Tulsiramji Gaikwad-Patil College of Engineering and Technology
Wardha Road, Nagpur-441 108
NAAC Accredited (A+ Grade)

B. Tech. IV Sem Aeronautical Engineering Honor

BAE32425: Analysis of structures

Teaching Scheme			Examination Scheme	
Lectures	**3hr/week**		**CIE**	40 Marks
Tutorials	**-**		**ESE**	60 Marks
Practical	**-**		**Total**	100 Marks
Total Credits	3		Duration of Exam: 3 Hours	

The Objectives of this course are:

1	To develop a fundamental understanding of elasticity theory, plane stress and plane strain conditions, and stress transformation techniques relevant to aircraft structural components.
2	Apply the degree of redundancy (DOR) for statically determinate and indeterminate beam structure
3	To study the behavior of beams on elastic foundations, curved beams, and to introduce classical theories of failure applicable to aerospace structural components
4	To understand the stability behavior of columns under various loading and boundary conditions and to evaluate critical loads using Euler, Rankine, and Johnson theories.
5	To apply energy methods for structural analysis and to analyze shear flow in single-cell and multi-cell closed section aircraft structures under torsional loading.

Course Contents

Unit I	**Introduction to Theory of Elasticity**: Introduction to Aircraft Structural Components, Equilibrium and Compatibility conditions for elastic solids, 2D elasticity equations for plane stress, plane strain and generalized plane strain causes Airy 's stress function. Simple problems in plane stress/plane strain stresses and strains on arbitrary planes and transformations. Concept of principle planes, stress and Strains, Construction of Mohr 's circle
Unit II	**REDUNDANT STRUCTURES:** Analysis of statically determinate structure and Indeterminate structure, order of redundancy, Introduction to redundant analysis, use of free body diagrams to explain compatibility and redundant analysis principles, Singularity method for uniform beams with various boundary and support conditions (props, hinges and fixities) subjected to distributed / discrete loads (including moment) moment area method analysis of various types of beams, three moment equation (Clapeyron theorem) of a continuous beams
Unit III	**BEAMS WITH ELASTIC SUPPORTS AND INITIAL CURVATURE, THEORIES OF FAILURE INTO WERE THEORIES OF FAILURE —** Direct solution of beams on elastic foundation, deflection of beams, Equation of equilibrium for curved beam and deflection of typical curved beams (Bulkhead sections on Fuselage) Introduction – Various theories of failure - Maximum Principal Stress Theory, Maximum Principal Strain Theory, Strain Energy and Shear Strain Energy Theory (Von Mises Theory) and fracture modes
Unit IV	**STABILITY OF COLUMNS** Stability of structural systems, Models of instability of columns. Euler 's formula for critical loads of column, end conditions of a column, Slenderness ratio, Effect of boundary conditions on mode shapes and critical loads. Column with initial curvature, effect of eccentricity Long, Medium and short column ranges. Rankine and Johnson's formulae. Effect of intermediate support. Concept of beam column.
Unit V	**ENERGY PRINCIPLES AND METHODS, SHEAR FLOW IN CLOSED SECTIONS** Introduction to energy principle and methods. Principle of virtual Displacements and principle of Virtual Force Castigliano's theorems, maxwell's reciprocal theorem and unit load method. Bredt-Batho formula. Single and multi-cell closed box structures. Semi monocoque and monocoque

structures. Approximate method for box beams. Shear flow in single and multicell monocoque and semi monocoque box beams subject to torsion.

	Text Books
1	Megson T. H. G (2012), Aircraft Structures for Engineering Students, 5th edition, Elsevier, New York.
2	Strenght of Materials by R.K Rajput S.chand publishers.
3	

	Reference Books
1	Irving Herman Shames, Clive L. Dym (2003), Energy and finite element methods structural analysis, McGraw Hill, New Delhi, India.
2	B. C. Punmia (2011), Theory of Structures, 13th edition, Laxmi Publications Ltd, Hyderabad.
3	Donaldson B. K (2008), Analysis of Aircraft Structures an introduction to Aeronautical Structures Analysis, 2nd edition, Cambridge University Press, USA.

