3
2.	XXXX	Open Elective-I	3	0	0	3
PRACTICAL						
3.	AE35P1	Project work Phase I	0	0	18	6
TOTAL			**6**	**0**	**18**	**12**

SEMESTER – IV

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	AE35P2	Project work Phase II	0	0	32	16
TOTAL			**0**	**0**	**32**	**16**

Syllabus

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA3503	Applied Mathematics	3	0	0	4
2.	AE3501	Aerodynamics	3	0	0	3
3.	AE3502	Aircraft Structural Mechanics	3	0	0	3
4.	AE3503	Aerospace Propulsion	3	0	0	3
5.	XXXX1	Department Elective-I	3	0	0	3
6.	XXXX2	Department Elective-II	3	0	0	3
PRACTICAL						
7.	AE3571	Aircraft Structures and Engine Lab	0	0	3	1
TOTAL			**18**	**0**	**3**	**20**

MA3503	APPLIED MATHEMATICS	L	T	P	C
		3	1	0	4

AIM:

To equip the students in the field of variational problems, application to queuing system and numerical techniques which provide necessary mathematical support and confidence to tackle real life problems.

OBJECTIVE:

To impart the basic knowledge about Matrices, Transforms, Conformal Mappings and Numerical problems so that those concepts could be adopted in their concerned branch.

Course Outcome - COs		**Cognitive Skills**
CO-01	To understand the advanced matrix theory.	U, A
CO-02	To apply the basic concepts of calculus of variations.	R, A
CO-03	Analyse the various simulations used in mathematics.	U, An
CO-04	Evaluate the concepts of conformal mapping in Engineering.	U, A
CO-05	Analyse the first and second order ordinary and partial differential equations.	U, A

R- Remember, U-Understand, A-Apply, An-Analyse, 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	L	M	L	L	L	M	M	S	S	M	M
CO-02	S	M	M	M	M	M	M	M	S	S	S	M	M
CO-03	M	M	L	M	M	L	M	M	S	S	M	M	M
CO-04	L	N	N	M	L	M	L	L	S	S	M	M	M
CO-05	S	M	S	S	M	M	S	S	S	S	S	M	M

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

UNIT I: ADVANCED MATRIX THEORY **9**

Generalised Eigen vectors– Jordan canonical form — Matrix norms – Singular value decomposition – Pseudo inverse – Least square approximations – QR decomposition.

UNIT II: CALCULUS OF VARIATIONS **9**

Euler's equation – Functional dependent on first and higher order derivatives – Functional dependent on functions of several independent variables —Isoperimetric Problems.

UNIT III: SIMULATION **9**

Discrete Event Simulation – Stochastic Simulation - Monte Carlo Simulation – Generation of Random Numbers using Congruent method – Applications to Queueing systems.

UNIT IV: CONFORMAL MAPPING **9**

Schwarz – Christoffel Transformation – Transformation of boundaries in parametric form – Physical applications – Application to fluid flow and heat flow.

UNIT V: FIRST AND SECOND ORDER ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS **9**

Solution of first order differential equations -Single step Methods: Taylor's Series, Fourth order Runge-Kutta method. Finite difference solution of one dimensional heat equation: Bender Schmidt Method– One dimensional wave equation and two dimensional Poisson equations.

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

REFERENCES:

1. Bronson, R., "Matrix Operations", Schaum's Outline Series, McGraw–Hill, New York , 1989.
2. Spiegel, M.R.," Theory and Problems of complex variables with an introduction to conformal mapping and its applications. Schaum's outline series" McGraw-Hill Book Co,1964.
3. Gupta, A.S., "Calculus of Variations with Applications", Prentice-Hall of India, New Delhi, 1997.
4. Dr.Venkataraman, M.K., " Higher Mathematics for Engineering and Science", National Publishing Company, 1992.
5. Jain M.K., Iyengar. S.R.K and Jain. R.K, "Numerical method for scientific and Engineering Computations", New Age International (P) Ltd., Publishers, 2003.
6. Grewal B.S., "Higher Engineering Mathematics"- 40th Edition, Khanna Publishers, Delhi 2007.
7. Taha, H.A. "Operations Research: An Introduction", Ninth Edition, Pearson Education Edition, Asia, New Delhi, 2002.
8. K Sharma "Operations Research" Macmillan, 2003

AE3501	AERODYNAMICS	L	T	P	C
		3	0	0	3

AIM

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

Course Outcome - COs		Cognitive Skill
CO-01	To understand the fundamental concepts of fluid mechanics.	U,A
CO-02	To analyse the detailed concepts of air foils.	An, R
CO-03	To remember the wing theory concepts.	R,U
CO-04	To evaluate the concepts of compressible flows.	E
CO-05	To understand the wind tunnels and its measurements.	U,R.

R- Remember, U-Understand, A-Apply, An-Analyse, 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	L	L	L	L	L	L	L
CO-02	M	S	L	L	L	M	L	L	L	M	L	M	L
CO-03	M	S	L	L	M	L	L	L	L	L	M	L	L
CO-04	S	M	L	M	L	L	L	L	M	L	L	L	L
CO-05	M	M	L	L	M	L	L	L	L	L	M	L	L

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

UNIT I: REVIEW OF BASIC FLUID MECHANICS **10**

Continuity and Momentum equations, Point source and sink, Free and Forced Vortex, Uniform parallel flow, combination of basic flows, Pressure and Velocity Distributions On bodies with and without circulation in ideal and real fluid flows, Magnus effect

UNIT II: AIRFOILS **9**

Conformal Transformation, Kutta condition, Karman – Treffz profiles, Thin aerofoil Theory and its applications.

UNIT III: WING THEORY **9**

Vortex line, Horse shoe vortex, Biot and savart law, lifting line theory, effects of aspect Ratio, plan-form and taper ratio.

UNIT IV: ELEMENTS OF COMPRESSIBLE FLOWS **9**

Isentropic flows – shock and expansion waves, compressibility effects on aerodynamic Coefficients, method of characteristics – small perturbation theory. Prandtl equation and Rankine – Hugonoit relation, Normal shock equations & Oblique shock equations, Rayleigh and Fanno Flow.

UNIT V: WIND TUNNELS **8**

Types of wind tunnels – Flow visualization processes – Measurements in wind tunnels, 6-component balance.

TOTAL: 45 HOURS

TEXT BOOK

1. J.D. Anderson, “Fundamental of Aerodynamics”, McGraw-Hill Book Co., New York, 1985.

REFERENCES

1. E.L. Houghton and N.B. Carruthers, “Aerodynamics for Engineering Students”, Edward Arnold Publishers Ltd., London (First Indian Edition).
2. W.H. Rae and A. Pope, “Low speed Wind Tunnel Testing”, John Wiley Publications.
3. Shapiro, A.H., Dynamics & Thermodynamics of Compressible Fluid Flow, Ronald Press,
4. Zucrow, M.J., and Anderson, J.D., Elements of gas dynamics McGraw-Hill Book Co., New York.
5. Rathakrishnan.E., Gas Dynamics, Prentice Hall of India, 1995.

AE3502	AIRCRAFT STRUCTURAL MECHANICS	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of aircraft structure and their behaviour

OBJECTIVE

To study different types of beams and columns subjected to various types of loading and support conditions with particular emphasis on aircraft structural components.

Course Outcome - COs		**Cognitive Skill**
CO-01	To apply the bending of beams in structural analysis.	A
CO-02	Apply the shear flow in open sections	E
CO-03	Apply shear flow in closed sections	An
CO-04	To analysis of stiffened tubular structures	E
CO-05	Evaluate the stability problems in structural analysis.	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	S	S	S	S	S	S	S	S
CO-02	S	S	S	M	S	S	S	M	S	S	S	M	M
CO-03	S	S	S	S	S	S	S	S	S	S	S	S	S
CO-04	S	M	M	M	S	M	S	S	M	M	S	S	M
CO-05	M	S	M	M	S	S	S	M	S	S	S	M	S

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

UNIT I: BENDING OF BEAMS 9

Elementary theory of bending - Introduction to semi-monocoque structures - Bredt-Batho theory - Stresses in beams of symmetrical and unsymmetrical sections -Box beams – General formula for bending stresses- principal axes method – Neutral axis method.

UNIT II: SHEAR FLOW IN OPEN SECTIONS 9

Shear stresses in beams – Shear flow in stiffened panels - Shear flow in thin walled open tubes – Shear centre – Shear flow in open sections with stiffeners.

UNIT III: SHEAR FLOW IN CLOSED SECTIONS 9

Shear flow in closed sections with stiffeners– Angle of twist - Shear flow in two flange and three flange box beams – Shear centre - Shear flow in thin walled closed tubes - Torsional shear flow in multi cell tubes - Flexural shear flow in multi cell stiffened structures.

UNIT IV: ANALYSIS OF STIFFENED STRUCTURES 9

Idealisation and analysis of stiffened tubular structures – Study of open tubes – Analysis of multi cell tubes. Analysis of rings and frames – Applications to aircraft structures.

UNIT V: STABILITY PROBLEMS AND ANALYSIS OF AIRCRAFT STRUCTURE 9

Buckling of sheets under compression, shear, bending and combined loads - Crippling stresses by Needham's and Gerard's methods–Sheet stiffener panels-Effective width, Inter rivet and sheet wrinkling failures-Tension field web beams - Loads on Wings Shear force, bending moment and torque distribution along the span of the Wing - Loads on fuselage.

TOTAL: 45 HOURS

TEXT BOOKS

1. E.F. Bruhn, "Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., 1980.
2. Megson, T.M.G; Aircraft Structures for Engineering Students, Edward Arnold, 1995.

