M. TECH. AEROSPACE ENGINEERING

SYLLABI 2015
(REGULAR)

Department of Aerospace Engineering
FACULTY OF ENGINEERING

KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University Established Under Section 3 of UGC Act 1956)

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M. TECH. AEROSPACE ENGINEERING (FULL TIME)

15MTAS101 APPLIED MATHEMATICS FOR AEROSPACE ENGINEERING 3 1 0 4 100
INTENDED OUTCOMES:

- The engineers will have an exposure on various topics such as Integral Equations, Calculus of Variations, Differential equations, Interpolation and Integration and Linear Programming problems to understand their applications in engineering problems.

UNIT - I INTEGRAL EQUATIONS

Introduction – conversion of a linear differential equation to an integral equations and vice versa – conversion of boundary value problem to integral equations using Green's function – solution of a integral equation – integral equations of the convolution type – Abel's integral equations –integro– differential equations – integral equations with separable kernels – solution of Fredholm equations with separable kernels.

UNIT - II DIFFERENTIAL EQUATIONS – NONLINEAR ORDINARY DIFFERENTIAL & PARTIAL DIFFERENTIAL EQUATIONS

Introduction – Equations, with separable variables – Equations reducible to linear form – Bernoulli's equation – Riccati's equation – Special forms of Riccati's equation – Laplace transform methods for one dimensional wave equation – Displacement in a long string – Longitudinal vibration of an elastic bar.

UNIT - III CALCULUS OF VARIATIONS

Introduction – Euler's equation – several dependent variables Lagrange's equations of Dynamics – Integrals involving derivatives higher than the first – Problems with constraints – Direct methods and eigen value problems – Rayeligh- Ritz method.

UNIT - IV INTERPOLATION AND INTEGRATION

Hermite's Interpolation – Cubic Spline Interpolation – Gaussian Quadraline – Cubature.

UNIT - V LINEAR PROGRAMMING PROBLEM

Simplex algorithm – Two phase and Big M Techniques – Duality theory – Dual simplex method – Integer programming

TEXT BOOKS:

S. No.	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Dr. Grewal B.S.	Higher Engineering Mathematics	40th edition, , Khanna Publishers	2011
2	Stephenson, G, Radmore, P.M	Advanced Mathematical Methods for Engineering and Science students	Cambridge University Press	1999

REFERENCES:

S. No.	Author(s) Name	Title of the book	Publisher	Year of Publication
1	Kreyszig,E	Advanced Engineering Mathematics	John Wiley & Sons, New Delhi.	2007
2	Gupta, A.S.	Calculus of Variations with Applications	Prentice Hall of India Pvt. Ltd., New Delhi	2008
3	Sankara Rao, K.	Introduction to Partial Differential Equations	Prentice Hall of India Pvt. Ltd., New Delhi	2010

WEBSITES:

1. www.mathworks.com
2. nptel.ac.in
3. www.mathworld.com

15MTAS102 LAUNCH VEHICLE AERODYNAMICS 3 1 0 4 100

INTENDED OUTCOMES:
To understand the behavior of airflow over bodies with particular emphasis on airfoil sections in the incompressible flow regime. Students will learn the concept of high speed aerodynamics and configurations of launch vehicles.

UNIT I BASIC HIGH SPEED AERODYNAMICS
Compressible flows-Isentropic relations- Isentropic flows , Normal shock , Oblique shock and expansion waves, compressibility effects on aerodynamic Coefficients, mathematical relations of flow properties across shock and expansion waves-fundamentals of Hypersonic Aerodynamics

UNIT II BOUNDARY LAYER THEORY
Basics of boundary layer theory-compressible boundary layer-shock shear layer interaction-Aerodynamic heating-heat transfer effects

UNIT III AERODYNAMIC ASPECTS OF LAUNCHING PHASE
Booster separation-cross wind effects-specific considerations in missile launching-missile integration and separation-methods of evaluation and determination- Stability and Control Characteristics of Launch
Vehicle Configuration- Wind tunnel tests

UNIT IV LAUNCH VEHICLE CONFIGURATIONS AND DRAG ESTIMATION
Types of Rockets and missiles-various configurations-components-forces on the vehicle during atmospheric flight-nose cone design and drag estimation

UNIT V AERODYNAMICS OF SLENDER AND BLUNT BODIES
Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles- determination of aero elastic effects.

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	J.D. Anderson	Fundamental of Aerodynamics-Fifth Edition	McGraw-Hill Book Co., New York.	2010
2.	Rathakrishnan.E	Gas Dynamics	Prentice Hall of India, New Delhi	2010

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Shapiro A.H	Dynamics and Thermodynamics of Compressible Fluid Flow	Ronald Press, New York	1982
2.	E.L. Houghton and N.B Caruthers	Aerodynamics for Engineering Students	Edward Arnold Publishers Ltd., London	1988
3.	Zucrow M.J and Anderson J.D	Elements of gas dynamics	McGraw-Hill Book Co., New York.	1989
4.	W.H. Rae and A. Pope	Low speed Wind Tunnel Testing	John Wiley Publications, New jersey.	1984

WEB REFERENCES:

www.grc.nasa.gov/
www.desktop.aero/appliedaero/compressibility/ssairfoils.html
naca.central.cranfield.ac.uk/reports/arc/rm/3051.pdf
www.potto.org/gasDynamics/node59.php
www.engineeringtoolbox.com/flow-meters-d_493.html

15MTAS103 AEROSPACE PROPULSION 3 1 0 4 100

INTENDED OUTCOMES:
To understand the principles of operation and design of aircraft and spacecraft power plants.
To study in detail about gas turbines, ramjet, fundamentals of rocket propulsion and chemical rockets.

UNIT I ELEMENTS OF AIRCRAFT PROPULSION

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 – Methods of Thrust augmentation.

UNIT II INLETS AND COMBUSTION CHAMBERS

Subsonic and supersonic inlets – Relation between minimum area ratio and external deceleration ratio – Starting problem in supersonic inlets –Modes of inlet operation. Classification of Combustion chambers - Combustion chamber performance – Flame tube cooling – Flame stabilization.

UNIT III COMPRESSORS AND TURBINES

Centrifugal compressor – Work done and pressure rise – Velocity diagrams – Elementary theory of axial flow compressor – degree of reaction – Impulse and reaction blading of gas turbines – Velocity triangles – Choice of blade profile, pitch and chord.

UNIT IV RAM JET, SCRAM JET PROPULSION AND NOZZLES

Principle of ramjets, Scramjet- problems relating to supersonic combustion-Integral ram rocket-sample Ramjet design calculations - jet nozzle – Efficiencies – Over expanded, under and optimum expansion in nozzles – Thrust reversal.

UNIT V ROCKET PROPULSION

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.

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Hill P.G and Peterson C.R	Mechanics and Thermodynamics of Propulsion	Pearson Publisher	2008
2.	Cohen H. Rogers G.F.C and Saravanamuttoo H.I.H	Gas Turbine Theory	Pearson Education; Fifth edition	2001

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	G.C. Oates	Aerothermodynamics of Aircraft Engine Components	AIAA Education Series, US.	1985
2.	G.P.Sutton	Rocket Propulsion Elements	John Wiley & Sons Inc., New York.	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., New Delhi.	1980
4.	Jack D. Mattingly	Elements of Gas Turbine Propulsion	Tata McGraw-Hill Education	2005

WEB REFERENCES:

www.elliott-turbo.com/
www.grc.nasa.gov/WWW/k-12/airplane/ramjet.html
www.uni-stuttgart.de/itlr/graduierten/grk_introduction.pdf
www.grc.nasa.gov/
www.jstor.org/stable/3101474

15MTAS104 AEROSPACE STRUCTURAL MECHANICS 3 0 0 3 100

INTENDED OUTCOMES:

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

UNIT I BENDING OF BEAMS

Elementary Theory of Bending – Bending moments - 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 AND CLOSED SECTIONS

Thin walled beams - Shear stress – Shear flow – Shear centre – Torsion and flexure of thin walled box type of structures – Flexural axis and axis of twist in open and closed sections.

UNIT III STIFFENED STRUCTURES

Shear flow in open and closed section with stiffeners - Analysis of rings and frames – Torsional shear flow in single and multi-cell tubes – Torsional and flexural shear flow in multi cell tubes.

UNIT IV STABILITY PROBLEMS

Stability problems of thin walled structures – Flexural, torsional and local failures – Influence of eccentricity and in elasticity – Buckling of plates and sheet stringer combinations - crippling loads – Tension field theory.

UNIT V ANALYSIS OF AEROSPACE STRUCTUREAL COMPONENTS

Missile structures- satellite – mini, micro structures. Crippling stresses by Needham's and Gerard's methods–Sheet stiffener panels- Effective width, Inter rivet and sheet wrinkling failures

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Megson T.M.G	"Aircraft Structures for Engineering Students" - 4th Edition	Butterworth-Heinemann, Jordan Hill, UK	2007
2.	Bruhn.E.H.	Analysis and Design of Flight vehicles Structures	Tri– state off set company, New York.	1985

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Peery D.J and Azar J.J	Aircraft Structures	McGraw-Hill, New York.	1993
2.	Stephen P. Tinnoshenko & S.woinowsky Krieger	Theory of Plates and Shells	McGraw-Hill, New York.	1990
3.	Rivello R.M	Theory and Analysis of Flight structures	McGraw-Hill, New York.	1993
4.	Lakshmi Narasaiah.G	Aircraft Structures	Routledge-BS publication, Hyderabad.	2011

WEB REFERENCES:

www.nasa.gov/centers/dryden/pdf/88569main_H-2206.pdf
www.sut.ac.th/engineering/civil/.../02_determinate_structures.pdf
www.ce.memphis.edu
www.roymech.co.uk/Useful_Tables/Mechanics/stress.html
http://aerostudents.com/files/aircraftStructuralAnalysis/bendingShearAndTorsion.pdf

15MTAS1E* **ELECTIVE-I** **3 0 0 3 100**

15MTAS111 AEROSPACE STRUCTURES LABORATORY 0 0 3 2 100

INTENDED OUTCOMES:

Study experimentally the load deflection characteristics of structural materials under different types of loads.