	Useful Links
1	https://cosmolearning.org/courses/introduction-aerospace-structures/
2	http://www.triumphgroup.com/business-units/aerospace-structures/
3	https://www.edx.org/course/introduction-to-aerospace-structures-and-materials

BAE32425	Course Outcomes	CL	Class Sessions
CO1	**Develop** the mathematical model for a physical structure subjected to external loads applied on it.	3	9
CO2	**Calculate** the degree of redundancy for statically determinate and indeterminate beam structure	3	9
CO3	**Determine** the curved deflection due to forces and moments on an aircraft fuselage structure	3	9
CO4	**Illustrate** the stresses and strains in members subjected to combined loading and apply the theories of failure for static loading	2	9
CO5	**Estimate** the buckling load equations for different boundary conditions of the columns and shear flow distribution in an aircraft structures like wings & fuselage	2	9

B. Tech. IV Sem Aeronautical Engineering Minor

BAE32421: Aerospace Materials

Teaching Scheme			Examination Scheme	
Lectures	3 Hr /Week		ESE	60 Marks
Tutorial	-		CIE	40 Marks
Practical	-		Total	100 Marks
Theory Credits : 3			Duration of Exam :3 Hours	

Course Objectives

The Objectives of this course are:

1.	**Acquire** knowledge of different aerospace materials & their properties.
2.	**Understand** the manufacturing processes of composite materials
3.	**Characteristics** and Applications of various Materials.
4.	**Acquire** knowledge of smart materials

Course Contents

Unit-I	**Introduction to aerospace materials** Classification, composition, properties, heat treatment & application of plain carbon steels, alloy steels. Stainless steels. Classification, composition, properties, heat treatment and application of aluminum and its alloys. Titanium alloys, Special alloys for high temperature.
Unit-II	**Composite Materials** Definition, classification of composite materials, classification of reinforcement, particulate, short fiber, whiskers, long fibers composites. Matrix materials, metals, ceramics, polymers (including thermoplastics and thermosets), Carbon Composites MMC with particulate and short fiber reinforcement, liquid and solid state processing of MMC, stir casting, squeeze casting. Propertiesof MMCs, Applications of Al, Mg, Ti based MMC.
Unit-III	**Manufacturing of advanced composites** Polymer matrix composites: Preparation of moulding compounds and prepregs, hand layup methodAutoclave method, Filament winding method, Compression moulding, Reaction injection moulding. Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding, Hot isostatic pressing.
Unit-IV	**Mechanical Properties** Tensile test, plastic deformation mechanisms, slip and twinning, role of dislocations in slip strengthening methods, strain hardening, refinement of the grain size, solid solution strengthening precipitation hardening, creep resistance, creep curves, mechanisms of creep, creep-resistant materials, fracture, the Griffith criterion, critical stress intensity factor and its determination, fatigue failure, fatigue tests, methods of increasing fatigue life, hardness, Rockwell and Brinell hardness, Knoop and Vickers micro hardness, Fracture and Fatigue, Stress Intensity Factor, Crack Growth Rate Derivation.
Unit-V	**Smart Materials** Ferromagnetism, domain theory, types of energy, hysteresis, hard and soft magnetic materials, ferrites, dielectric materials, types of polarization, Langevin-Debye equation, frequency effects on polarization, dielectric breakdown, insulating materials, Ferroelectric materials, superconducting materials and their properties. Smart materials like Piezoelectric materials, Shape Memory Alloys (SMA), magneto-strictive materials, Electro-rheological Fluids, Magneto Rheological Fluids. etc

Text Books		
1	Material Science and Technology: A comprehensive Treatment by R. W. Cahn, P. Haasen, E. J. Kramer, Tsu-Wei Chou, Wiley-VCH; Volume 13 edition, 1993.	
2	Composite Materials by K. K. Chawla, Springer-Verlag, New York, 1st edition, 1987.	
3	The Analysis of laminated Composite Structures by Calcote, L. R., Von-Noastrand Reinhold, 1st edition, 1970.	
Reference Books		
1	G. Askeland, D. "Materials Science and Engineering", Brooks Cole, 3rd edition, 2010.	
2	Smith, W.F., Hashemi, J. and Prakash, R., "Materials Science and Engineering", Tata McGraw Hill, A. 5th edition, 2016.	
	Useful Links	
1	https://nptel.ac.in/courses/101/104/101104010/	
2	https://nptel.ac.in/courses/101/106/101106038/	
3.	https://nptel.ac.in/courses/101/105/101105084/	

BAE32421	Course Outcomes	CL	Class Sessions
CO1	**Apply** the knowledge of properties and classification of materials inselection of materials for aerospace applications.	2	9
CO2	**Examine** the uses of composite materials in aircraft structures.	2	9
CO3	**Apply** the knowledge of different composite materials manufacturing processes for selecting appropriate processes for particular material.	3	9
CO4	**Apply** the knowledge for selection of appropriate tests for particular application through understanding different mechanical propertiesand testing methods.	3	9
CO5	**Comprehend** application of advanced materials in the aviation industry.	4	9