REFERENCES

1. Peery, D.J. and Azar, J.J., Aircraft Structures, 2nd Edition, McGraw-Hill, New York, 1993.
2. Stephen P. Tinnoshenko & S.woinowsky Krieger, Theory of Plates and Shells, 2nd Edition, McGraw-Hill, Singapore, 1990.
3. Rivello, R.M., Theory and Analysis of Flight structures, McGraw-Hill, N.Y., 1993

AE3503	AEROSPACE PROPULSION	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of aircraft propulsion

OBJECTIVE

To understand the principles of operation and design of aircraft and spacecraft power plants. To understand the principles of operation and design of aircraft and spacecraft power plants.

Course Outcome - COs		Cognitive Skill
CO-01	To understand the elements of aircraft propulsion	U
CO-02	Analyze the basics of propeller theory	U, A
CO-03	To understand the concepts of inlets, nozzles and combustion chambers	E
CO-04	To analyze the concepts of compressors and turbines	R, U
CO-05	Evaluate the concepts of rocket propulsion.	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	M	N	M	L	S	M	N	M	L	L
CO-02	M	N	S	L	S	M	N	S	L	S	M	N	N
CO-03	S	L	M	N	N	M	S	M	N	N	M	S	S
CO-04	S	M	L	S	L	S	N	L	S	L	S	N	N
CO-05	M	S	L	L	N	M	S	L	L	N	M	S	S

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

UNIT I: ELEMENTS OF AIRCRAFT PROPULSION 9

Classification of power plants based on methods of aircraft propulsion – Propulsive efficiency – Specific fuel consumption - Thrust and power- Factors affecting thrust and power- Illustration of working of Gas turbine engine - Characteristics of turboprop, turbofan and turbojet.

UNIT II: PROPELLER THEORY **9**

Propeller Power losses, propeller performance, incompressible theory for positive thrust, incompressible theory for negative thrust, prediction of static thrust, prediction of inflight thrust, propeller thrust control, propeller noise control, propeller chart, propeller inflight prediction of thrust.

UNIT III: THERMODYNAMICS OF JET ENGINES **9**

Thermodynamic analysis of jet engine – components of a jet engine – Compressor, combustion chamber, turbine and jet nozzle – their efficiencies – Introduction to ramjet, pulse jet and their application – Introduction to combustion and chemical kinetics.

UNIT IV: RAMJET AND SCRAMJET PROPULSION **9**

Ram jet -Operating principle – Sub critical, critical and supercritical operation – Combustion in ramjet engine – Ramjet performance - Fundamentals of hypersonic air birthing vehicles, Preliminary concepts in engine airframe integration, Various types of supersonic combustors, Requirements for supersonic combustors, Performance estimation of supersonic combustors.

UNIT V: ROCKET PROPULSION **9**

Introduction to rocket propulsion – Reaction principle – Thrust equation – Classification of rockets based on propellants used – solid, liquid and hybrid – Comparison of these engines with special reference to rocket performance – Thrust control in liquid rockets.

TOTAL: 45 HOURS

TEXT BOOKS

1. Hill,P.G. and Peterson, C.R. Mechanics and Thermodynamics of Propulsion, Addison – Wesley Longman Inc. 1999
2. Cohen, H. Rogers, G.F.C. and Saravanamuttoo,H.I.H, Gas Turbine Theory, Longman,1989

REFERENCES

1. G.C. Oates, "Aerothermodynamics of Aircraft Engine Components", AIAA Education Series, 1985.
2. G.P.Sutton, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1986.
3. W.P.Gill, H.J.Smith & J.E. Ziurys, "Fundamentals of Internal Combustion Engines as applied to Reciprocating, Gas turbine & Jet Propulsion Power Plants", Oxford & IBH Publishing Co., 1980.

AE3571	AIRCRAFT STRUCTURE AND ENGINE LAB	L	T	P	C
		0	0	3	1

AIM

To make the students familiarize the concept of aircraft structure and engines.

OBJECTIVE

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

Course Outcome - COs		Cognitive Skill
CO-01	To understand the shear Centre location for open and closed sections.	E
CO-02	Analyse the Calibration of Photo Elastic Materials.	A

CO-03	Familiarization of rocket engines	U
CO-04	Aircraft Engine servicing procedure	U
CO-05	Aircraft Engine preservation procedure	A

R- Remember, U-Understand, A-Apply, An-Analyse, 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	L	L	S	M	M	L	L	L
CO-02	M	S	N	N	S	N	N	N	N	S	N	N	N
CO-03	M	L	L	M	L	L	N	L	M	L	L	N	N
CO-04	L	M	M	S	N	S	S	M	S	N	S	S	S
CO-05	S	S	L	L	L	L	M	L	L	L	L	M	M

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

LIST OF EXPERIMENTS (Structures)

1. Perform the calibration of strain gauges
2. Perform the calibration of Photo Elastic Materials
3. Determine the Shear Centre Location for Open Section
4. Determine the Shear Centre Location for Closed Section
5. Determine the Stresses in Circular Disc Under Diametrical Compression

LIST OF EXPERIMENTS (Engines)

1. Safety precautions followed while working with aircraft engines.
2. Study of rocket engine.
3. Aircraft Engine starting procedure.
4. Aircraft Engine servicing procedure.
5. Aircraft Engine preservation procedure

TOTAL: 45 HOURS

LABORATORY EQUIPMENTS REQUIREMENTS (Structures)

1. Strain gauges
2. Experimental setup for location of shear centre (open & closed section)
3. Diffuser transmission type polariscope with accessories

LABORATORY EQUIPMENTS REQUIREMENTS (Engines)

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

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	AE3504	Flight Dynamics	3	0	0	3
2.	AE3505	Finite Element Methods	3	0	0	3
3.	AE3506	Computational Fluid Dynamics	3	0	0	3
4.	AE3507	Aero Elasticity	3	0	0	3
5.	XXXX3	Department Elective-III	3	0	0	3
6.	XXXX4	Department Elective-IV	3	0	0	3
PRACTICAL						
7.	AE3572	Computational Fluid Dynamics Laboratory	0	0	3	1
TOTAL			**18**	**0**	**3**	**19**

AE3504	FLIGHT DYNAMICS	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of dynamics of flight

OBJECTIVE

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

Course Outcome - COs		Cognitive Skill
CO-01	Calculate atmospheric properties at various altitudes.	U
CO-02	Calculate the performance of an airplane for non-accelerating flight conditions.	E
CO-03	Solve accelerated performance equations to get Take-off and landing distances.	An
CO-04	Estimate Longitudinal static stability and trim requirements for an aircraft.	E
CO-05	Assess lateral and directional stability requirements for an aircraft	S

R- Remember, U-Understand, A-Apply, An-Analyse, 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	S	M	M	N	L	M	S	L	M	L
CO-02	M	S	M	N	L	M	S	M	L	S	M	M	S

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

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

UNIT: I: INTRODUCTION TO PRINCIPLES OF FLIGHT 9

Physical properties and structure of the atmosphere, Temperature, pressure and altitude Relationship, Measurement of speed – True and Indicated Air speed, Components of an Airplane and their functions, Different types of flight vehicles.

UNIT II: DRAG OF BODIES 9

Types of Drag, effects of Reynold' number on skin friction and pressure drag, streamlined and bluff bodies, Drag reduction of airplanes, Momentum theory of finite wings, Drag polar

UNIT III: AIRCRAFT PERFORMANCE 9

Steady level flight conditions for minimum drag and minimum power required, Gliding and Climbing flight, Range and endurance, Take-off and landing, High left devices, Thrust Augmentation, turning performance, V-n diagram, Froude momentum and black elements Theory of propellers, Fixed and Variable pitch propellers.

UNIT IV: LONGITUDINAL STABILITY AND CONTROL 9

Degrees of freedom of a system, static and dynamic stability, static longitudinal stability, Contribution of individual components, neutral point, static margin, Hinge moment, Elevator control effectiveness, Power effects, elevator angle to trim, elevator angle per g, maneuver point, stick force gradient, aerodynamic balancing, Aircraft equations of motion, stability derivatives, stability quartic, Phugoid motion

UNIT V: LATERAL, DIRECTIONAL STABILITY AND CONTROL 9

Yaw and side slip, Dihedral effect, contribution of various components, lateral control, aileron control power, strip theory, aileron reversal, weather cock stability, directional control, rudder requirements, dorsal fin, one engine inoperative condition, Dutch roll, spiral and directional divergence, autorotation and spin.

TOTAL: 45 HOURS

TEXT BOOKS

1. Houghton, E.L., and Caruthers, N.B., Aerodynamics for engineering students, Edward Arnold Publishers, 1988.
2. Perkins C.D., & Hage, R.E. Airplane performance, stability and control, Wiley Toppan,

REFERENCES

1. Kuethe, A.M., and Chow, C.Y., Foundations of Aerodynamics, John Wiley & Sons, Clancey,L.J.
2. Aerodynamics, Pitman, 1986.
3. Babister, A.W. Aircraft stability and response, Pergamon Press, 1980.
4. Nelson, R.C. Flight Stability & Automatic Control, McGraw-Hill, 1989.
5. McCormic, B.W., Aerodynamics, Aeronautics & Flight Mechanics John Wiley, 1995.