1. Verification of Castingliano's theorem.
2. Determination of membrane stresses in a thin cylinder under internal pressure.
3. Shear Centre Location for Open Section
4. Shear Centre Location for Closed Section
5. Flexibility Matrix for Cantilever Beam
6. Beam with Combined Loading
7. Calibration of Photo Elastic Materials
8. Stresses in Circular Disc Under Diametrical Compression – Photo Elastic Method
9. Stresses in Beams using Photo Elastic Method
10. Vibration of Beams with Different Support Conditions

S.No.	Name of the Equipment	Quantity	Experiment No.
1	Beam Test Setup with various End Conditions	2	1,2,3,4
2	Dial Gauges	12	1,3,4,5
3	Weight 200 g	10	1,3,4,5
4	Weight 500 g	10	1,3,4,5
5	Weight pans	6	1,3,4,5,6
6	Open sections like "C" and "L" sections	1 (each)	3
7	Closed section like "D" section	1	4
8	Strain indicator & Strain gauges	1& 2	2,6,10
9	Photo Elastic Test bench with loading	1 set	7
10	Beam setup with combined loading	1 set	6
11	Flexibility matrix set up for Cantilever beam	1	5
12	Beam setup for Torsional , free and forced vibrations	1	10
14	Oscilloscope	1	7

15MTAS201 CFD FOR AEROSPACE APPLICATIONS 3 0 0 3 100

INTENDED OUTCOMES:
To study the flow of dynamic fluids by computational methods.

UNIT I NUMERICAL SOLUTIONS OF SOME FLUID DYNAMICAL PROBLEMS

Basic fluid dynamics equations, Equations in general orthogonal coordinate system, Body fitted coordinate systems, Stability analysis of linear system. Finding solution of a simple gas dynamic problem, Local similar solutions of boundary layer equations, Numerical integration and shooting technique.

Practical

Numerical solution for CD nozzle isentropic flows and local similar solutions of boundary layer equations.

UNIT II GRID GENERATION

Need for grid generation – Various grid generation techniques – Algebraic, conformal and numerical grid generation – Importance of grid control functions – boundary point control – orthogonality of grid lines at boundaries.

Practical

Elliptic grid generation using Laplace's equations for geometries like airfoil and CD nozzle.

UNIT III TRANSONIC RELAXATION TECHNIQUES

Small perturbation flows, Transonic small perturbation (TSP) equations, Central and backward difference schemes, conservation equations and shock point operator, Line relaxation techniques, Acceleration of convergence rate, Jameson's rotated difference scheme stretching of coordinates, shock fitting techniques Flow in body fitted coordinate system.

Practical

Numerical solution of 1-D conduction- convection energy equation using time dependent methods using both implicit and explicit schemes – application of time split method for the above equation and comparison of the results.

UNIT IV TIME DEPENDENT METHODS

Stability of solution, Explicit methods, Implicit Method, Time split methods, Approximate factorization scheme, Unsteady transonic flow around airfoils. Sometime dependent solutions of gas dynamic problems.

Practical

Numerical solution of unsteady 2-D heat conduction problems using SLOR methods.

UNIT V PANEL METHODS

Elements of two and three dimensional panels, panel singularities. panel method for incompressible flows – Two dimensional source panels ,three dimensional source panels and two-dimensional Vortex Lattice and Vorticity Panel Methods, Panel methods for compressible Subsonic and supersonic flows.

Practical

Numerical solution of flow over a cylinder using 2-D panel methods using both vertex and source panel methods for lifting and non lifting cases respectively.

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	T.J Chung	Computational Fluid Dynamics	Cambridge University Press, Cambridge.	2002
2	John Wendt	Computational Fluid Dynamics: An Introduction	Springer	2009
3	Richard H. Pletcher ,John C. Tannehill , Dale Anderson	Computational Fluid Mechanics and Heat Transfer	Taylor & Francis	2012

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	T.K Bose	Computation Fluid Dynamics	Wiley Eastern Ltd., India.	1988
3.	John D. Anderson	Computational Fluid Dynamics	McGraw-Hill & Co., New York.	1995
4.	J.C. Tannehill, D.A. Anderson and R.H. Pletcher	Computational Fluid Mechanics and Heat Transfer, Second Edition	Taylor and Francis.	1997
5.	C.A.J. Fletcher, ,	Computational Techniques for Fluid Dynamics Volume 1, Second Edition	Springer-Verlag.	1991

WEB REFERENCES:

www.cfd-online.com
audilab.bmed.mcgill.ca/AudiLab/teach/fem/fem.html
www.cmi.univ-mrs.fr/~herbin/PUBLI/bookevol.pdf
mathworld.wolfram.com
www.particleincell.com/2011/finite-volume
http://www.ara.co.uk/services/computational-aerodynamics/applied-aerodynamics/

15MTAS202 FLIGHT MECHANICS 3 0 0 3 100

INTENDED OUTCOMES:
To understand the behavior of airflow both internal and external in compressible flow regime with particular emphasis on supersonic flows.

UNIT I PRINCIPLES OF FLIGHT
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 AIRPLANE
Forces of flight , Types of Drag – lift versus drag , effects of Reynolds's number - Streamlined and bluff bodies - Momentum theory of finite wings - Drag polar - Drag reduction methods of airplanes , factors affect the stall .

UNIT III AIRCRAFT PERFORMANCE
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.

UNIT IV PROPELLER THEORY
Froude momentum and blade element theory of propellers - Fixed and Variable pitch propellers , Constant speed propellers – blade angle and pitch ,pitch and velocity - Propeller coefficients – Propeller chart

UNIT V AIRCRAFT STABILITY AND CONTROL
Degrees of freedom of a system, static and dynamic stability, static longitudinal stability, Static lateral stability, static directional stability, dynamic longitudinal stability - Phugoid motion, dynamic lateral and directional stability- Dutch roll and spiral instability Auto rotation and spin

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Houghton E.L and Caruthers N.B	Aerodynamics for Engineering Students	Elsevier India Pvt. Ltd..	2005
2	Perkins C.D & Hage	Airplane Performance, Stability & Control	Wiley India Pvt Ltd	2011

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
2.	Thomas R. Yechout, Stevan L. Morris, David E. Bosset, Wayne F. Hallgren	Introduction to aircraft flight Mechanics	AIAA Education Series	2006
3.	Babister A.W	Aircraft stability and response	Pergamon Press, Oxford.	1980
4	Nelson R.C	Flight Stability & Automatic Control	McGraw-Hill, New York.	1989

WEB REFERENCES:

www.me.memphis.edu/menews/OneD_Flow.pdf
www.iaa.ncku.edu.tw/~cywen/course/gas%20dynamics/Ch4.ppt
www.does.org/masterli/e50.htm
www.adl.gatech.edu/classes/dci/aerodesn/dci03aero.html
www.lockheedmartin.com/data/assets/14617.pdf

15MTAS203 AEROSPACE MATERIALS 3 0 0 3 100

INTENDED OUTCOME:
To understand the advanced concepts of aerospace materials to the engineers and to provide the necessary mathematical knowledge that is needed in understanding their significance and operation. The students will have an exposure on various topics such elements of aerospace materials, mechanical behavior of materials, ceramics and composites and will be able to deploy these skills effectively in the understanding of aerospace materials.

UNIT I ELEMENTS OF AEROSPACE MATERIALS

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

UNIT II MECHANICAL BEHAVIOUR OF MATERIALS

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

UNIT III CORROSION & HEAT TREATMENT OF METALS AND ALLOYS

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

UNIT IV CERAMICS AND COMPOSITES

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

UNIT V HIGH TEMPERATURE MATERIALS CHARACTERIZATION

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

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Titterton.G.,	Aircraft Materials and Processes,	V Edition, Pitman Publishing Co.	2012
2	Raghavan.V	Materials Science and Engineering,	Prentice Hall of India, New Delhi,	2004

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	G. Y. Lai	High-Temperature Corrosion and Materials Applications	ASM International	2007
2	Michael F. Ashby, D. R. H. Jones	Engineering Materials: v. 1: An Introduction to Their Properties and Applications	Butterworth-Heinemann Ltd; New edition	1995

WEB REFERENCES:

www.iitg.ernet.in/engfac/rtiwari/resume/usdixit.pdf
www.luxinzheng.net/publication3/FEM_DEM_CSE09.htm
www.ibb.uni-stuttgart.de/publikationen/fulltext/2010/rahman.pdf
www.simytec.com/docs/Dvorkin_Bathe.pdf
www.me.mtu.edu/~bettig/MEEM4405/Lecture08.pdf

15MTAS204 LAUNCH VEHICLES AND SPACECRAFT PROPULSION 3 0 0 3 100

INTENDED OUTCOMES:
To study in detail about ongoing research studies in the dynamic environments field applicable to spacecraft and launch vehicle design.

UNIT I INTRODUCTION
Introduction - Historical Note / Basic Propulsion Devices - Architectural description of Launch Vehicles and Satellites - Rocket Equation -Staging / Payload - Launch weight relation - Propulsion Requirements / Thrust and time requirements - Types of rockets - propellants - choices.

UNIT II NOZZLE FLOWS AND AEROTHERMO CHEMISTRY
Nozzle flows / Introduction - Performance parameters - Review of aero thermo chemistry - Propellant and burning - Internal Ballistics - Grains - Ignition etc.

UNIT III PROPELLANTS AND HEAT TRANSFER
System Description - Propellants - Combustion - Heat Transfer - Cooling - Feed Systems - R-4 Auxiliary Components – Monopropellants- Catalytic systems -Ignition - Restart - Environmental problems.

UNIT IV SATELLITE INTEGRATION
Cold gas systems - Thruster satellite integration - Propellant management in spacecrafts - Propellant access in microgravity.

UNIT V PROPULSION SYSTEMS
Air breathing options in launch vehicles - Non chemical propulsion options - Nuclear Rockets. Electrostatic and Electromagnetic propulsion. Special thermal and integration problems

TEXTBOOK:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	C.D. Brown	Spacecraft Propulsion	AIAA Education Series, Washington DC	1996
3.	Sutton, G, P.,	. Rocket Propulsion Elements	Wiley, New York,	2006

REFERENCE BOOKS

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Oates, G. C	Aerothermodynamics of Gas Turbine and Rocket Propulsion	AIAA Education Series	1997.

