SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with "A" Grade by NAAC
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SAEA1502	AEROSPACE PROPULSION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To introduce the concepts of applying Aero thermodynamics to non air breathing propulsion.
- To familiarize the student's ability to analyze the concepts of Advance Propulsion.
- To understand the basics of Solid Propellant, Liquid Propellant and Cryogenics.
- To understand the basics of Micro propellants.

UNIT 1 FUNDAMENTALS OF ROCKET PROPULSION **9 Hrs.**

History and evolution of rockets - Rocket principle and Rocket equation - Classification of rockets - Mass ratio of rocket- Rocket Nozzles - Classifications - Nozzle Performance - Nozzle area ratio - Mass flow rate Characteristic velocity - Thrust coefficient-Performance parameters and Efficiencies of rocket - Staging and Clustering.

UNIT 2 SOLID PROPELLANT ROCKET **9 Hrs.**

Hardware components and its functions - Mechanism of burning - Ignition system and igniter types- Propellant grain configuration and its applications - Burn rate - Factors influencing burn rates-Burn rate index for stable operation - Action time and burn time - Design of Solid Propellant rocket.

UNIT 3 LIQUID AND CROGENIC PROPELLANT ROCKET **9 Hrs.**

Classifications - Hardware components and its functions-Propellant feed systems and Turbo pump feed system - Injectors and types - Thrust chamber and its cooling-Cryogenic propulsion system, Special features of cryogenic systems. Thermo- physical Properties of Cryogenic Propellants; Geysering Phenomenon.

UNIT 4 ADVANCE PROPULSION TECHNIQUES **9 Hrs.**

Hybrid propellant rocket and gelled propellants - Electrical rockets - Electro-thermal, Electro-static and Electro-magnetic propulsion system- Arc-jet thruster - Ion thruster - Hall Effect Thruster - Magneto plasma dynamic thruster- Nuclear rockets - Solar sail.

UNIT 5 MICRO PROPULSION SYSTEM RAMJET PROPULSION **9 Hrs.**

Operating principle – Subcritical, critical and supercritical operation – Combustion in ramjet engine – Ramjet performance – Sample ramjet design calculations – Introduction to scramjet– Preliminary concepts in supersonic combustion – Integral ram- rocket- Numerical problems.Recent Micro Spacecraft Developments; Micro propulsion Options; Primary Set of Micro propulsion Requirements; Chemical Propulsion Options; Review of Electric Propulsion Technologies for Micro and Nano- satellites; Emerging Technologies: MEMS and MEMS- Hybrid Propulsion System.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analogise the Evolution of rockets with working principles, equation, performance parameters, efficiencies and its classification

CO2 - Discriminate the sound foundation in the design principles of solid propellants Rockets.

CO3 - Differentiate the operation various types of Liquid and Cryogenic Propellant Rocket.

CO4 - Distinguish the Working principles of hybrid rocket propellant rockets, Electrical, Electro thermal, Nuclear, Ion and Solar sail

CO5 - Compare the Working principle and performance of. Micro Spacecraft propulsion system

CO6 - Review of Electric Propulsion Technologies for Micro and Nano- satellites; Emerging Technologies: MEMS and MEMS- Hybrid Propulsion System.

TEXT / REFERENCE BOOKS

1. George P. Sutton and Oscar Biblarz. "Rocket Propulsion Elements" 9th Edition, Wiley Publication, 2016.
2. Ramamurthi.K: "Rocket propulsion" Macmillan Publishing Co, India. 1st Edition. 2010.
3. Hill.P.G. and Peterson.C.R: "Mechanics and thermodynamics of propulsion" 2nd Edition .Pearson Education, 1999.
4. V.Ganesan., "Gas Turbines", Tata McGraw-Hill Education, 3rd Edition, 2010.
5. Philip Hill and Carl Peterson, "Mechanics and thermodynamics of propulsion", Pearson India, 2nd Edition, 2010.
6. Cohen.H, Rogers.G.F.C. andSaravanamuttoo.H.I.H, "Gas turbine theory". Pearson education, 5th Edition, 2001.
7. Saeed Farokhi, "Aircraft Propulsion", John Wiley & Sons, Inc ., 2009.

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SAEA1504	FINITE ELEMENT METHODS FOR AIRCRAFT STRUCTURES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of finite elements methods.
- To evaluate the characteristics of structural members.
- To know the basic methods to solve the solid mechanics problems.
- To discuss the structural mechanics and its applications.