AE3505	FINITE ELEMENT METHODS	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of finite element discrete analysis

OBJECTIVE

To introduce the concept of numerical analysis of structural components

Course Outcome - COs		Cognitive Skill
CO-01	Formulate and solve axially loaded bar problem	R
CO-02	Implement numerical methods to solve mechanics of solid problem.	A
CO-03	Ability to analyze and solve complex engineering problem.	E
CO-04	Implement the formulation techniques to solve two dimensional problem	An
CO-05	Ability to analyse and solve the heat transfer problem.	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	S	M	S	L	S	L
CO-02	S	S	M	N	L	S	S	M	L	S	S	S	M
CO-03	M	M	S	M	S	L	M	S	S	M	S	S	M
CO-04	M	S	S	S	N	M	L	S	M	S	M	M	S
CO-05	S	S	S	S	S	L	N	S	M	M	M	S	S

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

UNIT I: INTRODUCTION **9**

Review of various approximate methods – Rayleigh-Ritz, Galerkin and Finite Difference Methods - Stiffness and flexibility matrices for simple cases - Basic concepts of finite element method - Formulation of governing equations and convergence criteria.

UNIT II: DISCRETE ELEMENTS **9**

Use of bar, Truss and beam elements for static, dynamic and structural analysis – Bar of varying section.

UNIT III: CONTINUUM ELEMENTS **9**

Different forms of 2-D elements and their applications for plane stress, plane strain and axisymmetric problems – CST Element – LST Element - Consistent and lumped load vectors. Use of local co-ordinates. Numerical integration. – 2-D formulations for scalar variable problems.

UNIT IV: ISOPARAMETRIC ELEMENTS **9**

Definition and use of different forms of 2-D and 3-D elements. - Formulation of element stiffness matrix and load vector.

UNIT V: HEAT TRANSFER / FLUID FLOW **9**

Steady state heat transfer, 1 D heat conduction governing equation, boundary conditions, One dimensional element, Functional approach for heat conduction, Galerkin approach for heat conduction, heat flux boundary condition, 1 D heat transfer in thin fins. Basic differential equation for fluid flow in pipes, around solid bodies, porous media.

TOTAL: 45 HOURS

TEXT BOOKS

1. Segerlind,L.J. "Applied Finite Element Analysis", Second Edition, John Wiley and Sons Inc., New York, 1984.
2. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 2002
3. S.S.Rao, "Finite Element Method in Engineering", Butterworth, Heinemann Publishing, 3rd Edition, 1998

REFERENCES

1. Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt "Concepts and Applications of Finite Element Analysis", 4th Edition, John Wiley & Sons, 2002.
2. K.J. Bathe and E.L. Wilson, "Numerical Methods in Finite Elements Analysis", Prentice Hall of India Ltd., 1983.
3. C.S. Krishnamurthy, "Finite Elements Analysis", Tata McGraw-Hill, 1987
4. P.Seshu, "Textbook of Finite Element Analysis"-PHI, 2004.
5. J.N.Reddy, "Finite Element Method"- McGraw -Hill International Edition.Bathe K J. Finite Elements Procedures, PHI.
6. Cook R. D., et al. "Concepts and Application of Finite Elements Analysis"-4th Edition, Wiley&sons, 2003.

AE3506	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of fluid flow analysis through computer simulation

OBJECTIVE

To study the flow of dynamic fluids by computational methods

Course Outcome – COs		Cognitive Skill
CO-01	Describe the flow phenomena in a flow field with correspondence with elliptic, parabolic and hyperbolic.	U,E
CO-02	Able to do numerical grid generation and having knowledge about mapping techniques.	R,U
CO-03	Can understand various panel methods	R,U
CO-04	Can clearly understand elementary boundary layer theory and its synthesis.	U
CO-05	Knowledge about the fundamental aspects of simple and PESO schemes	R

R- Remember, U-Understand, A-Apply, An-Analyse, 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	S	M	S	S	M	N	N	N	L	S	M	S
CO-03	N	M	S	L	L	S	N	N	N	L	M	L	S
CO-04	L	L	S	M	M	N	N	N	N	L	M	L	S
CO-05	N	L	N	M	S	S	N	N	N	L	S	L	S

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

UNIT I: FUNDAMENTAL CONCEPTS 10

Introduction – Basic Equations of Fluid Dynamics-conservative & non-conservative forms – Introduction to governing equations usage in CFD codes with suitable examples.

UNIT II: DISCRETIZATION, TRANSFORMATION AND GRIDS 10

Introduction to different types of grid generation schemes - Finite Difference Method – Finite Element Method & Finite Volume Method. Introduction to transformations basics in CFD. The Lax-Wendroff method, MacCormack's Method basics - examples of the specific methods in CFD codes.

UNIT III: PANEL METHODS 5

Introduction to – Source panel method using examples (Non-lifting flows). Introduction to Vortex panel method using examples (Lifting flows)

UNIT IV: BOUNDARY LAYER EQUATIONS – STABILITY PROPERTIES 10

Introduction to Boundary layer Equations, Implicit time dependent methods, Concept of numerical dissipation, Stability properties of explicit and implicit methods, Conservative upwind discretization for hyperbolic systems, Leapfrog scheme. Application of these schemes in CFD codes using suitable examples.

UNIT V: INTRODUCTION TO SIMPLE, PESO SCHEMES & EXAMPLE PROBLEMS 10

Introduction to Flux splitting schemes, pressure correction solvers – SIMPLE, PESO – Introduction to turbulence modeling. Application of these schemes in CFD codes using suitable examples.

TOTAL: 45 HOURS

TEXT BOOKS

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

REFERENCES

1. T. J. Chung, "Computational Fluid Dynamics", Second Edition, Cambridge University Press, 2014.
2. Suhas V. Patankar, "Numerical Heat Transfer and Fluid Flow", CRC Press, 1980.
3. John D Anderson Jr., 'Computational Fluid Dynamics – The Basics with Applications', McGraw-Hill Education, New York, 1995.
4. Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics", Vol. 1 and Vol. 2, Second Edition, Springer-Verlag, Berlin, 2013.

5. Charles Hirsch, "Numerical Computation of Internal and External Flows", Vols. 1 and 2, Second Edition, John Wiley and Sons, New York, 2007.
6. John F. Wendt (Editor), "Computational Fluid Dynamics: An Introduction", Third Edition, Springer-Verlag, Berlin, 2008.

AE3507	AERO ELASTICITY	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of elastic deformation in aircrafts

OBJECTIVE

To understand the theoretical concepts of material behaviour with particular emphasis on their elasticity property.

Course Outcome - COs		Cognitive Skill
CO-01	To Apply The Basic Knowledge Of Aero elastic Phenomena	A
CO-02	To Understand The Theoretical Concepts Of Aero elasticity	U
CO-03	Ability To Solve and Analyze Aero elastic Problem In Various Aspects	An
CO-04	Ability to analyze the flutter concept through various phenomena	S
CO-05	Ability to solve various aero elastic problems in aircraft.	U

R- Remember, U-Understand, A-Apply, An-Analyse, 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	M	N	M	M	S	M	M	M
CO-02	M	S	L	N	L	M	S	L	L	S	S	M	S
CO-03	S	S	S	S	S	L	S	M	M	M	S	L	M
CO-04	S	L	S	M	N	L	S	S	M	S	M	M	S
CO-05	M	L	M	M	M	L	N	S	M	M	M	S	S

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

UNIT I: AEROELASTIC PHENOMENA 6

Stability versus response problems – The aero-elastic triangle of forces – Aeroelasticity in Aircraft Design – Prevention of aeroelastic instabilities. Influence and stiffness coefficients. Coupled oscillations.

UNIT II: DIVERGENCE OF A LIFTING SURFACE 10

Simple two dimensional idealisations-Strip theory – Integral equation of the second kind – Exact solutions for simple rectangular wings – 'Semirigid' assumption and approximate solutions – Generalised coordinates – Successive approximations – Numerical approximations using matrix equations.

UNIT III: STEADY STATE AEROLASTIC PROBLEMS 9

Loss and reversal of aileron control – Critical aileron reversal speed – Aileron efficiency – Semi rigid theory and successive approximations – Lift distribution – Rigid and elastic wings. Tail efficiency. Effect of elastic deformation on static longitudinal stability.

UNIT IV: FLUTTER PHENOMENON **14**

Non-dimensional parameters – Stiffness criteria – Dynamic mass balancing – Dimensional similarity. Flutter analysis – Two dimensional thin airfoils in steady incompressible flow – Quasisteady aerodynamic derivatives. Galerkin method for critical flutter speed – Stability of disturbed motion – Solution of the flutter determinant – Methods of determining the critical flutter speeds – Flutter prevention and control.

UNIT V: EXAMPLES OF AEROELASTIC PROBLEMS **6**

Galloping of transmission lines and Flow induced vibrations of transmission lines, tall slender structures and suspension bridges - 1931 Transcontinental & Western Air Fokker F-10 crash – Case Study.

TOTAL: 45 HOURS

TEXT BOOKS

1. Y.C. Fung, "An Introduction to the Theory of Aeroelasticity", John Wiley & Sons Inc., New York, 2008.
2. E.G. Broadbent, "Elementary Theory of Aeroelasticity", Bun Hill Publications Ltd., 1986.

REFERENCES

1. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, "Aeroelasticity", II Edition Addison Wesley Publishing Co., Inc., 1996.
2. R.H. Scanlan and R.Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.
3. R.D.Blevins, "Flow Induced Vibrations", Krieger Pub Co., 2001

AE3572	CFD LAB	L	T	P	C
		0	0	3	1

AIM

To make the students familiarize the concept of fluid flow analysis through computer simulation

OBJECTIVE

To familiarize the students in the basic concepts of CFD and usage of software.