WEB REFERENCES:

http://www.isro.org/satellites/spacemissions.aspx
http://www.space.com/24268-manned-mars-mission-nasa-feasibility.html
www.hpcc-space.de/.../AIAA5595JCP2007DarkAbbreviated.pdf
http://nineplanets.org/spacecraft.html
www.fas.org/man/dod-101/sys/ship/eng/reactor.html

15MTAS2E* **ELECTIVE-II** **3 0 0 3 100**

15MTAS211 AERODYNAMICS LABORATORY 0 0 3 2 100

INTENDED OUTCOMES:
To study experimentally the aerodynamic forces on different bodies at low speeds and High speeds.

1. Calibration of subsonic wind tunnel
2. Pressure distribution over a smooth and rough cylinders
3. Pressure distribution over a two dimensional symmetric aerofoil
4. Pressure distribution over a two dimensional cambered aerofoil
5. Force measurement using wind tunnel balance for various models
6. Pressure distribution over a three dimensional symmetric aerofoil
7. Pressure distribution over a three dimensional cambered aerofoil
8. Flow visualization studies in incompressible flows
9. Study of Supersonic Wind Tunnel
10. Supersonic Flow Visualization Studies – Shadowgraph
11. Calibration of supersonic wind Tunnel

S.No.	Name of the Equipment	Quantity	Exp. No.
1	Wind Tunnel test section size around 300 X 300 mm with test section flow speed of 60 m/s	1	1 – 7
2	2 - D airfoil sections symmetrical & Cambered	2 (each)	3 & 4
3	3 - D airfoil sections symmetrical & Cambered	2 (each)	6 & 7
4	Angle of incidence changing mechanism	1	3 – 7
5	Multiple manometer stand with 20 -30 tubes	1	1 – 7
6	U- tube manometer	1	1 – 7
7	Velocity survey rake	1	1
8	Total pressure probes	4	1
9	Pitot-Static tubes	4	1 – 7
10	Rough and smooth circular cylindrical models	1 (each)	2
11	Wind Tunnel balances (3 or 5 or 6 components)	1	5
12	Pressure transducers with digital display	1 set	1 – 8
13	Flow visualization – Hele Shaw apparatus, smoke tunnel, Water flow channel	1	8
14	Supersonic wind tunnel	1	9
15	Supersonic flow visualization technique-Shadowgraph	1	10

15MTCC301 RESEARCH METHODOLOGY, PEDAGOGY & COMMUNICATION SKILLS **3 0 0 3 100**

UNIT I HIGHER EDUCATION AN INTRODUCTION

Historical perspectives, the objectives of higher education, role of higher education-social focus, curricular focus, administrative focus, drivers of change in higher education-globalization, changing demographics, structuring of employment, technological change, demand of accountability, consumerism - Expectations by employers, rate of knowledge growth, campus demographics, concern for community - Restructuring and new patterns of decision making.

UNIT II RESEARCH PROCESSES AND METHODOLOGY

Introduction to Research – Research strategies – Ethics – Code of conduct for Research – Health and Safety – IPR – Research Events – Networks – Outreach Activities – Best Research practices – Quality assurance for Research – Career Management for Researchers – Research seminars – Journal critiques -.

UNIT III EFFECTIVE RESEARCH SKILLS

Data collection – Modeling – Simulation – Analysis – Prototyping – Presentation Skills – Data Presentation Skills – Research Writing skills (For Articles, Reports, Journals and Thesis) – Creative Skills – Effective Interview Skills – Team Building Skills – Communication and Interpersonal Skills – knowledge Transfer skills – Vivo voce – Teaching and Information Skills – Effective use of Library – Survey Skills – Planning and Control Methods – Statistical Tools – Patents and Copyrights – Advanced Research Techniques and Tools.

UNIT IV TECHNIQUES OF TEACHING AND EVALUATION

Large group techniques – lecture, seminar, symposium, panel discussion-project approaches and workshop. Small Group techniques-group discussion simulation, role playing-Buzz techniques, brain storming, case discussion and assignment…system approach in education. Individualized techniques-CAI Keller plan – PSI and programmed learning-methods of evaluation-self evaluation and student evaluation in higher education, question banking, diagnostic testing and remedial teaching.

UNIT V ESSENTIALS FOR EFFECTIVE COMMUNICATION IN ENGLISH

Improving Vocabulary stock-general and technical vocabulary-British and American vocabulary-homophones & homonyms, idioms and phrases-Different grammatical functions of the same word-Grammar-Tenses, Voice, reported speech, Modals, spoken English structures, formal and informal-letters, project reports, descriptions, circulars, synopsis and summary writing. Listening skills for competitive exams-Reading skills-skimming and scanning – Reading journals, magazines and newspapers for comprehension. Practical use of English – conversation, seminars, individual speeches and group discussions. Reference skills-Using dictionary, thesaurus and encyclopedia effectively. Error shooting for better use of English.

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Alley Michael	The Craft of Scientific Writing	Springer, New York	1996
2	Alley Michael	The Craft of Scientific Presentations	Springer, New York	2003

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Kumar.K.H	Educational technology	New Delhi- New age international (Pvt) Ltd., India.	1997
2.	Tony Bates.A.N	Technology, e-learning and distance education	Rout ledge, New York	2005
3.	Aggarwal. J.C	Essential of educational technology	Vikas publishing house (p) Ltd., New Delhi.	1995
4.	M. Ashraf Rizvi	Effective technical communication	TataMcGraw Hill Co.Ltd. New Delhi.	2005

WEB REFERENCES:

www.english4engineer.com
www.learn4good.com/language/engineer
www.experiment-resources.com/research-process.html
www.teachervision.fen.com
www.palgrave.com

15MTAS302 ADVANCED COMPOSITE MATERIALS AND STRUCTURES 3 0 0 3 100

INTENDED OUTCOMES:

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

UNIT I CLASSIFICATION AND CHARACTERISTIC OF COMPOSITE MATERIALS

General Introduction to advanced composite materials - Classification based on Matrix Material, Fiber Reinforced Composites. Fiber Reinforced Polymer (FRP) Composites, Particulate Composites - Advantages & limitations of Composites Role and Selection or reinforcement materials. Fibres-Mechanical properties and its types, Matrix – Properties and its Functions, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. - Fibre reinforced Polymer (FRP) Laminated composites Lamina & Laminate Lay-up – Application of composite to Aircraft structures .

UNIT II BASIC CONCEPTS

Generalized Hooke's Law – Stiffnesses, Compliances and Elastic constants for anisotropic, orthotropic and isotropic materials - Micromechanics and Macro mechanics approach. - Mass and volume fraction of fibers and resins-Effect of voids, Effect of temperature and moisture, Lamina stress-strain relations referred to natural axes and arbitrary axes.

UNIT III ANALYSIS OF LAMINATED COMPOSITES

Mechanics of materials approach, elasticity approach to determine material properties - Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates. Static, dynamic and stability analysis for simpler cases of composite plates. Inter-laminar stresses.

UNIT IV METHODS OF ANALYSIS AND FAILURE THEORY

Netting analysis, Macro-Mechanical Failure Theories - Maximum Stress Theory, Maximum Strain Theory, Tsai-Hill theory, Tsai-Wu Theory, Flexural rigidity of Sandwich beams and plates.

UNIT V MANUFACTURING & FABRICATION PROCESSES

Various Open and closed mould processes, Autoclave curing, Manufacture of fibers – Types of resins and properties and applications- Other Manufacturing Processes, Combined Fiber-Matrix performs.Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films - Applications of composites.

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.M. Jones	Mechanics of Composite Materials	Taylor & Francis, London.	1999
2.	Autar K.Kaw	Mechanics of Composite Materials, Second Edition	CRC press, University of South Florida, ,USA	2005

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	L.R. Calcote	Analysis of laminated structures	Van Nostrand Reinhold Co., New York.	1989
2.	G.Lubin	Hand Book on Fibre glass and advanced plastic composites	Van Nostrand Co., New York	1989
3	B.D. Agarwal and L.J. Broutman	Analysis and Performance of fiber composites	John-Wiley and Sons, New Jersey.	1990
4.	Vasiliev & Morozov	"Advanced Mechanics of Composite materials", Second Edition	Elsevier Science	2007
5.	Ori Ishai, Isaac M.Daniel	"Engineering Mechanics of Composite Materials", Second Edition	Oxford University Press	2005

WEB REFERENCES:

www.engineering.com/Library/.../Stress-Strain-Relationship.aspx
cw.mit.edu/courses/materials-science-and.../3-11...of.../ss.pdf
www.nsti.org/procs/Nanotech2003v1/12/W33.02
www.ae.iitkgp.ernet.in/ebooks/chapter8.html
www.mdacomposites.org/mda/psgbridge_cb_mfg_process.html

15MTAS303 CHEMICAL ROCKET TECHNOLOGY 3 0 0 3 100

INTENDED OUTCOMES:
To study and acquire knowledge in depth about chemical rocket propulsion

UNIT I SOLID ROCKET PROPULSION

Various subsystems of Solid rocket motor and their functions- Propellant grain design- erosive burning – L * instability – internal ballistics of solid rocket motor – types of ignites - igniter design considerations – special problems of solid rocket nozzles.

UNIT II LIQUID ROCKET PROPULSION

Classification of liquid rocket engines – rocket thrust control – thrust chamber and injector design considerations – various types of liquids rocket injectors – thrust chamber cooling- cryogenic rocket propulsion – problems peculiar to cryogenic engines- propellant slosh- combustion instability.

UNIT III HYBRID ROCKET PROPULSION

Standard and reverse hybrid propulsion systems – applications – current status and limitations – combustion mechanism – propellant system selection – internal ballistics of hybrid rocket systems.