UNIT 1 INTRODUCTION **9 Hrs.**

Basic finite element concepts-Basic ideas in a finite element solution, General finite element solution procedure, Finite element equations using modified Galerkin method, Application: Axial deformation of bars, Axial spring element.

UNIT 2 BEAM BENDING **9 Hrs.**

Governing differential equation for beam bending, two node beam element, Exact solution for uniform beams subjected to distributed loads using superposition, Calculation of stresses in beams, Thermal stresses in beams

UNIT 3 ANALYSIS OF TRUSSES AND FRAMES **9 Hrs.**

Two dimensional truss element, three dimensional space truss element, Stresses due to lack of fit and temperature changes. Plane frame element, Thermal stresses in frames, Three dimensional space frame element

UNIT 4 TWO DIMENSIONAL ELASTICITY AND AXISYMMETRIC ELASTICITY **9 Hrs.**

Governing differential equations, Constant strain triangular element, Four node quadrilateral element, Eight node isoperimetric element. Problems-Governing equations for axisymmetric elasticity, Axisymmetric linear triangular element, Axisymmetric four nodes isoperimetric element

UNIT 5 APPLICATION FINITE ELEMENT METHODS **9 Hrs.**

Vibrational problems – equations of motion based on weak form –longitudinal vibration of bars – transverse vibration of beams Mesh Generation-Errors in the finite element method – various measures of errors- accuracy of the solution- Eigen value Problems - h & p elements- Applications of FEM software to solve simple problems, types of solver – a brief.Applications of FEM software to solve simple problems, types of solver, Applications based on general two dimensional boundary value Problem-Ideal fluid flows around an irregular object, Two dimensional steady state heat flow, Torsion of prismatic bars

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Derive the Finite element equations using modified Galerkin method for the Axial deformation of bars and Axial spring element.

CO2 - Derive the Governing differential equation for beam bending, two node beam element and thermal stresses on the beams

CO3 - Analyse the three-dimensional space truss element and space free element

CO4 - Analyse the Two-dimensional Elasticity and Axisymmetric Elasticity elements.

CO5 - Apply FEM software to solve two-dimensional boundary value Problem and Ideal fluid flows around an irregular object

CO6 - Apply FEM software to solve Two-dimensional steady state heat flow, Torsion of prismatic bars

TEXT / REFERENCE BOOKS

1. J.N Reddy. "An Introduction to the Finite Element Method", McGraw Hill, International Edition, 2011.
2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2012.
3. Segerlind L.J, "Applied Finite Element Analysis", John Wiley, 2012.
4. Rao. S.S, "Finite Element Method in Engineering", Pergamon Press, 2013.
5. Chandrupatla & Belagundu , "Finite Elements in Engineering", Prentice Hall of India Private Ltd., 1997. 6. Cook, Robert Davis et al, "Concepts and Applications of Finite Element Analysis" , Wiley, John & Sons, 1999.
6. George R Buchanan, "Schaum's Outline of Finite Element Analysis", McGraw Hill Company, 1994.
7. Taylor.C and Hughes.J.B. "Finite Element Programming of the Navier Stoke equation" Pineridge Press Limited, UK 1981.

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AEA1701	AIRCRAFT COMPOSITE MATERIALS AND STRUCTURES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To study the mechanics of composites in micro level and macro level.
- To study the plate, shell and sandwich theories of composites for various applications.
- To understand the fabrication methods and design of composite structures.

UNIT 1 MICROMECHANICS **9 Hrs.**

Introduction - advantages and application of composite materials – types of reinforcements and matrices - micro mechanics
– mechanics of materials approach, elasticity approach- bounding techniques – fiber volume ratio – mass fraction – density of composites. Effect of voids in composites

UNIT 2 MACROMECHANICS **9 Hrs.**

Generalized Hooke's Law - elastic constants for anisotropic, orthotropic and isotropic materials - macro mechanics stress- strain relations with respect to natural axis, arbitrary axis – determination of in plane strengths of a lamina - experimental characterization of lamina. Failure theories of a lamina. Hygrothermal effects on lamina.

UNIT 3 LAMINATED PLATE THEORY **9 Hrs.**

Governing differential equation for a laminate. Stress – strain relations for a laminate. Different types of laminates. in plane and flexural constants of a laminate. Hygrothermal stresses and strains in a laminate. failure analysis of a laminate. Impact resistance and interlaminar stresses. netting analysis

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UNIT 4 SANDWICH CONSTRUCTIONS **9 Hrs.**

Basic design concepts of sandwich construction - materials used for sandwich construction - failure modes of sandwich panels - bending stress and shear flow in composite beams.