Course Outcome - COs		Cognitive Skill
CO-01	Students will understand the principles of fluid dynamics and algorithms of CFD modeling.	U
CO-02	Students will be able to employ commercial codes to develop CFD models and interpret the results into the physical process.	An
CO-03	Understanding the underlying principles of CFD analysis and finite difference methods	An
CO-04	Understand the numerical models in flow modeling.	U
CO-05	The student will 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	M	S	S	S	M	M	N	M	M	S	M	M	M
CO-02	M	S	L	N	L	M	S	L	L	S	S	M	S
CO-03	S	S	S	S	S	L	S	M	M	M	S	L	M
CO-04	S	L	S	M	N	L	S	S	M	S	M	M	S
CO-05	M	L	M	M	M	L	N	S	M	M	M	S	S

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

LIST OF EXPERIMENTS

1. Design and Analyse the Isentropic flow through a conical CD nozzle
2. Flow over a bluff body at low Reynolds number
3. Flow over a bluff body at high Reynolds number
4. Flow over a NACCA 4412 aerofoil at different mach numbers (0 to 5)
5. Flow over a NACCA 4412 aerofoil at different angle of attack
6. Design and Analyse the Flow through a subsonic diffuser-ejector
7. Design and Analyse the Flow through a supersonic diffuser-ejector
8. Design and Analyse the Flow through a inlet
9. Design and Analyse the Flow through a supersonic ejector-diffuser
10. Design and Analyse the Flow over a multi-element aerofoil

TOTAL: 45 HOURS

LABORATORY EQUIPMENTS REQUIREMENTS

Sl.No.	Name of the Equipment	Quantity
1	Computer nodes	30
2	Gambit	30 licenses
3	ANSYS, Fluent	30 licenses

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	AE****	Department Elective-V	3	0	0	3
2.	XXXX	Open Elective-I	3	0	0	3
PRACTICAL						
3.	AE35P1	Project work Phase I	0	0	18	6
TOTAL			**6**	**0**	**18**	**12**

AE35P1	PROJECT WORK PHASE-I	L	T	P	C
		0	0	18	6

AIM

To make the students apply their knowledge in aeronautical engineering to innovate a new idea

OBJECTIVE

The objective of the project work is to enable the students individually perform 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 back round 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	M	S	S	L	S	S	N	N	N	L	S	S	S
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	L	L	S	M	M	N	N	N	N	L	M	L	S
CO-05	L	L	N	M	S	S	N	N	N	L	S	L	S

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

SEMESTER – IV

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	AE35P2	Project work Phase II	0	0	32	16
TOTAL			**0**	**0**	**32**	**16**

AE35P2	PROJECT WORK PHASE-II	L	T	P	C
		0	**0**	**32**	**16**

AIM

To make the students apply their knowledge in aeronautical engineering to innovate a new idea

OBJECTIVE

The objective of the project work is to enable the students individually perform 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

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

LIST OF DEPARTMENT ELECTIVES

SI. NO	Course Code	Course Title	L	T	P	C
1.	AE35A1	Wind tunnel Techniques	3	0	0	3
2.	AE35A2	Experimental Stress Analysis	3	0	0	3
3.	AE35A3	Advanced Heat Transfer	3	0	0	3
4.	AE35A4	Aircraft Design	3	0	0	3
5.	AE35A5	Advanced Propulsion Systems	3	0	0	3
6.	AE35A6	Space Mechanics	3	0	0	3
7.	AE35A7	Hypersonic Aerodynamics	3	0	0	3
8.	AE35A8	Mechanics of Structural Impact	3	0	0	3
9.	AE35A9	Experimental Methods in Fluid Mechanics	3	0	0	3
10.	AE35B1	Industrial Aerodynamics	3	0	0	3
11.	AE35B2	Fatigue and Fracture Mechanics	3	0	0	3
12.	AE35B3	High Temperature Gas Dynamics	3	0	0	3
13.	AE35B4	Boundary Layer Theory	3	0	0	3
14.	AE35B5	Theory of Vibrations	3	0	0	3
15.	AE35B6	Cryogenics	3	0	0	3
16.	AE35B7	Avionics	3	0	0	3

AE35A1	WIND TUNNEL TECHNIQUES	L	T	P	C
		3	0	0	3

AIM

To make the students familiar with the experimental methods of flow analysis using wind tunnel.

OBJECTIVE

- To provide extensive treatment of the operating principles and limitations of pressure and temperature measurements.
- To cover both operating and application procedures of hot wire anemometer.
- To describe flow visualization techniques and the discussion of analogue methods.

Course Outcome - COs		Cognitive Skill
CO-01	To understand the fundamental measurements in fluid mechanics.	U,A
CO-02	To analyze the wind tunnel measurements.	An, R
CO-03	Synthesis the flow visualization and analogue methods.	S,U
CO-04	To evaluate pressure, velocity and temperature measurements.	E,U
CO-05	To understand the special flows and uncertainty analysis	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	PO-M
CO-01	S	M	L	L	L	M	L	L	M	M	M	L	M
CO-02	S	M	M	L	L	L	M	M	L	L	M	L	L
CO-03	M	L	M	M	L	L	M	L	M	L	M	L	L
CO-04	S	M	L	M	L	M	L	M	L	L	L	M	M
CO-05	S	L	L	M	L	L	M	L	L	M	M	M	L

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

UNIT I: BASIC MEASUREMENTS IN FLUID MECHANICS 7

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

UNIT II: WIND TUNNEL MEASUREMENTS 10

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

UNIT III: FLOW VISUALIZATION AND ANALOGUE METHODS 9

Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Schlieren system – Shadowgraph - Hydraulic analogy – Hydraulic jumps – Electrolytic tank.

UNIT IV: PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS 9

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

UNIT V: SPECIAL FLOWS AND UNCERTAINTY ANALYSIS 10

Experiments on Taylor-Proudman theorem and Ekman layer – Measurements in boundary layers - Data acquisition and processing – Signal conditioning – Uncertainty analysis – Estimation of measurement errors – External estimate of the error – Internal estimate of the error – Uncertainty calculation - Uses of uncertainty analysis.

TOTAL: 45 HOURS

TEXT BOOKS:

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

REFERENCES:

1. Bradsaw "Experimental Fluid Mechanics", Elsevier, 2nd edition, 1970.
2. Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.

AE35A2	EXPERIMENTAL STRESS ANALYSIS	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of experimental methods in stress deformation analysis

OBJECTIVE

To bring awareness on experimental method of finding the response of the structure to different types of load.

Course Outcome - COs		Cognitive Skill
CO-01	To describe the Mechanical, optical, pneumatic and electrical strain gauges for strain measurement.	R
CO-02	To analyse strain gauge techniques under static and dynamic loads.	An
CO-03	To create awareness about photo-elastic techniques.	S
CO-04	Analysis of various non-destructive methods.	An
CO-05	To study the induction heating instrumentation and recording techniques.	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	L	L	L	M	L	L	M	M	M	L	M
CO-02	S	M	M	L	L	L	M	M	L	L	M	L	L
CO-03	M	L	M	M	L	L	M	L	M	L	M	L	L
CO-04	S	M	L	M	L	M	L	M	L	L	L	M	M
CO-05	S	L	L	M	L	L	M	L	L	M	M	M	L

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

UNIT I: INTRODUCTION **9**

Extensometers – Types – Mechanical, Electrical, Electronic and Optical – Review of bridge circuits.

UNIT II: STRAIN GAUGE TECHNIQUES **9**

Strain gauge and transducers for measurement of static and dynamic loads – Instrumentation, measurement and recording systems.

UNIT III: PHOTO ELASTIC TECHNIQUES **9**

Stress analysis by two- and three-dimensional photo elasticity – Interpretation of stress patterns – Typical applications – Description and users of reflection polariscope.

UNIT IV: NON – DESTRUCTIVE TESTING **9**

Fundamentals of NDT. Radiography, ultrasonic, Holography, Laser holography magnetic particle inspection, fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique, Moire fringes — Grid methods.

UNIT V: OTHER TECHNIQUES **9**

Stress analysis by stress coat —Induction heating instrumentation, measurement and recording techniques – Creep testing. X-ray – applications. Fundamentals of brittle coating methods, Introduction to Moiré techniques, ultrasonic C- Scan, Thermograph, Fiber – optic Sensors.

TOTAL: 45 HOURS

TEXT BOOKS

1. J.W. Dally and M.F. Riley, "Experimental Stress Analysis", McGraw-Hill Book Co., New York, 1988.
2. Srinath,L.S., Raghava,M.R., Lingaiah,K. Gargesha,G.,Pant B. and Ramachandra,K. – Experimental Stress Analysis, Tata McGraw Hill, New Delhi, 1984
3. P. Fordham, "Non-Destructive Testing Techniques" Business Publications, London, 1988.

REFERENCES

1. M. Hetenyi, "Handbook of Experimental Stress Analysis", John Wiley & Sons Inc., New York, 1980.
2. G.S. Holister, "Experimental Stress Analysis, Principles and Methods", Cambridge University Press, 1987.
3. A.J. Durelli and V.J. Parks, "Moire Analysis of Strain", Prentice Hall Inc., Englewood Cliffs, New Jersey, 1980.

AE35A3	ADVANCED HEAT TRANSFER	L	T	P	C
		3	0	0	3

AIM

To make the students learn the various techniques in heat transfer applications

OBJECTIVE

To introduce the concepts of heat transfer and application of finite element methods in heat transfer which enable the students to design components subjected to thermal loading.

Course Outcome – COs		Cognitive Skill
CO-01	To understand the basics of heat transfer	U
CO-02	Evaluate the conductive heat transfer	E
CO-03	Evaluate the basic concepts of convective heat transfer	E
CO-04	Understand the basic radiative heat transfer	U
CO-05	Apply the finite element methods in heat transfer	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	M	N	N	S	M	N	S	L	L
CO-02	M	S	M	M	S	N	N	S	M	N	M	N	M
CO-03	S	M	M	L	M	N	N	M	M	N	S	L	M
CO-04	S	M	S	M	S	N	N	S	M	N	S	L	M
CO-05	S	M	M	L	N	N	N	L	M	N	M	M	M

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

UNIT I: BASICS OF HEAT TRANSFER 9

Basic review of heat transfer –Conduction – Fins - Convection -Radiation– Aerospace problems- Application of numerical methods.