UNIT IV PROPELLANT TECHNOLOGY

Selection criteria for solid and liquid rocket propellants – calculation of adiabatic flame temperature – assessment of rocket performance- selections of propellant formulation – determination of propellant burn rate and factors influencing the burn rate – solid propellant processing

UNIT V TESTING AND SAFETY

Static testing of rocket – instrumentation required – thrust Vs time – pressure Vs time diagrams – specific impulse calculation – safety procedures for testing of rockets and solid propellants –ignition delay testing

TEXTBOOK:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Brown, C. D	Spacecraft Mission Testing	AIAA Education Series, Washington DC	1992
2.	Van de Kamp, P	Elements of Astromechanics	Pitman	1979

3.	Sutton, G, P.,	Rocket Propulsion Elements	Wiley, New York,	2006

REFERENCE BOOKS

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Cornelisse, J. W	Rocket Propulsion and Space Dynamics	W.H. Freeman & Co	1984
2.	Parker, E. R.	Materials for Missiles and Spacecraft	McGraw Hill Book Co., Inc	1982
3.	D.A. Vallado	Fundamentals of Astrodynamics and Applications	Space Technology Library	2004
4.	Peter C. Hughes	Spacecraft attitude dynamics	Dover Publication	2004

WEB REFERENCES:

http://www.braeunig.us/space/missions.htm
http://spaceflightnow.com/
http://echo-spacemission.com/
http://www.space.com/24926-nasa-europa-mission-2015-budget.html
http://www.euclid-ec.org/

15MTAS3E* **ELECTIVE- III** **3 0 0 3 100**

15MTAS3E* **ELECTIVE- IV** **3 0 0 3 100**

15MTAS391 **PROJECT WORK - PHASE I** **0 0 6 3 100**

15MTAS491 **PROJECT WORK - PHASE II** **0 0 24 12 300**

ELECTIVES

15MTAS_E01 EXPERIMENTAL STRESS ANALYSIS 3 0 0 3 100

INTENDED OUTCOMES:
To bring awareness on experimental method of finding the response of the structure to Different types of load.

UNIT I INTRODUCTION

Principles of measurements, Accuracy , Sensitivity and range of measurements , Extensometers – Types – Mechanical, Electrical, Electronic and Optical – Uses and their Advantages and disadvantages - Review of bridge circuits.

UNIT II STRAIN GAUGE TECHNIQUES

Principle of operation and requirements , Types and their uses , Materials for Strain gauge , Strain gauge and transducers for measurement of static and dynamic loads – Instrumentation, measurement and recording systems.

UNIT III PHOTO ELASTIC TECHNIQUES

Stress analysis by two and three dimensional photo elasticity – Interpretation of stress patterns – Typical applications – Description and uses of reflection polariscope -Effect of stressed model in Plane and Circular polariscope. Interpretation of fringe pattern Isoclinics and Isochromatics.-Fringe sharpening and Fringe multiplication techniques-Compensation and separation techniques- Introduction to three dimensional photoelasticity..

UNIT IV INTERFEROMETRY TECHNIQUES

Basic Principle – Basic types of interferometers - Moire fringes – Calculations- Geometrical approach and Interferometric approach , Implications and applications - Laser holography – Grid methods – Stress coat .

UNIT V NON DESTRUCTIVE TECHNIQUES

Fundamentals of NDT. Radiography, ultrasonic, Holography , Laser holography magnetic particle inspection, Fluorescent penetrant technique, Infrared thermography , Eddy current testing, Acoustic Emission Technique.

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	J.W. Dally and M.F. Riley	Experimental Stress Analysis	McGraw-Hill Book Co., New York.	1998
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

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
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, Cambridge.	1987
3.	A.J. Durelli and V.J. Parks.	Moire Analysis of Strain	Prentice Hall Inc., New Jersey.	1980
4.	James F. Doyle	Nonlinear Analysis of Thin-Walled Structures	Springer	2001

WEB REFERENCES:

nptel.iitm.ac.in/courses/112106068
courses.washington.edu/me354a/photoelas.pdf
www.nrc-cnrc.gc.ca/obj/iar-ira/doc/stress-analysis
www.ndt.net/ndtaz/ndtaz.php
www.engr.sjsu.edu/WofMatE/Mat'sChar3.htm

15MTAS_E02 ADVANCED HEAT TRANSFER 3 0 0 3 100

INTENDED OUTCOME :
To introduce the concepts of advanced heat transfer to enable the students to design components subjected to thermal loading.

UNIT I CONDUCTION AND RADIATION HEAT TRANSFER

One dimensional energy equations and boundary condition - three-dimensional heat conduction equations - extended surface heat transfer - conduction with moving boundaries - radiation in gases and vapour.Gas radiation and radiation heat transfer in enclosures containing absorbing and emitting media – interaction of radiation with conduction and convection.

UNIT II TURBULENT FORCED CONVECTIVE HEAT TRANSFER

Momentum and energy equations - turbulent boundary layer heat transfer - mixing length concept - turbulence model – k Є model - analogy between heat and momentum transfer – Reynolds, Colburn, Prandtl turbulent flow in a tube - high speed flows.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER

Condensation with shears edge on bank of tubes - boiling – pool and flow boiling – Types of heat exchanger - Є – NTU approach and design procedure - compact heat exchangers – Pressure drop in heat exchanger .

UNIT IV NUMERICAL METHODS IN HEAT TRANSFER

Finite difference formulation of steady and transient heat conduction problems – discretization schemes – explicit - Crank Nicolson and fully implicit schemes - control volume formulation -steady one-dimensional convection and diffusion problems - calculation of the flow field – SIMPLER Algorithm.

UNIT V MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION

Mass transfer - vaporization of droplets - combined heat and mass transfers - heat transfer correlations in various applications like I.C. engines - compressors and turbines.

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Incropera F.P and DeWitt. D.P	Fundamentals of Heat & Mass Transfer	John Wiley & Sons, New Jersey.	2002
2.	Holman J.P	Heat Transfer	Tata McGraw Hill, New Delhi.	2002

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Ozisik M.N	Heat Transfer – A Basic Approach	McGraw-Hill Co, New York	1985
2.	Nag P.K	Heat Transfer	Tata McGraw Hill, New Delhi.	2002
3.	Ghoshdastidar P.S	Heat Transfer	Oxford University Press, UK.	2004

WEB REFERENCES:

www.jhu.edu/virtlab/conduct/conduct.htm
www.engineeringtoolbox.com/convective-heat-transfer-d_430.html
www.engineeringtoolbox.com/radiation-heat-transfer-d_431.html
web.mit.edu/lienhard/www/ahtt.html
www.personal.psu.edu/cxc11/AERSP560.pdf

15MTAS_E03 BOUNDARY LAYER THEORY 3 0 0 3 100

INTENDED OUTCOMES:
To introduce and understand the concept of Boundary layer theory.

UNIT I CONCEPTS IN IDEAL FLUID FLOW

Basic laws of fluid flow – continuity, momentum and energy equations as applied to system and control volume – concepts of flow fields – flow around bodies – moment of momentum theorem and its application to fixed and moving vanes – Hot wire and laser Doppler anemometry.

UNIT II INTRODUCTION TO BOUNDARY LAYER

Development of boundary layer – Estimation of boundary layer thickness, Displacement thickness - Momentum and energy thicknesses for two dimensional flow – Discussion of Navier Stokes equations – Two dimensional boundary layer equations – Blasius solution.

UNIT III LAMINAR AND TURBULENT BOUNDARY LAYERS

Laminar and turbulent flows on a flat plate – Laminar and turbulent boundary layers – Transition from laminar to turbulent boundary layers - Velocity profiles – Turbulence modeling .

UNIT IV APPROXIMATE SOLUTION TO BOUNDARY LAYER EQUATIONS

Momentum Integral Equation for boundary layer flow – Introduction to axisymmetric and three dimensional boundary layer equations – von Karman – Polhausen method – Thermal boundary layer calculations.

UNIT V HEAT TRANSFER IN BOUNDARY LAYER

Introduction to in boundary layers – Thermal boundary layer – Turbulent boundary layer on a flat plate – flows in pressure gradient – boundary layer control.

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	H. Schlichting , K. Gersten	Boundary Layer Theory – 8th Edition	McGraw-Hill, New York.	2000

2.	Frank White	Viscous Fluid flow	McGraw Hill, New York.	1998

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	A.J. Reynolds	Turbulent flows in Engineering	John Wiley & Sons, New Jersey.	1980
2.	Ronald L Panton	Incompressible fluid flow	John Wiley & Sons, New Jersey.	1984
3.	TuncerCebeci and Peter Bradshaw	Momentum transfer in boundary layers	Hemisphere Publishing Corporation, Washington.	1977

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www.mdme.info/MEMmods/MEM23041A/fluid.../fluid_flow.html
www.aer.mw.tum.de/fileadmin/tumwaer/www/pdf/.../lecture_00.pdf
www.witpress.com/978-1-85312-294-1.html
www.desktop.aero/appliedaero/blayers/lambl.html
www.crsim.utah.edu/Classes/6603/lectures/lecture15/lecture15.pdf

15MTAS_E04 INDUSTRIAL AERODYNAMICS 3 0 0 3 100

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

UNIT I ATMOSPHERE

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

UNIT II WIND ENERGY COLLECTORS

Horizontal axis and vertical axis machines – Savonious and Darrieus, Power coefficient, Actuator disc theory, Betz coefficient by momentum theory, Blade element momentum theory,

UNIT III VEHICLE AERODYNAMICS

Power requirements and drag coefficients of automobiles, Rolling resistance, Effects of cut back angle, Aerodynamics of trains and Hovercraft, Race car Aerodynamics, pressure distribution over a car

UNIT IV BUILDING AERODYNAMICS

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

UNIT V FLOW INDUCED VIBRATIONS

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

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	M.Sovran (Ed)	Aerodynamics and drag mechanisms of bluff bodies and road vehicles	Springer	2013
2.	P. Sachs	Winds forces in engineering	Pergamon Press, oxford.	1978

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.D. Blevins	Flow induced vibrations	Van Nostrand.	1990
2.	N.G.Calvent	Wind Power Principles	Charles Griffin & Co., London.	1979
3.	John D. Holmes	Wing loading of Structures,second edition	Taylor & Francis	2007

WEB REFERENCES:

www.windfarms.net.au/html/development_portfolio/collector.php
www.icpress.co.uk/architecture/p161.html
www.elsevier.com/wps/product/authors/505658
onlinelibrary.wiley.com/doi/10.1002/0470091455.ecm065/pdf
www.pwri.go.jp/eng/ujnr/joint/38/paper/38-31sarkar.pdf

15MTAS_E05 THEORY OF PLATES & SHELLS 3 0 0 3 100

INTENDED OUTCOMES::
To study the behavior of the plates and shells with different geometry under various types of loads.