UNIT 5 FABRICATION PROCESS AND REPAIR METHODS **9 Hrs.**

Various open and closed mould processes, manufacture of fibers, importance of repair and different types of repair techniques in composites – autoclave and non-autoclave methods. Structural applications of Composite Materials-Aerospace, Automobiles, Marine, Electrical, civil, Chemical etc. Manufacturing Processes.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Summarize the manufacturing processes of composite materials and its classification.
CO2 - Analyse the micromechanics and micromechanics behaviour of composite material.
CO3 - Accumulate the failure modes of composite materials and sandwich panels.
CO4 - Determine the mid plane strain and inter laminar stress of composite material.
CO5 - Evaluate the bending and buckling of laminated beams for different boundary conditions
CO6 - Estimate the natural frequency of laminated beams and plates under in-plane loads

TEXT / REFERENCE BOOKS

1. Dam Ishai., "Mechanics of Composite Materials", 2010.
2. Autar K Kaw, 'Mechanics of Composite Materials', CRC Press, 2012.
3. Madhuji Mukhapadhyay, Mechanics of Composite Materials and Structures, University Press, 2012.
4. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites," John Wiley and sons. Inc., New York, 95.
5. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989.
6. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Nostrand Reinhold Company, New York 1998.

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SAEA1702	UNMANNED AERIAL VEHICLE DESIGN	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To introduce the concepts of applying aerodynamics to UAV Design.
- To familiarize the student's ability to analyse the concepts of Avionics.
- To understand the basics of navigation in UAV Design.
- To understand the basics of Image Processing.

UNIT 1 INTRODUCTION TO UAV **9 Hrs.**

History of UAV –classification –basic terminology- The Systemic Basis of UAV-System Composition- Conceptual Phase- Preliminary Design-Selection of the System- Some Applications of UAV- Characteristics Of Aircraft Types.

UNIT 2 BASICS OF AERODYNAMICS AND AIRFRAME CHARACERTICTICS OF UAV **9 Hrs.**

Lift-induced Drag - Parasitic Drag - Rotary-wing Aerodynamics - Response to Air Turbulence- Airframe –dynamics – modelling- structures –wing design- engines types-equipment maintenance and management-control surfaces- specifications.

UNIT 3 AVIONICS HARDWARE **9 Hrs.**

Geysering Phenomenon. Autopilot –AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply processor, integration, installation, configuration, and testing.

UNIT 4 COMMUNICATION PAYLOADS, CONTROLS AND NAVIGATION **9 Hrs.**

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency , range –SAS-flight director- commands and videos-elements of control loops-flight computer, -Sensors- Waypoints navigation.

UNIT 5 DIGITAL IMAGE PROCESSING FOR UAV **9 Hrs.**

Waypoints navigation-ground control software-Recent trends in UAV-Case Studies Principles of digital aerial photography- Sensors for aerial photography - Photo-interpretation, objective analysis and image quality - Image Recognition - Image Classification – Image Fusion – Colour Image Processing - Video Motion Analysis.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Summarise the various stages for designing the Unmanned Aerial Vehicle
CO2 - Comprehend the sound foundation in the Aerodynamics and Airframe characteristics
CO3 - Choose the various Avionics Hardware based on the UAV application
CO4 - Choose the Communication payloads, Controls and Navigation for UAV
CO5 - Apply the Digital Aerial Photography techniques for UAV
CO6 - Apply the Digital image processing techniques for UAV

TEXT / REFERENCE BOOKS

1. Kimon P. Valavanis, George J. Vachtsevanos, " Handbook of Unmanned Aerial Vehicles " Volume Set- FIRST Edition, ISBN-13: 978-9048197064, 2015.
2. R. Jha. "Theory, Design, and Applications of Unmanned Aerial Vehicles".1st Edition, 2015.
3. Jane's Unmanned Aerial Vehicles and Targets, Jane' s Information Group; ASIN: 071 061 2575,1999.
4. Alex Elliott,"Build Your Own Drone Manual: The practical guide to safely building, operating and maintaining an Unmanned Aerial Vehicle (UAV)".2016.
5. R. Said and H. Chayeb, "Power supply system for UAV", KTH, 2002.
6. Robert C. Nelson, Flight Stability and Automatic Control, McGraw -Hill, Inc, 1998.
7. Skafidas, "Microcontroller Systems for a UAV", KTH, TRITA-FYS 2002:51 ISSN 0280-316 X.34, 2002.
8. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007.