UNIT II: CONDUCTIVE HEAT TRANSFER 9

Conduction – Convection systems – Numerical treatment of 1-D and 2-D heat conduction – Problems in Cartesian and polar coordinate systems – *conduction with heat generation* - Heat transfer problems in infinite and semi-infinite solids – 1-D Transient analysis.

UNIT III: CONVECTIVE HEAT TRANSFER 9

Convection- Numerical treatment of steady 1-D and 2-d heat convection-diffusion steady-unsteady problems- Computation of thermal boundary layer flows-Transient free convection from a heat vertical plate.

UNIT IV: RADIATIVE HEAT TRANSFER 9

Radiation- Numerical treatment of radiation problems- transient mixed convection and radiation from a vertical fin.

UNIT V:APPLICATIONS OF FINITE ELEMENT METHODS IN HEAT TRANSFER 9

Finite element equation for one dimensional heat conduction equations – Heat transfer in two dimensions – Shape function derivation, stiffness matrix and load vector for heat transfer 2D element – Numerical problems.

TOTAL: 45 HOURS

TEXT BOOKS

1. P. S. Ghoshdasidar , “Computer simulation of low and Heat transfer” McGraw-Hill Book Co., Inc., New Delhi, 1998.
2. C.S. Krishnamurthy, “Finite Elements Analysis”, Tata McGraw-Hill, 1987.
3. Yunus A. Cengel, Heat Transfer – A Practical Approach Tata McGraw Hill Edition, 2003
4. S.C. Sachdeva, “Fundamentals of Engineering Heat & Mass Transfer”, Wiley Eastern Ltd., New Delhi, 1981.

REFERENCES

1. John H. Lienhard, “A Heat Transfer Text Book”, Prentice Hall Inc., 1981.
2. J.P. Holman, “Heat Transfer”, McGraw-Hill Book Co., Inc., New York, 6th Edition, 1991.
3. John D. Anderson, JR” Computational Fluid Dynamics”, McGraw-Hill Book Co., Inc., New York.
4. T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002
5. C.Y.Chow, “Introduction to Computational Fluid Dynamics”, John Wiley, 1979.

AE35A4	AIRCRAFT DESIGN	L	T	P	C
		3	0	0	3

AIM

To make the students familiar with the designing of an aircraft

OBJECTIVE

To introduce and develop the basic concept of aircraft design

Course Outcome – COs		Cognitive Skill
CO-01	Identify the power plant and the procedures for the propeller configuration.	R
CO-02	Solve the calculations of takeoff, landing, gliding and manoeuvring flight.	U, An
CO-03	Knowledge about the estimation of static and dynamic stability analysis.	R,A
CO-04	Be clear in design of new prototype of aircrafts and able to present new layout or plan.	R,U
CO-05	Understand the various designs of wings, fuselage and other aircraft parts with good knowledge about the aircraft 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	S	S	S	S	S	M	M	M	M	M	S	L	S
CO-02	M	S	M	S	S	S	M	M	M	M	S	L	S
CO-03	S	S	M	S	S	L	M	M	M	L	S	L	S
CO-04	S	M	S	S	S	L	M	M	M	M	S	L	S
CO-05	M	M	S	S	S	L	M	M	M	L	S	L	S

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

UNIT I: INTRODUCTION TO AIRCRAFT CONCEPT DESIGN 9

Design process, flow chart, survey of various types of airplanes, over-view of design process – Airplane configuration description - Initial Airplane layout – Three view drawings – Take-off weight – Preliminary Estimate.

UNIT II: AIRCRAFT PERFORMANCE DESIGN 9

Selection of geometric and aerodynamic parameters – Weight estimation and balance diagram – Drag estimation of complete aircraft – Level flight, climb, take – off and landing calculations – range and endurance.

UNIT III: AIRCRAFT STABILITY DESIGN **9**

Static and dynamic stability estimates – control requirements. Maximum range of climb, shallow angle of climb, High Lift devices

UNIT IV: SPECIAL PROBLEMS & PROPULSION DESIGN **9**

Layout peculiarities of subsonic and supersonic aircraft – optimisation – of wing loading to achieve desired performance – loads on undercarriages and design requirements. Characteristics of different types of power plants – Propeller characteristics and selection – Relative merits of location of power plant.

UNIT V: AIRPLANE STRUCTURES 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. Raymer, D.P. Aircraft conceptual Design, AIAA series, 5th edition, 2012. 2. Torenbeck, E. Synthesis of Subsonic Airplane Design, Delft University Press, U.K. 1986.
2. G. Corning, “Supersonic & Subsonic Airplane Design”, II Edition, Edwards Brothers Inc., Michigan, 1953.
3. E.F. Bruhn, “Analysis and Design of Flight Vehicle Structures”, Tristate Offset Co., U.S.A., 1980.
4. A.A. Lebedenski, “Notes on airplane design”, Part-I, I.I.Sc., Bangalore, 1971.
5. 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.

AE35A5	ADVANCED PROPULSION SYSTEMS	L	T	P	C
		3	0	0	3

AIM

To make the students familiar with the concepts of new technologies in propulsion.

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 understand the thermodynamic cycle analysis of air-breathing propulsion systems.	R
CO-02	To analyse the concepts of ramjets and scramjet engines.	An
CO-03	To understand the nuclear propulsion system.	U
CO-04	To analyse the electric and ion propulsion systems.	An
CO-05	To Understand Solar rockets and radio isotope rockets.	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	M	M	S	L	S	N	N	L	S	L	L
CO-02	M	S	L	L	M	M	L	N	N	M	N	L	M
CO-03	S	M	M	L	S	L	M	N	N	L	M	L	L
CO-04	M	S	S	L	M	M	L	N	N	M	L	L	M
CO-05	S	M	M	M	L	M	M	N	N	L	L	M	L

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

UNIT I: AIR-BREATHING PROPULSION SYSTEMS 9

Introduction - Thermodynamic cycles - Air breathing propulsion systems – Working of Turbojet, turboprop, turbo fan and Air augmented rockets – Performance characteristics - Pulse jet engine – Thrust - Thrust augmentation and its types.

UNIT II: RAMJETS AND SCRAMJET ENGINES 10

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

UNIT III: NUCLEAR PROPULSION 8

Basic thruster technology - Working of Nuclear rocket engine - Nuclear rocket engine design and performance – nuclear rocket reactors – nuclear rocket nozzles – nuclear rocket engine control – Nuclear thermal rocket - Nuclear engine for rocket vehicle application

UNIT IV: ELECTRIC AND ION PROPULSION 8

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

UNIT V: SOLAR ROCKET AND RADIO ISOTOPE PROPULSION 9

Working of solar rocket engine - Solar sail – Concept of nozzle less propulsion - Pulsed inductive thruster – Variable specific impulse magneto plasma rocket (VASIMR) – Vacuum arc thruster - radioisotope propulsion - nozzle performance of radio isotope propulsion systems.

TOTAL: 45 HOURS

TEXT BOOKS

1. G.P. Sutton, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 1998.
2. William H. Heiser and David T. Pratt, Hypersonic Airbreathing propulsion, AIAA Education Series, 2001.

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.

AE35A6	SPACE MECHANICS	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of space mechanics

OBJECTIVE

To study the basic concepts of orbital Mechanics with particular emphasis on interplanetary trajectories.

Course Outcome – Cos		Cognitive Skill
CO-01	Understanding the basic concepts of space mechanics	R
CO-02	Analyze the general n-body problem.	U
CO-03	Understand the satellite injection and satellite orbit perturbations.	S
CO-04	Analyze the interplanetary trajectories	An
CO-05	Evaluate the ballistic missile trajectories 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	M	M	M	S	L	S	N	N	L	S	L	L
CO-02	M	S	L	L	M	M	L	N	N	M	N	L	M
CO-03	S	M	M	L	S	L	M	N	N	L	M	L	L
CO-04	M	S	S	L	M	M	L	N	N	M	L	L	M
CO-05	S	M	M	M	L	M	M	N	N	L	L	M	L

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

UNIT I: INTRODUCTION TO SPACE MECHANICS **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 INJECTIONAND 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 6

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

UNIT V: BALLISTIC MISSILE TRAJECTORIES AND MATERIALS 13

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. Cornelissen, 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.

AE35A7	HYPERSONIC AERODYNAMICS	L	T	P	C
		3	0	0	3

AIM

To make the students familiar with the methods of high-speed aerodynamics

OBJECTIVE

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

Course Outcome - COs		Cognitive Skill
CO-01	To understand the fundamentals of hypersonic aerodynamics	U, An
CO-02	To apply simple solution methods for hypersonic inviscid flows	A,U
CO-03	To analyze the viscous hypersonic flow theory	An, R
CO-04	To apply the viscous interactions in hypersonic flows	A,U
CO-05	To apply the high temperature effects in hypersonic flows	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	L	M	M	L	L	L	L	L	M	M	L	L
CO-02	M	M	L	L	M	L	M	L	L	L	L	M	L
CO-03	S	M	L	L	L	L	M	L	M	L	L	M	L
CO-04	M	S	M	L	L	L	L	M	L	M	L	L	M
CO-05	M	M	L	L	M	L	L	L	M	L	M	L	L

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

UNIT I: FUNDAMENTALS OF HYPERSONIC AERODYNAMICS 9

Introduction to hypersonic aerodynamics – differences between hypersonic aerodynamics and supersonic aerodynamics - concept of thin shock layers and entropy layers – hypersonic flight paths – hypersonic similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT II: SIMPLE SOLUTION METHODS FOR HYPERSONIC INVISCID FLOWS 9

Local surface inclination methods – Newtonian theory – modified Newtonian law – tangent wedge and tangent cone and shock expansion methods – approximate methods - hypersonic small disturbance theory – thin shock layer theory.