UNIT I INTRODUCTION

Overview of Plate and shell structures in aerospace vehicles-Introduction to Strain displacement relation for plates - Engineering Strain- Green Lagrangian Strain

UNIT II SMALL DEFLECTION THEORY OF PLATES

Bending of thin plates-isotropic and orthotropic flat plates of different geometry – rectangular, square and skew plates-circular plates-different edge conditions-bi-harmonic equation for plate deflections.

UNIT III SHEAR DEFORMATION AND LARGE DEFLECTION THEORY OF PLATES

Assumptions-shear deformation – Analysis of flat plates and applications- general equations of large deflection plates – Bending of Circular plates by moment uniformly distributed along the edge – A simply supported circular plate under uniform load

UNIT IV STABILITY OF PLATES

Instability of Plates-different edge conditions – Applications of strain energy method –Skewed plate – Triangular plate and elliptical plates – non linear problems in bending of circular plates

UNIT V SHELLS

Basic concepts – Deformation – Membrance theory of shells applied to shells of form of surface of revolution. General theory of cylindrical shells – Circular cylindrical shells – spherical shells and conical shells.

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	S.P Timoshenko and S.W Krieger	Theory of Plates and Shells	Tata Mcgraw Hill Education Private Limited	2010
2.	H Kraus	Thin Elastic Shells	John Wiley & Sons, Inc., New York.	1987

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	W.Flugge	Stresses in Shells, II Edition	Springer Verlag Co., New York.	1983
2.	A.L.Goldenvizier	Theory of Elastic Thin Shells	Pergamon Press, New York.	1981
3.	Eduard Ventsel, Theodor Krauthammer	Thin Plates and Shells	CRC Press	2001

WEB REFERENCES:

www.ketchum.org/ShellTandF/index.html
www.mitcalc.com/doc/plates/help/en/plates.htm
www.cs.odu.edu/~mln/ltrs-pdfs/NASA-aiaa-98-2023.pdf
www.engg.uaeu.ac.ae/.../p6_vibration_and_stability.pdf
www.shellmuseum.org/

15MTAS_E06 HELICOPTER AERODYNAMICS 3 0 0 3 100

INTENDED OUTCOMES:
To present the basic ideas of evolution, performance and associated stability problems of helicopter.

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

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

UNIT II ELEMENTS OF HELICOPTER AERODYNAMICS

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

UNIT III TAIL ROTOR THEORY

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

UNIT IV POWER ESTIMATES

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

UNIT V GROUND EFFECT MACHINES

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

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R. W. Prouty	Helicopter Aerodynamics	Macmillan and Co., New York	2004
2.	G.H. Elsley and A.J. Devereux	Hovercraft Design and Construction	David Charies, London	1982

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	B.W McCormic	Aerodynamics of V/STOL Flight	Academic Press, New York.	1978
2.	J.Gordon Leishman	Principles of helicopter Aerodynamics – 2nd edition	Cambridge aerospace series	2005

WEB REFERENCES:

www.dynamicflight.com/aerodynamics/
www.helicopterpage.com/
www.cambridge.org/9780521858601
www.public.iastate.edu/~aero442/unit2.pdf
www.sti.nasa.gov/sscg.pdf

15MTAS_E07 AIRCRAFT DESIGN 3 0 0 3 100

INTENDED OUTCOMES::
To introduce and develop the basic concept of aircraft design. Each student is assigned the design of an Airplane (or Helicopter or any other flight vehicle), for given preliminary specifications..

UNIT I REVIEW OF DEVELOPMENTS IN AVIATION

Categories and types of aircraft specifications – various configurations – Layouts and their relative merits – strength, stiffness, fail safe and fatigue requirements – Manoeuvering load factors – Gust and manoeuverability envelopes – Balancing and maneuvering loads on tail planes.

UNIT II POWER PLANT TYPES AND CHARACTERISTICS

Characteristics of different types of power plants – Propeller characteristics and selection – Relative merits of location of power plant.

UNIT III PRELIMINARY DESIGN

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 – static and dynamic stability estimates – control requirements.

UNIT IV SPECIAL PROBLEMS

Layout peculiarities of subsonic and supersonic aircraft – optimisation – of wing loading to achieve desired performance – loads on undercarriages and design requirements.

UNIT V STRUCTURAL DESIGN

Estimation of loads on complete aircraft and components – Structural design of fuselage, wings and undercarriages, controls, connections and joints. Materials for modern aircraft – Methods of analysis, testing and fabrication.

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	D.P Raymer	Aircraft conceptual design	AIAA Educational Series, 4th Ed.,	2006
2.	G Corning	Supersonic & Subsonic Airplane Design	Edwards Brothers Inc., Michigan.	1953

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Ajoy Kumar Kundu	Aircraft Design	Cambridge University Press	2010
2.	H.N Kota	Integrated design approach to Design fly by wire	Lecture notes Interline Pub. Bangalore	1992
3.	E. Torenbeek	Synthesis of Subsonic Airplane Design	Delft University Press, London.	1976

WEB REFERENCES:

www.sil.si.edu/smithsoniancontributions/.../pdf.../SAOF-0001.4.pdf
www.un.org/esa/sustdev/csd/csd9_bp9.pdf
www.seeds2lrn.com/airIndex.html
www.oregonaircraftdesign.com/
www.aiaa.org/content.cfm?pageid=223

15MTAS_E08 STRUCTURAL DYNAMICS 3 0 0 3 100

INTENDED OUTCOMES:
To understand the analysis and design of structures.

UNIT I FORCE-DEFLECTION PROPERTIES OF STRUCTURES

Constraints and Generalized coordinates – Virtual work and generalized forces – Force – Deflection influence functions – stiffness and flexibility methods.

UNIT II PRINCIPLES OF DYNAMICS

Free and forced vibrations of systems with finite degrees of freedom – Damped oscillations – D'Alembert's principle – Hamilton's principle – Lagrangian equations of motion and applications.

UNIT III NATURAL MODES OF VIBRATION

Equations of motion for free vibrations Solution of Eigen value problems – Normal coordinates and orthogonality relations.

UNIT IV ENERGY METHODS

Rayleigh's principle – Rayleigh – Ritz method – Coupled natural modes – Effect of rotary inertia and shear on lateral vibrations of beams – Natural vibrations of plates.

UNIT V APPROXIMATE METHODS

Approximate methods of evaluating the Eigen frequencies and the dynamics response of continuous systems – Matrix methods of dynamic stress analysis.

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Singiresu S. Rao	Mechanical Vibration	Mechanical Vibration	2003
2.	W.C. Hurty and M.F. Rubinstein	Dynamics of Structures	Prentice Hall of India Pvt., Ltd., New Delhi.	1987

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.K Vierck	Vibration Analysis	Thomas Y. Crowell & Co., New York.	1989
2.	S.P. Timoshenko and D.H. Young	Vibration Problems in Engineering	John Willey & Sons Inc.	1984
3.	Von Karman and A. Biot	Mathematical Methods in Engineering	McGraw-Hill Book Co., New York.	1985
4.	Roy R. Craig, Andrew J. Kurdila	Fundamentals of Structural dynamics	John Willey & Sons Inc.	2011

WEB REFERENCES:

www.jce.divched.org/journal/Issues/1989/Sep/.../JCE1989p0703.pdf
www.sdtools.com/sdt/
www.structdynamics.com/
www.thestructuralengineer.info
www.wind.civil.aau.dk/lecture/7sem/notes/Lecture3.pdf

15MTAS_E09 AERO ELASTICITY 3 0 0 3 100

INTENDED OUTCOMES:
To understand the theoretical concepts of material behavior with particular emphasis on their elasticity property.

UNIT I AEROELASTIC PHENOMENA

Stability versus response problems – The aero-elastic triangle of forces – Aero plasticity in Aircraft Design – Prevention of aero elastic instabilities.

UNIT II DIVERGENCE OF A LIFTING SURFACE

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

UNIT III STEADY STATE AEROLASTIC PROBLEMS

Loss and reversal of aileron control – Critical aileron reversal speed – Aileron efficiency – Semi rigid theory and successive approximations – Lift distribution – Rigid and elastic wings.

UNIT IV FLUTTER PHENOMENON

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

UNIT V EXAMPLES OF AEROELASTIC PROBLEMS IN CIVIL AND MECHANICAL ENGINEERING

Galloping of transmission lines and flow induced vibrations of tall slender structures and suspension bridges. Mathematical model for bluff body oscillations in steady and fluctuating flows

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	E.G Broadbent	Elementary Theory of Aeroelasticity	Bun Hill Publications Ltd, London	1986
2.	Y.C. Fung	An Introduction to the Theory of Aeroelasticity	John Wiley & Sons Inc., New York.	1990

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.L Bisplinghoff, H Ashley , R.L. Halfmann.	Aeroelasticity	Addison Wesley Publishing Co., Inc.	1987
2.	R.H. Scanlan , R.Rosenbaum	Introduction to the study of Aircraft Vibration and Flutter	Macmillan Co., New York	1981
3.	Robert Clark , E.H. Dowell	A Modern Course in Aeroelasticity-Fourth Edition	Kluwer Academic Publishers, Netherlands	2004

WEB REFERENCES:

www.ifasd2011.com/
www.merriam-webster.com/dictionary/aeroelasticity
www.asdjournal.org/
www.ecn.nl/units/wind/rd-programme/integrated.../aero-elasticity/
aeroelasticity.larc.nasa.gov/

15MTAS_E10 CRYOGENICS 3 0 0 3 100

INTENDED OUTCOMES:
To understand the theoretical concepts of Cryogenics.

UNIT I FUNDAMENTALS OF CRYOGENICS

Theory behind the production of low temperature – expansion engine – heat exchangers – Cascade process - Joule Thomson and Magnetic effects – cryogenic liquids as cryogenic propellants for cryogenic rocket engines – properties of various cryogenic propellants – handling problems associated with cryogenic propellants.

UNIT II CRYOGENIC SYSTEMS EFFICIENCY

Types of losses and efficiency of cycles – amount of cooling – the features liquefied – cooling coefficient of performance – Thermodynamic efficiency – The energy balancing method.