UNIT III: VISCOUS HYPERSONIC FLOW THEORY 9

Boundary layer equations for hypersonic flow – hypersonic boundary layers – self similar and non self-similar boundary layers – solution methods for non-self-similar boundary layers – aerodynamic heating and its adverse effects on airframe.

UNIT IV: VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9

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

UNIT V: HIGH TEMPERATURE EFFECTS in HYPERSONIC FLOWS 9

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

TOTAL: 45 HOURS

TEXT BOOK

1. John D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", Mc.Graw hill Series, New York, 1996.

REFERENCES

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

AE35A8	MECHANICS OF STRUCTURAL IMPACT	L	T	P	C
		3	0	0	3

AIM

To make the students equipped in the concepts of structural impact.

OBJECTIVE

To provide student with a fundamental knowledge of impact mechanics and model the basic structural impact mechanics problems.

Course Outcome – COs		Cognitive Skill
CO-01	To understand basic concepts of structural impact	R
CO-02	To analyze the concepts of multi-dimensional structural impact mechanics	An
CO-03	To understand the concept of constitutive models for material deformation and plasticity.	U
CO-04	To apply the concept of experimental impact mechanics	A
CO-05	To synthesis the concept of computational impact mechanics	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	M	M	S	M	N	N	M	S	N	M	M	M
CO-02	M	S	L	N	L	M	N	L	M	N	S	M	S
CO-03	S	M	S	S	L	N	N	M	S	N	S	L	M
CO-04	M	S	S	M	N	L	N	M	M	N	M	M	L
CO-05	M	S	M	M	M	S	N	M	N	N	M	S	S

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

UNIT I: INTRODUCTION TO STRUCTURAL IMPACT 9

Introduction to Structural Impact, Rigid Body Impact Mechanics, Coefficient of Restitution, Oblique Impact, One Dimensional Impact Mechanics of Deformable Bodies,1-D Wave Propagation in Solids Induced by Impact.

UNIT II: MULTI DIMENTIONAL STRUCTURAL IMPACT MECHANICS 9

Analysis of Stress, Mohr's Circles, Octahedral Stress, Decomposition into Hydrostatic and Pure States, Equation of motion of body in Cartesian, Cylindrical, Spherical coordinates, Analysis of Strain, Linearized Stress Strain Relations, Wave propagation in infinite and semi-infinite media

UNIT III: MODELLING OF DEFORMATION AND FAILURE 9

Constitutive models for material deformation and plasticity, Isotropic and Kinematic Hardening, Thermo Elastic Plastic, Power law, Johnson-Cook, Zerilli – Amstrong,,Steinberg-Guinan, Constitutive models for composites, Failure and damage models

UNIT IV: EXPRIMENTAL IMPACT MECHANICS 9

Quasi-static material test, Pendulum Impact Test, Split-Hopkinson's Bar Test, Taylor Cylinder Test, Drop Impact Test, Drop Weight Impact Test

UNIT V: COMPUTATIONAL IMPACT MECHANICS 9

Principles of numerical formulations, Classical continuum methods, Particle based Methods, Meshless Methods, Numerical Integration Methods, and Contact Impact Considerations.

TOTAL: 45 HOURS

TEXT BOOKS

1. C. Lakshmana Rao, V.Narayanamurthy, K. R. Y. Simha, Applied Impact Mechanics,2016 Print ISBN:9781119241805
2. W.J.Stronge, Impact Mechanics, Cambridge University Press January 2010 doi.org/10.1017/CBO9780511626432
3. Norman Jones Structural Impact, February 2012,isbn: 9781139200493

REFERENCES

1. Stefan Hiermaier, Structures Under Crash and Impact: Continuum Mechanics,2010
2. Tod A. Laursen, Computational Contact and Impact Mechanics: Springer Publications 2014
3. C. A. Brebbia, Advances in Dynamics and Impact Mechanics, 2003

E-BOOKS

1. onlinelibrary.wiley.com/doi/book/10.1002/9781119241829
2. books.google.co.in/books/about/Impact_Mechanics.html?id=nHgcS0bfZ28C&redir_esc=y
3. http://admin.cambridge.org/academic/subjects/engineering/solid-mechanics-andmaterials/structural-impact-2nd-edition

AE35A9	EXPERIMENTAL METHODS IN FLUID MECHANICS	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of experimental analysis of fluid flow

OBJECTIVES

- To learn basic principles of fluid properties measuring instruments
- To learn the rate of flow in wind tunnel.
- To learn experiments and drawing to measure the pressure, velocity and Temperature

Course Outcome – Cos		Cognitive Skill
CO-01	Understanding basic principles of fluid properties measuring instruments	U
CO-02	Evaluation of the rate of flow in wind tunnel.	E
CO-03	Conducting experiments and methods in various flow visualisation instruments.	An
CO-04	Conducting experiments and drawing to measure the pressure, velocity and Temperature	S
CO-05	Model study in data acquisition and 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	S	M	M	S	M	N	N	M	S	N	M	M	M
CO-02	M	S	L	N	L	M	N	L	M	N	S	M	S
CO-03	S	M	S	S	L	N	N	M	S	N	S	L	M
CO-04	M	S	S	M	N	L	N	M	M	N	M	M	L
CO-05	M	S	M	M	M	S	N	M	N	N	M	S	S

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

UNIT I: INTRODUCTION TO MEASUREMENTS 8

Objective of experimental studies – Fluid mechanics measurements – Properties of fluids – Measuring instruments – Performance terms associated with measurement systems – Direct measurements - Analogue methods – Flow visualization –Components of measuring systems – Importance of model studies - Experiments on Taylor-Proudman theorem and Ekman layer – Measurements in boundary layers -

UNIT II: WIND TUNNEL MEASEUREMENTS 8

Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel – Instrumentation and calibration of wind tunnels – Turbulence- Wind tunnel balance – Principle and application and uses – Balance calibration.

UNIT III: FLOW VISUALIZATION AND ANALOGUE METHODS 10

Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Shadowgraph - Schlieren system – Background Oriented Schlieren (BOS) System - Hydraulic analogy – Hydraulic jumps – Electrolytic tank

UNIT IV: PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS 10

Pitot-Static tube characteristics - Velocity measurements - Hot-wire anemometry – Constant current and Constant Temperature Hot-Wire anemometer – Hot-film anemometry – Laser Doppler Velocimetry (LDV) – Particle Image Velocimetry (PIV) – Pressure Sensitive Paints - Pressure measurement techniques - Pressure transducers – Temperature measurements.

UNIT V: DATA ACQUISITION SYSTEMS 9

Data acquisition and processing – Signal conditioning - Estimation of measurement errors

TOTAL: 45 HOURS

TEXT BOOKS

1. Rathakrishnan, E., “Instrumentation, Measurements, and Experiments in Fluids,” CRC Press – Taylor & Francis, 2007.

REFERENCES

1. Robert B Northrop, “Introduction to Instrumentation and Measurements”, Second Edition, CRC Press, Taylor & Francis, 2006.

AE35B1	INDUSTRIAL AERODYNAMICS	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of interaction of aerodynamic forces with different bodies

OBJECTIVE

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

Course Outcome - COs		**Cognitive Skill**
CO-01	To understand the basics of atmospheric boundary layer	U,An
CO-02	To analyze the bluff body aerodynamics	An,R
CO-03	To synthesis the wind energy colletors	S,A
CO-04	To evaluate the basics of building aerodynamics	E,A
CO-05	To remember the flow induced vibrational concepts.	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	L	M	L	M	L	M	L	L	M
CO-02	M	L	L	M	L	M	L	L	M	L	M	L	M
CO-03	M	M	L	M	L	M	L	L	M	M	L	L	L
CO-04	S	M	L	L	M	L	M	L	L	M	L	L	L
CO-05	S	M	L	M	L	L	L	M	L	L	L	L	L

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

UNIT I: ATMOSPHERIC BOUNDARY LAYER 9

Atmospheric circulation-local winds – terrain types – mean velocity profiles- power law and logarithmic law, wind speeds, turbulence profiles, Roughness parameters – simulation techniques in wind tunnels

UNIT II: BLUFF BODY AERODYNAMICS 9

Boundary layers and separation, 2-D wake and vortex formation, Strouhal and Reynolds numbers, separation and reattachments, power requirements and drag coefficients of automobiles, effect of cut back angle, and aerodynamics of trains, Aerodynamics of Hovercraft.

UNIT III: WIND ENERGY COLLETORS 9

Horizontal and vertical axis machines, energy density of different rotors, power coefficient, Betz coefficient by momentum theory.

UNIT IV: BUILDING AERODYNAMICS 10

Pressure distribution on low rise buildings, wind forces on buildings, environmental winds in city blocks, and special problems of tall buildings, building codes, ventilation and architectural aerodynamics.