UNIT III THERMODYNAMIC CYCLES FOR CRYOGENIC PLANTS

Classification of cryogenic cycles – The Structure of cycles – Throttle expansion cycles – Expander cycles – Mixed throttle expansion and expander cycles – Thermodynamic analysis – Numerical problems.

UNIT IV PECULIAR PROBLEMS ASSOCIATED WITH CRYOPROPELLANTS

Storage problems of cryogenic propellants – cryogenic loading Aerospace Materials – zero gravity problems associated with cryopropellants – phenomenon of tank collapse – geysering effect.

UNIT V CRYOGENIC ROCKET ENGINES

Peculiar design difficulties associated with the design of feed system, injector and thrust chamber of cryogenic rocket engines – Relative performance of cryogenic when compared to non-cryo engines.

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Haseldom G.	Cryogenic Fundamentals	Academic Press. USA.	1971
2.	Dieter K. Huzel, David H. Huang, Rocketdyne Divisi D. Huzel And D. Huang	Modern Engineering for Design of Liquid-Propellant Rocket Engines	AIAA (American Institute Of Aeronautics & Ast)	1992

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sutton G.P	Rocket Propulsion Elements	John Wiley, New York.	1993
2.	Barron R.F	Cryogenic Systems	Oxford University press, Oxford.	1985
3.	Parner S.F	Propellant Chemistry	Reinfold Publishing Corporation, New York.	1989
4.	Klaus D. Timmerhaus,R. Richard Palmer Reed	Cryogenic Engineering	Springer	2007

WEB REFERENCES:

www.journals.elsevier.com/cryogenics/
www.cryogenicsociety.org/
www.omega.com/prodinfo/cryogenics.html
cryogenics.nist.gov/
www.internationalcryogenics.com/

15MTAS_E11 HIGH TEMPERATURE PROBLEMS IN STRUCTURE 3 0 0 3 100

INTENDED OUTCOMES:
To understand the problems that arise in Structures subjected to thermal loading at high temperatures

UNIT I TEMPERATURE EQUATIONS & AERODYNAMIC HEATING

For condition, radiation and convection – Fourier's equation – Boundary and initial conditions – One-dimensional problem formulations – Methods and Solutions. Heat balance equation for idealised structures – Adiabatic temperature – Variations – Evaluation of transient temperature.

UNIT II THERMAL STRESS ANALYSIS

Thermal stresses and strains – Equations of equilibrium – Boundary conditions – Thermoelasticity – Two dimensional problems and solutions – Airy stress function and applications.

UNIT III THERMAL STRESS IN BEAMS, TRUSSES AND THIN CYLINDERS

Thermal stresses in axially loaded members, beams with varying cross sections. Effect of temperature in thin cylinders.

UNIT IV THERMAL STRESSES IN PLATES

Membrane thermal stresses – Circular plates – Rectangular plates – Bending thermal stresses – Thick plates with temperature varying along thickness – Thermal vibration of plates.

UNIT V SPECIAL TOPICS & MATERIALS

Thermal bucking, Fatigue and shock applications – High temperature effects on material properties.

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Bruno A. Boley, Jerome H. Weiner	Theory of Thermal Stresses	Dover Publications	2012
2.	N.J Hoff	High Temperature effects in Aircraft Structures	John Wiley & Sons Inc., London.	1986

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	D.J. Johns	Thermal Stress Analysis	Pergamon Press, Oxford.	1985
2.	Earl A. Thornton	Aerospace Thermal Structures and Materials for a New Era	American Institute of Aeronautics and Astronautics	1995
3.	Carlos A. Mota Soares, J.A.C. Matins, H.C. Rodrigues	Computational mechanics	Springer Verlag Co., New York.	2006

WEB REFERENCES:

www.nasa.gov/centers/dryden/pdf/88193main_h-1602.pdf
history.nasa.gov/conghand/structur.html
www.iitk.ac.in/gate/gate2012/pdffiles/me.pdf
www.stresscalc.ru/cosmos/basicsystem_2.pdf
www.geogebra.org/en/wiki/index.php/workshop_materials

15MTAS_E12 ROCKETRY AND SPACE MECHANICS 3 0 0 3 100

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

UNIT I ORBITAL MECHANICS
Description of solar system – Keplers Laws of planetary motion – Newton's Law of Universal gravitation – Two body and Three-body problems – Jacobis Integral, Librations points - Estimation of orbital and escape velocities

UNIT II SATELLITE DYNAMICS
Geosynchronous and geostationary satellites life time – satellite perturbations – Hohmann orbits – calculation of orbit parameters – Determination of satellite rectangular coordinates from orbital elements.

UNIT III ROCKET MOTION
Principle of operation of rocket motor - thrust equation – one dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields – Description of vertical, inclined and gravity turn trajectories determinations of range and altitude – simple approximations to burnout velocity – staging of rockets.

UNIT IV ROCKET AERODYNAMICS
Description of various loads experienced by a rocket passing through atmosphere – drag estimation – wave drag, skin friction drag, form drag and base pressure drag – Boat-tailing in missiles – performance at various altitudes – conical and bell shaped nozzles – adapted nozzles – rocket dispersion – launching problems.

UNIT V MATERIALS FOR SPACECRAFT AND MISSILES
Space environment – peculiarities - Selections of materials for spacecraft and missiles – special requirements of materials to perform under adverse conditions – ablative materials.

TEXT BOOKS:

S.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	G.P Sutton	Rocket Propulsion Elements	Willey/BSP Publications	2010
2.	J.W Cornelisse	Rocket Propulsion and Space Dynamics	J.W. Freeman & Co. Ltd., London	1982

REFERENCE BOOKS:

S.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Van de Kamp	Elements of Astromechanics	PitmanPublishingCo., Ltd., London.	1980
2.	E.R. Parker	Materials for Missiles and Spacecraft	McGraw-Hill Book Co., New York.	1982
3.	Vallado,D. A	Fundamentals of Astrodynamics and Applications	Microcosm Press/Springer, 3rd Edition.	2007

WEB REFERENCES:

www.n55.dk/manuals/n55rocketsystem/n55rocketsystem.html
www.rasaero.com/
www.relativitycalculator.com/rocket_equations.html
www.fas.org/man/dod-101/sys/missile/docs/RocketBasics.htm
http://www.craftsmanspace.

15MTAS_E13 NON-LINEAR VIBRATIONS 3 0 0 3 100

INTENDED OUTCOME:
To study the Non-Linear Vibrations of various aircraft structural components under different types of loads.

UNIT I QUALITATIVE METHODS

Fundamental properties of nonlinear systems. Nonlinear equations of motion of some mechanical systems Phase planes, Singular points, Liapunov stability, Sub harmonic and super harmonic solutions. Bifurcation theory.

UNIT II QUANTITATIVE METHODS

Perturbation Method, Harmonic balancing, Krylov – Bogoliubov method, Method of averaging, Multiple time scales. Determination of stability criteria – characteristic exponents. Nyquists diagram. Autonomous and non- autonomous systems. Duffing's oscillator, Jump phenomena.

UNIT III FLOW INDUCED OSCILLATIONS

Self-excited oscillations in mechanical systems. Van-der-Pol's oscillator, Limit cycles. Vortex induced oscillations – Strouhal number, Galloping, Mathematical model for bluff body oscillations in steady and fluctuating flows.

UNIT IV PARAMETRIC EXCITATION

Mathieu Hill equations, stability of solutions, Natural frequency of Elastic rod periodic structure, Dynamics of two link pendulum with a fast rotating second link- Systems with very strong Excitation - Equation governing slow motion

UNIT V SOLUTION OF EQUATIONS

Sub harmonic and super harmonic solutions, multiple solutions, Poincare maps, Basin of attractions, Strong parametric Excitation due to oscillating inertia –Large solutions- Smoothening of dry friction

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Alexander Fidlin	Nonlinear Oscillations in Mechanical Engineering	Clarendon Press, Oxford.	2005
2.	A.H Nayfeh and D.T Mook	Nonlinear Oscillations	John Wiley & Sons, New York.	1979

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	C Hayashi	Nonlinear Oscillations in Physical Systems	McGraw-Hill, New York.	1984
2.	N Minorsky	Nonlinear Oscillations	Van Nostrand Princeton NJ.	1982
3.	R.D Blevins	Flow Induced Vibration	Van Nostrand, Reinhold Co., New York.	1992
4.	V.I. Babitsky	Vibration of Strongly Nonlinear Discontinuous Systems	Springer	2001

WEB REFERENCES:

www.ncbi.nlm.nih.gov/pubmed/14984842
home.iitk.ac.in/~smittal/res_act/flow-ind_osci_sing_multi_cyl.html
www.energeticforum.com › ... › Renewable Energy
lib.physcon.ru/download/p1741.pdf
audiophile.tam.cornell.edu/randdocs/nlvibe52.pdf

15MTAS_E14 THEORY OF PLASTICITY 3 0 0 3 100

INTENDED OUTCOMES:
To understand the theoretical concepts of material behavior with particular emphasis on their Plasticity property.

UNIT I INTRODUCTION

Introduction to the concept of plastic deformation using simple ideas and familiar examples., Difference between elasticity and plasticity, role of geometry and thermodynamics in plastic deformation.

UNIT II CONTINUUM MECHANICS

Tensor algebra and tensor analysis, Kinematics (body, configuration and motion, deformation gradient, strains), Balance laws (integral theorems, balance of mass, momentum and energy), Second law of thermodynamics (Clausius-Duhem inequality), Constitutive relations (superimposed rigid body motions, material symmetry).

UNIT III GENERAL THEORY OF PLASTIC DEFORMATION

Unloading elastic bodies to zero stress, Deformation and incompatibility (dislocation density, single dislocations, geometrically necessary and statistically stored dislocations), Invariance under compatible changes in the reference configuration, Thermodynamics of plastic flow (state variables and constitutive assumptions, dissipation, isothermal and dissipative processes), Flow rules and yield criteria (general restrictions), Rate dependent and rate independent plasticity.

UNIT IV PLASTICITY WITH SMALL ELASTIC STRAIN AND ELASTIC RIGIDITY

Ilyushin's postulate of maximum plastic work(including Drucker's postulate), Maximum dissipation and normality rule, Plasticity with small elastic strains: Associated flow rules, Rigid perfectly plasticity: yield criterions and flow rules, Hardening rules, Uniqueness theorems and variational principles in plasticity, Elastic plastic torsion, Plane problems: Slip line theory, Theory of stability under plastic flow.

UNIT V PLASTIC WAVES

Introduction to dynamic plasticity, One-dimensional waves, Shock waves, Acceleration waves, Theory of strain localization.

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Jagabanduhu Chakrabarty	Theory of Plasticity	Elsevier	2011
2.	E. Kroener	Continuum theory of defects	Elsevier Science Publishing CO., Inc.,USA.	1981

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	L. M. Kachanov	Fundamentals of the theory of plasticity	Dover Publication, Netherlands.	1971

WEB REFERENCES:

www.its.caltech.edu/~ae102/
www.springer.com
www.lajss.org
www.vgu.edu.vn/

15MTAS_E15 THEORY OF ELASTICITY 3 0 0 3 100

INTENDED OUTCOMES:
To understand the theoretical concepts of material behavior with particular emphasis on their elasticity property.

UNIT I INTRODUCTION

Definition, notations and sign conventions for stress and strain – Stress - strain law –Number of elastic constants – Stress ellipsoid – stress invariants – Principal stresses in 2-D and 3-D

UNIT II BASIC EQUATIONS OF ELASTICITY

Equations of equilibrium – Compatibility equations in strains and stresses – Boundary Conditions - Saint-Venant's principle.

UNIT III 2 - D PROBLEMS IN CARTISIAN COORDINATES

Plane stress and plain strain problems - Airy's stress function – Biharmonic equations – 2 -D problems – Cantilever and simply supported beams

UNIT IV 2 – D PROBLEMS IN POLAR COORDINATES

Equations of equilibrium – Strain – displacement relations – Stress – strain relations – Airy's stress function – Axi symmetric problems - Kirsch, Boussinasque's and Michell's problems.

UNIT V SAINT VENANT'S TORSION

Saint Venant's Semi-Inverse method, Classical Torsion theory, Torsion of elliptical, equilateral triangular and rectangular sections- Representation of stress state at top cross-section of rod under torsion, Representation of circular rod under torsion cross-section

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	S.P. Timoshenko and J.N. Goodier	Theory of Elasticity	Tata Mcgraw Hill Education Private Limited	2010
2.	E. Sechler	Elasticity in Engineering	John Wiley & Sons Inc., New York.	1980

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Ugural, A.C and Fenster S.K	Advanced Strength and Applied Elasticity	Prentice hall, New Delhi.	2003
2.	Wang, C.T	Applied elasticity	McGraw Hill, New York.	1993
3.	Enrico Volterra and Caines J.H	Advanced strength of Materials	Prentice hall, New Delhi.	1991

WEB REFERENCES:

www.iue.tuwien.ac.at/phd/dhar/node17.html

www2.egr.uh.edu/~lliu21/Elasticity.pdf
www.iue.tuwien.ac.at/phd/dhar/node17.html
trove.nla.gov.au/work/
www.sciencedirect.com/science/article/

15MTAS_E16 HYPERSONIC AERODYNAMICS 3 0 0 3 100

INTENDED OUTCOMES:
To present the basic ideas of hypersonic flow and the associated problem areas.

UNIT I BASICS OF HYPERSONIC AERODYNAMICS

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

UNIT II SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS

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

UNIT III APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS`

Approximate methods hypersonic small disturbance equation and theory – thin shock layer theory: exact methods of characteristics hypersonic shock wave shapes and correlations.

UNIT IV VISCOUS HYPERSONIC FLOW THEORY

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

UNIT V VISCOUS INTERACTIONS IN HYPERSONIC FLOWS

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

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	John D. Anderson	Hypersonic and High Temperature Gas Dynamics – second edition	McGraw-Hill, New York.	2006

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	John T. Bertin	Hypersonic Aerothermodynamics	Published by AIAA Inc., Washington D.C.	1996
2.	William H. Heiser and David T. Praff	Hypersonic Air Breathing propulsion	AIAA Education Series, US.	1998
3.	John.D Anderson	Modern Compressible Flow with Historical perspective	Hypersonic Series, Washington.	1991

WEB REFERENCES:

www.grc.nasa.gov/www/bgh/index.html
www.dept.aoe.vt.edu/~mason/mason_f/configaerohypersonics.pdf
www.grc.nasa.gov/www/bgh/shorth.html
www.rand.org › reports and bookstore › notes
www.mechanicalengineeringblog.com/tag/hypersonic-aerodynamics

15MTAS_E17 HIGH TEMPERATURE GAS DYNAMICS 3 0 0 3 100

INTENDED OUTCOMES:

To understand the basic difference between incompressible and compressible flow
To study the phenomenon of shock waves and its effect on flow

UNIT I INTRODUCTION

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

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

UNIT III KINETIC THEORY AND HYPERSONIC FLOWS

Chemical equilibrium calculation of equilibrium composition of high temperature air – equilibrium properties of high temperature air – collision frequency and mean free path – velocity and speed distribution functions chemical and vibrational non equilibrium.

UNIT IV INVISCID HIGH TEMPERATURE FLOWS

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

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 and absorbing gases.

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	John David Anderson	Hypersonic and High Temperature Gas Dynamics	Ingram Publisher	2002
2.	John D. Anderson Jr	Modern Compressible Flow with Historical perspective	McGraw-Hill Series, New York.	1996

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	William H. Heiser and David T. Pratt	Hypersonic Air breathing propulsion	AIAA Education Series, US.	1998
2.	John T. Bertin	Hypersonic Aerothermodynamics	AIAA Inc., Washington, D.C.	1994
3.	Dr John Anderson	Hypersonic and High - Temperature Gas Dynamics – Second Edition	AIAA Education Series	2006

WEB REFERENCES:

www.nature.com/nmeth/journal/v8/n5/full/nmeth.1595.html
www.chem.arizona.edu/~salzmanr/480b/statt01/statt01.html
www.dtic.mil/dtic/tr/fulltext/u2/a468381.pdf
www.waset.org/journals/ijens/v4/v4-1-9.pdf
www.veccal.ernet.in/~icpaqgp/SGupta.pdf

15MTAS_E18 ADVANCED PROPULSION SYSTEMS 3 0 0 3 100

INTENDED OUTCOMES:
To study in detail about gas turbines, ramjet, fundamentals of rocket propulsion and chemical rockets.

UNIT I THERMODYNAMIC CYCLE ANALYSIS OF AIR- BREATHING PROPULSION SYSTEMS

Air breathing propulsion systems like Turbojet, turboprop, ducted fan, Ramjet and Air augmented rockets – Thermodynamic cycles – Pulse propulsion – Combustion process in pulse jet engines – inlet charging process – Supercritical charging and subcritical discharging – Subcritical charging and subcritical discharging – Subcritical charging and supercritical discharging.

UNIT II RAMJETS AND AIR AUGMENTED ROCKETS

Preliminary performance calculations – Diffuser design and hypersonic inlets – combustor and nozzle design – air augmented rockets – engines with supersonic combustion.

UNIT III SCRAMJET PROPULSION SYSTEM

Fundamental considerations of hypersonic air breathing vehicles – Preliminary concepts in engine airframe integration – calculation of propulsion flow path – flow path integration – Various types of supersonic combustors – fundamental requirements of supersonic combustors – Mixing of fuel jets in supersonic cross flow – performance estimation of supersonic combustors.

UNIT IV NUCLEAR PROPULSION

Nuclear rocket engine design and performance – nuclear rocket reactors – nuclear rocket nozzles – nuclear rocket engine control – radioisotope propulsion – basic thruster configurations – thruster technology – heat source development – nozzle development – nozzle performance of radiosotope propulsion systems.

UNIT V ELECTRIC AND ION PROPULSION

Basic concepts in electric propulsion – power requirements and rocket efficiency – thermal thrusters – electrostatic thrusters – plasma thruster of the art and future trends – Fundamentals of ion propulsion – performance analysis – electrical thrust devices – ion rocket engine.

TEXT BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	John D. Anderson Jr.	Hypersonic and High Temperature Gas Dynamics	McGraw-Hill Series, New York.	1996
2.	John T. Bertin	Hypersonic Aerothermodynamics	AIAA Inc., Washington D.C.	1994

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	John D.Anderson Jr	Modern Compressible Flow with Historical perspective	McGraw-Hill Series, New York.	1996
2.	William H. Heiser and David T. Pratt	Hypersonic Air breathing propulsion	AIAA Education Series, Washington D.C.	1996
3.	Martin J. L Turner	Rocket and Spacecraft Propulsion, Second Edition	Springer Verlag Co., New York.	2012

WEB REFERENCES:

www.hpcc-space.de/.../AIAA5595JCP2007DarkAbbreviated.pdf
www.daviddarling.info/.../A/advanced_propulsion_concepts.html
www.fas.org/man/dod-101/sys/ship/eng/reactor.html
www.mendeley.com/.../nonequilibrium-hypersonic-aero
www.landmarkonthenet.com/.../hypersonic-aerothermodynamics.

15MTAS_E19 WIND ENGINEERING 3 0 0 3 100

INTENDED OUTCOMES:
To avoid wind related disasters in the society the effects of wind on the built environment.

UNIT I THE ATMOSPHERE

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

UNIT II ATMOSPHERIC BOUNDARY LAYER

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

UNIT III BLUFF BODY AERODYNAMICS

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

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

UNIT V AEROELASTIC PHENOMENON

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

TEXTBOOK:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Emil Simiu & Robert H Scanlan	Wind effects on structures - fundamentals and applications to design	John Wiley & Sons Inc. New York.	1996

REFERENCE BOOKS:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Tom Lawson	Building Aerodynamics	Imperial College Press London.	2001
2.	N J Cook	Design Guides to wind loading of buildings structures Part I & II	Butter worths, London	1985

WEB REFERENCES:

www.cppwind.com/support/.../CommercialWindEngineering.pdf
www.sciencedirect.com
www.springer.com
www.routledge.com
www.nap.edu/catalog/1995.html
en.wikipedia.org/wiki/Wind

15MTAS_E20 EXPERIMENTAL METHODS IN FLUID MECHANICS 3 0 0 3 100

INTENDED OUTCOMES:
To study in detail about basic measurements and wind tunnel measurements of fluid flow.