UNIT V: FLOW INDUCED VIBRATION **8**

Vortex shedding, effect of Reynolds number on wake formation in turbulent flows, across wind galloping, wake galloping, along wind galloping of circular cables, oscillation of tall structures and launch vehicles under wind loads, stall flutter.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Gino Sovran, "Aerodynamics Drag Mechanisms of Bluff Bodies and Road Vehicles" Springer;2012
2. Sachs P, "Wind Forces in Engineering:, Pergamon Press,1988
3. Tom Lawson, Building Aerodynamics", Imperial College Press; first edition, 2001
4. Steven R.H, Rex E.B., "Wind Flow and Vapor Cloud Dispersion at Industrial and Urban Sites", John Wiley& Sons, 2003.
5. Blevins R.D., "Flow Induced Vibrations", Van Nostrand, 1990.
6. Wolf-Heinrich Hucho, "Aerodynamics of Road Vehicles. From Fluid Mechanics to Vehicle Engineering" Butterworth-Heinemann Ltd, Year: 1987.
7. Antony Wood, "Wind Tunnel Testing of High-Rise Buildings" Routledge Publisher, 2013.
8. Wind tunnel testing for buildings and other structures : ASCE/SEI 49-12, American Society of Civil Engineers, Year: 2012

REFERENCES:

1. J. B. Barlow, W. H. Rae, A. Pope, "Low Speed Wind Tunnel Testing", John Wiley & Sons Publisher, 1999.
2. John D.Holmes, "Wind Loading of Structures", CRC Press, second Edition, 2007

AE35B2	FATIGUE AND FRACTURE MECHANICS	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of fracture mechanics

OBJECTIVES

- To learn to analyse the fracture due to fatigue.
- To learn the theory for analysis of unstable fracture in materials.
- To learn the basic mechanisms of fatigue crack initiation and growth in metals.

Course Outcome - COs		Cognitive Skill
CO-01	Explain about effect of mean stress, notches and stress concentration and S-N curves	U
CO-02	Ability to perform low cycle and high cycle fatigue and cycle counting techniques	A
CO-03	Ability to analyse the crack growth and final fracture.	An
CO-04	Understand the theory for analysis of unstable fracture in materials	E
CO-05	Ability to analyse the elastic plastic fracture mechanics.	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	L	S	S	N	N	N	L	S	N	S
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	L	L	S	M	M	N	N	N	N	L	M	L	S
CO-05	S	M	M	S	L	N	N	M	L	S	L	M	N

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

UNIT I: FATIGUE OF STRUCTURES 10

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

UNIT II: STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR 8

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

UNIT III: PHYSICAL ASPECTS OF FATIGUE 5

Phase in fatigue life – Crack initiation – Crack growth – Final fracture – Dislocations – Fatigue fracture surfaces.

UNIT IV: FRACTURE MECHANICS 15

Strength of cracked bodies – potential energy and surface energy – Griffith's theory – Irwin – Orwin 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: ELASTIC PLASTIC FRACTURE MECHANICS 7

Fracture beyond general yield. The Crack-tip opening displacement. The Use of CTOD criteria. Experimental determination of CTOD. Parameters affecting the critical CTOD, Use of J integral, Limitation of J integral.

TOTAL: 45 HOURS

TEXT BOOKS:

1. D.Brock, "Elementary Engineering Fracture Mechanics", Noordhoff International Publishing Co., London, 1994.
2. Anderson, **"Fracture Mechanics-Fundamental and Application"** -,T.L CRC press1998
3. J.F.Knott, "Fundamentals of Fracture Mechanics", Butterworth & Co., (Publishers) Ltd., London, 1983.

REFERENCES:

1. W.Barrois and L.Ripley, "Fatigue of Aircraft Structures", Pergamon Press, Oxford, 1983.
2. C.G.Sih, "Mechanics of Fracture", Vol.1 Sijthoff and Noordhoff International Publishing Co., Netherland, 1989.
3. Engineering fracture mechanics - S.A. Meguid Elsevier.
4. Fracture of Engineering Brittle Materials, Applied Science - Jayatilake, London.
5. Fracture and Fatigue Control in Structures- Rolfe and Barsom, Prentice Hall.

AE35B3	HIGH TEMPERATURE GAS DYNAMICS	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of interaction of gas with high temperature

OBJECTIVE:

To create the students with basic knowledge and understanding in High Temperature Gas Dynamics.

Course Outcome – Cos		Cognitive Skill
CO-01	To understand the nature of high temperature and their effects on fluid flows	R
CO-02	To understand the concept of statistical thermodynamics and microscopic description of gasses	U
CO-03	To analyse the viscous high temperature flows	An
CO-04	To evaluate the equilibrium and non-equilibrium conditions in inviscid hypersonic flows	E
CO-05	To know the salient aspects of transport phenomena in high temperature gases.	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	M	M	M	L	N	L	N	N	S	L	L
CO-02	M	S	L	L	S	M	N	L	M	N	N	M	N
CO-03	S	M	S	M	S	M	N	L	N	N	L	M	M
CO-04	S	M	M	L	L	L	N	L	N	N	M	L	M
CO-05	M	M	L	L	S	M	N	N	N	N	L	L	M

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

UNIT I: INTRODUCTION **8**

Nature of high temperature flows – Chemical effects in air – Real perfect gases – Gibb's free energy and entropy by chemical and non-equilibrium – Chemically reacting mixtures.

UNIT II: STATISTICAL THERMODYNAMICS **8**

Introduction to statistical thermodynamics – Relevance to hypersonic flow - Microscopic description of gases – Boltzman distribution – Cartesian function

UNIT III: VISCOUS HIGH TEMPERATURE FLOWS **9**

Introduction, Governing Equations for Chemically Reacting Viscous Flow, Alternate Forms of the Energy Equation, Boundary-Layer Equations for a Chemically Reacting Gas, Boundary Conditions: Catalytic Walls, Boundary-Layer Solutions: Stagnation-Point Heat Transfer for a Dissociating Gas, Parabolized Navier-Stokes Solutions to Chemically Reacting Flows.

UNIT IV: INVISCID HIGH TEMPERATURE FLOWS **10**

Equilibrium and non – equilibrium flows – governing equations for inviscid high temperature equilibrium flows – equilibrium normal and oblique shock wave flows – frozen and equilibrium

flows – equilibrium conical and blunt body flows – governing equations for non-equilibrium inviscid flows.

UNIT V: TRANSPORT PROPERTIES IN HIGH TEMPERATURE GASES 10

Transport coefficients – mechanisms of diffusion – total thermal conductivity – transport characteristics for high temperature air – radiative transparent gases – radiative transfer equation for transport, absorbing and emitting gases.

TOTAL: 45 HOURS

TEXT BOOKS

1. John D. Anderson, Jr., Hypersonic and High Temperature Gas Dynamics, McGraw-Hill Series, New York, 1996.
2. John D. Anderson, Jr., Modern Compressible Flow with Historical perspective, McGraw-Hill Series, New York, 1996.

REFERENCES

1. William H. Heiser and David T. Pratt, Hypersonic Air breathing propulsion, AIAA Education Series.
2. John T. Bertin,Hypersonic Aerothermodynamics publishers - AIAA Inc., Washington, D.C.,1994.
3. T.K.Bose, High Temperature Gas Dynamics.

AE35B4	BOUNDARY LAYER THEORY	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of boundary layer interaction with fluid

OBJECTIVES

- To learn the fundamental equations of viscous flow
- To learn the solutions of viscous flow equations
- To learn the solutions for laminar flow boundary layer equations

Course Outcome - COs		Cognitive Skill
CO-01	Outline the fundamental equations of viscous flow	R
CO-02	To understand the solutions of viscous flow equations	U
CO-03	To analyze the solutions for turbulent flow boundary layer equations	An
CO-04	To Find the solutions for turbulent flow through the pipe	A
CO-05	To evaluate the solutions for thermal boundary layer equations	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	S	M	M	N	M	M	S	M	M	M
CO-02	M	S	L	N	L	M	S	L	L	S	S	M	S
CO-03	S	S	S	S	S	L	S	M	M	M	S	L	M
CO-04	S	L	S	M	N	L	S	S	M	S	M	M	S
CO-05	M	L	M	M	M	L	N	S	M	M	M	S	S

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

UNIT I: BASIC CONCEPTS OF VISCOUS FLOWS **9**

Viscous flow characteristics, introduction to hydrodynamic and thermal boundary layer theory, governing equations with effect of viscosity, flow over the flat plate at zero incidences, boundary layer thickness, displacement thickness, momentum thickness, energy thickness, boundary layer equation and their general properties - Navier-Stokes Equations.

UNIT II: SOLUTIONS TO BOUNDARY LAYER FLOWS **9**

Flat plate at zero angle of incidence, method of exact solution - Blassius solution to boundary layer problems, Approximate solutions - Vonkarman solution to boundary layer flows over the flat plate, flow with pressure gradient, flow over a cylinder, plane Couette flow, circular Couette flow, flow between parallel plates - numerical problems

UNIT III: TURBULENT BOUNDARY LAYER **9**

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

UNIT IV: TURBULENT FLOW THROUGH PIPE **9**

Flow thorough pipe, governing equations and velocity profile for fully developed flow through pipe, effect of roughness, smooth pipes, relation between laws of friction & velocity distribution – Numerical problems

UNIT V: THERMAL BOUNDARY LAYER **9**

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

TOTAL: 45 HOURS

TEXT BOOKS

1. H. Schlichting, “Boundary Layer Theory”, McGraw-Hill, New York, 1979.
2. Frank White – Viscous Fluid flow – McGraw Hill, 1998

REFERENCES

1. A. J. Reynolds, “Turbulent flows in Engineering”, John Wiley & Sons, 1980.
2. Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, “Fluid Mechanics and Machinery”, 2011.
3. Ronald L., Panton, “Incompressible fluid flow”, John Wiley & Sons, 1984.
4. Tuncer Cebeci and Peter Bradshaw, “Momentum transfer in boundary layers”, Hemisphere Publishing Corporation, 1977.