UNIT I BASIC MEASUREMENTS IN FLUID MECHANICS
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
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
Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Shadowgraph - Schlieren system – Background Oriented Schliren (BOS) System - Hydraulic analogy – Hydraulic jumps – Electrolytic tank.

UNIT IV PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS
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 AND UNCERTAINTY ANALYSIS
Data acquisition and processing – Signal conditioning - Estimation of measurement errors – Uncertainty calculation- Uses of uncertainty analysis.

TEXTBOOK:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Rathakrishnan, E.	Instrumentation, Measurements, and Experiments in Fluids	CRC Press, Taylor & Francis.	2007

REFERENCE BOOK:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Robert B Northrop	Introduction to Instrumentation and Measurements	CRC Press, Taylor & Francis.	2006

WEB REFERENCES:

www.springer.com
www.uio.no/studier/emner/matnat/math/MEK9600/index.xml
en.wikipedia.org/wiki/Fluid_mechanics
www.thermopedia.com
www.journals.elsevier.com/experimental-thermal-and-fluid-science/
www.codecogs.com › Engineering › Fluid Mechanics › Pipes

15MTAS_E21 SPACECRAFT TECHNOLOGY 3 0 0 3 100

INTENDED OUTCOMES:

To understand the general spacecraft problems and satellite orbit perturbation mechanism.

To study in detail about the Materials in spacecraft Technology.

UNIT I BASIC CONCEPTS

The solar system - Reference 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

The Many body problem - Lagrange - Jacobi identity - The circular restricted three body problem – Libration points - Relative Motion in the N-body problem - The two - body problem - Satellite orbits - Relations between position and time - Orbital elements.

UNIT III SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS

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 variations of orbital elements - General perturbations approach.

UNIT IV INTERPLANETARY TRAJECTORIES BALLISTIC MISSILE - TRAJECTORIES

Two-dimensional interplanetary trajectories - Fast interplanetary trajectories - Three dimensional interplanetary trajectories - Launch of interplanetary spacecraft - Trajectory about the target planet. The boost phase – The ballistic phase - Trajectory geometry - Optimal flights - Time of flight - Re-entry phase - The position of the impact point - Influence coefficients.

UNIT V MATERIALS FOR SPACECRAFT

Space environment - Peculiarities -Effect of space environment on the selection of materials of spacecraft- Applications of Materials in spacecraft- ceramic, graphite

TEXTBOOK:

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Brown, C. D	Spacecraft Mission Testing	AIAA Education Series, Washington DC	1992

2.	Van de Kamp, P	Elements of Astromechanics	Pitman	1979
3.	Sutton, G, P.,	Rocket Propulsion Elements	Wiley, New York,	2006

REFERENCE BOOKS

S. No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Cornelisse, J. W	Rocket Propulsion and Space Dynamics	W.H. Freeman & Co	1984
2.	Parker, E. R.	Materials for Missiles and Spacecraft	McGraw Hill Book Co., Inc	1982
3.	D.A. Vallado	Fundamentals of Astrodynamics and Applications	Space Technology Library	2004
4.	Peter C. Hughes	Spacecraft attitude dynamics	Dover Publication	2004

WEB REFERENCES:

http://www.braeunig.us/space/missions.htm
http://spaceflightnow.com/
http://echo-spacemission.com/
http://www.space.com/24926-nasa-europa-mission-2015-budget.html
http://www.euclid-ec.org/

15MTAS_E22 THEROY OF VIBRATION 3 0 0 3 100

INTENDED OUTCOMES:

To study the dynamic behavior of different aircraft components and the interaction among the aerodynamic, elastic and inertia forces.

UNIT I SINGLE DEGREE OF FREEDOM SYSTEMS

Simple harmonic motion, definition of terminologies, Newton's Laws, D'Alembert'sprinciple, Energy methods. Free vibrations, free damped vibrations, and forced vibrations with and without damping, base excitation, and vibration measuring instruments.

UNIT II MULTI-DEGREES OF FREEDOM SYSTEMS

Two degrees of freedom systems, Static and dynamic couplings, Eigen values, Eigen vectors and orthogonality conditions of eigen vectors, Vibration absorber, Principal coordinates, Principal modes. Hamilton's principle, Lagrangean equation and their applications.

UNIT III VIBRATION OF ELASTIC BODIES

Transverse Vibrations of strings, Longitudinal, lateral and torsional vibrations. approximate methods for calculating natural frequencies.

UNIT IV EIGEN VALUE PROBLEMS & DYNAMIC RESPONSE OF LARGE SYSTEMS

Eigen value extraction methods – Subspace hydration method, Lanczos method – Eigen value reduction method – Dynamic response of large systems – Implicit and explicit methods.

UNIT V ELEMENTS OF AEROELASTICITY

Stability versus response– Collar's triangle of courses – Prevention of aeroelastic instabilities. Influence and stiffness coefficients - Wing divergence – Aileron control reversal – Flutter phenomenon – Flutter prevention and control .

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Timoshenko S	Vibration Problems in Engineering	Bertrams	2008
2	Meirovitch L	Elements of Vibration Analysis	McGraw-Hill Inc., New York.	1986

3	Fung Y.C	An Introduction to the Theory of Aeroelasticity	John Wiley & Sons Inc., New Jersey.	1985

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	F.S. Tse, I.F. Morse and R.T. Hinkle	Mechanical Vibrations	Prentice-Hall of India, New Delhi.	1985
2	Rao.J.S. and Gupta.K	Theory and Practice of Mechanical Vibrations	Wiley Eastern Ltd., New Delhi.	1999
3.	A.A. Shabana	Theory of Vibration : An Introduction	Springer	1996
4.	William T. Thomsan, Maric Dillon Dahleh	Theory of Vibration with Application – 5^{th} Edition	Pearson Education Inc .	2007

WEB REFERENCES:

www.vibrationdata.com/unit_step.pdf
www.acs.psu.edu/drussell/Demos/multi-dof/multi-dof.html
www.sdrl.uc.edu/book/Chap-5.pdf
simpleharmonicmotion.net/
www.aero.polimi.it/masarati/Publications/08erf_ae.pdf

15MTAS_E23 FATIGUE AND FRACTURE MECHANICS 3 0 0 3 100

INTENDED OUTCOMES:

To study the Fatigue and Fracture mechanics of various aircraft structural components under different types of loads.

UNIT I FATIGUE OF STRUCTURES

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

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

Phase in fatigue life – Crack initiation – Crack growth – Final fracture – Dislocations – Fatigue fracture surfaces- Residual Strength and Critical Crack Size- R-curve Mixed Mode Loading: Fracture and Crack Path.

UNIT IV FRACTURE MECHANICS

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 FATIGUE DESIGN AND TESTING

Safe life and fail safe design philosophies – Importance of Fracture Mechanics in aerospace structure – Application to composite materials and structures.

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	David Broke	Elementary Engineering Fracture Mechanics	Springer	2013
2.	J.F Knott	Fundamentals of Fracture Mechanics	Butterworth & Co.Ltd., London.	1983

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	C.G.Sih	Mechanics of Fracture Vol.1	Sijthoff and NoordhoffInternational Publishing, Netherland	1989
2.	M.H. Aliabadi	Thermomechanical fatigue and fracture	WIT Press	2002

WEB REFERENCES:

www.fatiguefracture.com/
www.efunda.com/formulae/...mechanics/fracture_mechanics/index
www.engin.brown.edu/courses/.../Fracturemechs/Fracturemechs.html
onlinelibrary.wiley.com › Materials Science › Ceramics › Book Home
www.pmdatabase.com/global/download/PMFatigueDesign.pdf

15MTAS_E24 SOLID PROPELLANT ROCKET MOTOR DESIGN 3 0 0 3 100

INTENDED OUTCOMES:

To study the solid propellant rocket motor design and its structural and material properties for various loading conditions.

UNIT I OVERVIEW OF SOLID PROPELLANT ROCKET MOTOR DESIGN

General Characteristics, Rocket Motor Design Features, Rocket Motor Case Construction, Propellant Property Characterization, Thermal Properties, Mechanical Properties, Failure Properties.

UNIT II APPLICATION OF STRUCTURAL INTEGRITY AND STRUCTURAL ANALYSIS

Introduction, Load Analysis, Stress-Strain Behaviour, Analyses Based On Elasticity, Viscoelasticity, Structural Test Motors

UNIT III MATERIAL CHARACTERISATION

Analyses For Specific Loads-Uniform Cooling, Pressurization, Acceleration

UNIT IV MARGIN OF SAFETY DETERMINATION

Cumulative Damage And Margin Of Safety, Grain Geometry, Effects of microstructure on explosive behavior

UNIT V FAILURE CRITERIA

Failure Analyses- Cohesive Fracture, Adhesive Bond Fracture, Excessive Deformation, Creep Compliance, Dynamic Modulus

TEXT BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Vigor Yang , Thomas B. Brill , Wu-Zhen Ren	Solid Propellant Chemistry Combustion and Motor Interior Ballistic	American Institute of Aeronautics	2000
2.	A. Davenas	Solid Rocket Propulsion Technology	Pergamon; 1st edition	1992

REFERENCE BOOKS:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	George P. Sutton, Oscar Biblarz	Rocket Propulsion Elements	Wiley India Pvt Ltd; Seventh edition	2010
2.	Martin J. L Turner	Rocket and Spacecraft Propulsion, Second Edition	Springer Verlag	2012

WEB REFERENCES:

http://arc.aiaa.org/doi/book/10.2514/MSPR64
http://isssp.in/evolution-of-solid-propellant-rockets-in-india/
http://www.drdo.gov.in/drdo/pub/monographs/Introduction/rocket-2014.pdf
http://pubs.acs.org/doi/abs/10.1021/ba-1969-0088.ch007
http://www.aerospace.org/education/inspiring-the-next-generation/space-primer/solid-propellants/
http://www.intechopen.com/books/polyurethane/htpb-polyurethane-a-versatile-fuel-binder-for-composite-solid-propellant