AE35B5	THEORY OF VIBRATION	L	T	P	C
		3	0	0	3

AIM

To make the students learn about the concepts of vibration

OBJECTIVE

Students will get the detailed knowledge about the analysis of vibration detailed knowledge about the analysis of vibration

Course Outcome - COs		Cognitive Skill
CO-01	Explain about the free, forced, damped, un damped and vibration measuring instrument	R, U
CO-02	Calculate natural frequency for two Degrees and Multi degrees of Freedom Systems	An
CO-03	Apply the natural frequency of a system using approximate methods	E
CO-04	Outline the application of elements of aero-elasticity	R
CO-05	Ability to analyse the computational technique in vibration and beam element.	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	L	M	M	S	N	L	L	N	L	L	S
CO-02	M	M	L	S	M	L	N	N	L	N	L	M	S
CO-03	S	M	M	S	M	L	L	N	L	M	L	M	M
CO-04	M	M	L	M	L	M	L	L	L	L	M	M	L
CO-05	S	L	M	L	S	M	M	M	M	N	S	N	N

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

UNIT I: SINGLE DEGREE OF FREEDOM SYSTEMS 10

Introduction to simple harmonic motion, D'Alembert's Principle, Free vibrations –Damped vibrations – Forced Vibrations, with and without damping – supportexcitation – Vibration measuring instruments.

UNIT II: MULTI DEGREES OF FREEDOM SYSTEMS 10

Two degrees of freedom systems - Static and Dynamic couplings – vibrationabsorber- Principal co-ordinates - Principal modes and orthogonal condition – Eigenvalue problems - Hamilton's principle - Lagrangean equations and application.

UNIT III: CONTINUOUS SYSTEMS & APPROXIMATE METHODS 9

Vibration of elastic bodies - Vibration of strings - Longitudinal - Lateral and TorsionalVibration, Approximate methods - Rayleigh's method - Dunkerlay's method – Rayleigh-Ritz method, Matrix Iteration method.

UNIT IV: ELEMENTS OF AEROELASTICITY 8

Vibration due to coupling of bending and torsion - Aeroelastic problems – Collarstriangle - Wing Divergence - Aileron Control reversal – Flutter – Buffeting.

UNIT V: SOLUTION METHOD 8

Computational technique in vibration, Vibrating string, General method, Beam element, Global matrices, Transformation of matrices, Equation of motion of complete system, Consistent and Lombard mass.

TOTAL: 45 HOURS

TEXT BOOKS

1. Thomson W T, 'Theory of Vibration with Application' - CBS Publishers, 1990.
2. G.K.Grover, "Mechanical Vibrations", 7th Edition, Nem Chand Brothers, Roorkee,India, 2003.

REFERENCES

1. Timoshenko S., Vibration Problems in Engineering – John Wiley and Sons, NewYork, 1993.
2. Bisplinghoff R.L., Ashely H and Hogman R.L., Aeroelasticity – Addision WesleyPublication, New york, 1983.
3. William W Seto, 'Mechanical Vibrations' – McGraw Hill, Schaum Series.
4. TSE. F.S., Morse, I.F., Hunkle, R.T., Mechanical Vibrations – Prentice Hall,New York, 1984.
5. Leonard Meirovitch, 'Elements of Vibration Analysis' – McGraw Hill InternationalEdition Clarence W DeSilva, `Vibration – Fundamentals and Practice', CRCPress, Special Indian Edition, 2005.

AE35B6	CRYOGENICS	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of low temperature oxygen

OBJECTIVE

To study the engineering concept of cryogenic and its application in various field

Course Outcome - COs		Cognitive Skill
CO-01	To gain knowledge on fundamental concept of cryogenic engineering	R
CO-02	To understand the concept of cryogenic system.	U
CO-03	Ability to evaluate the concepts of gas liquefaction systems	E
CO-04	Ability to apply the cryogenic fluid storage and transfer system	A
CO-05	To analyse the cryogenic instrumentation.	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	L	M	S	N	L	L	N	L	L	L
CO-02	S	S	L	S	M	L	N	N	M	N	L	M	M
CO-03	M	M	L	S	M	S	L	N	L	N	S	M	M
CO-04	M	S	N	S	L	S	L	L	M	N	M	M	L
CO-05	M	S	M	S	S	M	N	M	M	N	S	N	N

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

UNIT I: FUNDAMENTALS OF CRYOGENICS **9**

Introduction to Cryogenic Systems, Historical development, Low Temperature properties of Engineering Materials, Mechanical properties- Thermal properties- Electric and magnetic properties – Cryogenic fluids and their properties.

Applications of Cryogenics: Applications in space, Food Processing, super conductivity, Electrical Power, Biology, Medicine, Electronics and Cutting Tool Industry. Low temperature properties of engineering materials

UNIT II: CRYOGENIC SYSTEMS **9**

Liquefaction systems ideal system, Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Claude & Cascaded System, Magnetic Cooling, Stirling Cycle Cryo Coolers.

UNIT III: GAS LIQUEFACTION SYSTEMS **9**

Introduction-Production of low Temperatures-General Liquefaction systems- Liquefaction systems for Neon. Hydrogen and Helium –Critical components of Liquefaction systems.

Cryogenic Refrigeration systems: Ideal Refrigeration systems. Refrigeration using liquids and gases as refrigerant- Refrigerators using solids as working media

UNIT IV: CRYOGENIC FLUID STORAGE AND TRANSFER SYSTEMS **9**

Cryogenic Storage vessels and Transportation, Thermal insulation and their performance at cryogenic temperatures, Super Insulations, Vacuum insulation, Powder insulation, Cryogenic fluid transfer systems.

UNIT V: INSTRUMENTATION **9**

Cryogenic instrumentation, Pressure flow-level and temperature measurements. Types of heat exchangers used in cryogenic systems (only description with figure) Cryo pumping Applications

TOTAL: 45 HOURS

TEXT BOOKS

1. J. H. Boll Jr, Cryogenic Engineering
2. R. B. Scott, Cryogenic Engineering, Van Nostrand Co., 1959
3. Randal F.Barron, Cryogenic systems, McGraw Hill, 1986

REFERENCE BOOKS:

1. Klaus D.Timmerhaus and Thomas M.Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.

AE35B7	AVIONICS	L	T	P	C
		3	0	0	3

AIM

To make the students familiarize the concept of avionic systems

OBJECTIVE

To introduce the basic concepts of navigation & communication systems of aircraft.

Course Outcome - COs		Cognitive Skill
CO-01	Recognize avionics terminology and avionics in civil and military aircraft and space and system.	U
CO-02	Evaluate the principles of digital systems in avionics.	E
CO-03	Demonstrate avionics system architecture and salient features as well as applications of data buses.	A
CO-04	Evaluate the various types of display technologies used in the aviation.	E
CO-05	Understand the various design methodology and certification process of avionics systems.	S

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

Mapping of Course Outcome with Programme Outcome

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

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

UNIT I: INTRODUCTION TO AVIONICS 8

Need for Avionics in civil and military aircraft and space systems – Integrated Avionics system – Typical avionics sub systems – Design approaches and recent advances - Application Technologies.

UNIT II: PRINCIPLES OF DIGITAL SYSTEMS 10

Digital Computers – Digital number system- number systems and codes-Fundamentals of logic and combinational logic circuits –Digital arithmetic – interfacing with analogue systems - Microprocessors – Memories.

UNIT III: DIGITAL AVIONICS ARCHITECTURE 8

Avionics system architecture– salient features and applications of Data buses MIL–STD 1553 B–ARINC 429–ARINC 629.

UNIT IV: FLIGHT DECK AND COCKPITS 9

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

UNIT V: AVIONICS SYSTEMS 10

Communication Systems - Navigation systems - Flight control systems - Radar electronic warfare - Utility Systems Reliability and maintainability - Certification.

TOTAL: 45 HOURS

TEXT BOOKS

1. Malcrno A.P. and Leach, D.P., "Digital Principles and Application", Tata McGraw-Hill, 1990.
2. Gaonkar, R.S., "Microprocessors Architecture – Programming and Application", Wiley and Sons Ltd., New Delhi, 1990.

REFERENCES

1. Middleton, D.H., Ed., "Avionics Systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989.
2. Spitzer, C.R., "Digital Avionic Systems", Prentice Hall, Englewood Cliffs, N.J., USA., 1987.
3. Brain Kendal, "Manual of Avionics", The English Book House, 3rd Edition, New Delhi, 1993.

LIST OF OPEN ELECTIVES

SI. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	AE35B8	Aircraft Composite Materials & Structures	3	0	0	3

AE35B8	AIRCRAFT COMPOSITE MATERIALS AND STRUCTURES	L	T	P	C
		3	0	0	3

AIM

To make the students learn about the composites used in aircrafts.

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 stress strain relation	U
CO-02	Evaluate the method of analysis	E
CO-03	Analyze and remember the concept of sandwich construction	An
CO-04	Understand and evaluate the exact fabrication process	E
CO-05	Understanding and Analyze mechanical properties and testing	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	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: LAMINATED PLATES 10

Governing differential equation for a general laminate, angle ply and cross ply laminates. Failure criteria for composites.

UNIT III: SANDWICH CONSTRUCTIONS 9

Basic design concepts of sandwich construction -Materials used for sandwich construction - Failure modes of sandwich panels.

UNIT IV: FABRICATION PROCESS 8

Various Open and closed mould processes. Manufacture of fibers – Types of resins and properties and applications – Netting analysis – Thermal Protection Applications.

UNIT V: MECHANICAL PROPERTIES AND TESTING 10

Mechanism of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell) Impact test (Izod and Charpy), Fatigue and Creep test.

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.