

BMEE321L	Composite Materials		L	T	P	C
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<b>Pre-requisite</b>	BMEE202L, BMEE202P		<b>Syllabus version</b>			
			1.0			
<b>Course Objectives</b>						
<p>1. Provide students a basic understanding and uses of composite materials, develop skill to understand different composites manufacturing methods.</p> <p>2. To enable the students to find physical and mechanical properties of composites using micromechanics and experimental methods.</p> <p>3. Illuminate the knowledge and skills to design the composite laminate subjected to different in-plane loading conditions by applying the mechanics and failure theories of the composite materials.</p>						
<b>Course Outcome</b>						
<p>At the end of the course, the student will be able to</p> <p>1. Analyse the various fabrication techniques and select suitable method for given application.</p> <p>2. Evaluate material properties of composite material using micromechanics.</p> <p>3. Calculate displacement, strain and stresses in composite laminates.</p> <p>4. Propose the construction of laminate for given loading conditions.</p> <p>5. Examine the failure of laminate using different failure theories.</p> <p>6. Evaluate experimentally the material properties of the composite laminates.</p>						
<b>Module:1</b>	<b>Introduction</b>					<b>5 hours</b>
<p>Definition, Classification of Composites, Applications of Composites Reinforcing Fibers: Synthetic fiber, Natural Fibers; Matrix Materials: Polymers such as Thermosetting and Thermoplastic Polymers, Metals and ceramics.</p> <p>Fabrication of PMC's, MMC's C/C and CMC's Composites.</p>						
<b>Module:2</b>	<b>Micromechanics of Unidirectional Composites</b>					<b>6 hours</b>
<p>Introduction, Micromechanical Analysis of a Lamina-Volume and Weight Fractions and void content Prediction of Elastic constants using Micromechanics, Ultimate Strengths of a Unidirectional Lamina, Coefficients of thermal and Moisture expansion.</p>						
<b>Module:3</b>	<b>Macro mechanical Analysis of Lamina</b>					<b>8 hours</b>
<p>Introduction, Stress-Strain Relations for Orthotropic Materials, Transversely Isotropic Material, Isotropic Material, Transformation of Engineering Constants, Hooke's Law and Stiffness and Compliance Matrices: General Anisotropic Material, Transformation of Stress and Strain, Orthotropic Material under Plane Stress Compliance Tensor and Compliance Matrix, Relations between Engineering Constants and Elements of Stiffness and Compliance Matrices, Transformation of Stiffness and Compliance Matrices.</p>						
<b>Module:4</b>	<b>Analysis of Laminated Composites</b>					<b>8 hours</b>
<p>Classical Lamination Theory (CLT): Introduction, Laminate Displacements and Strains, Laminate Stresses, Resultant Forces and Moments, Laminate Constitutive Relations, Laminate Description System Design, Construction and Properties of Laminates: Symmetric Laminates Unidirectional, Cross-Ply, and Angle-Ply Laminates Quasi-Isotropic Laminates</p>						
<b>Module:5</b>	<b>Theories of Failures</b>					<b>6 hours</b>
<p>Strengths of an Orthotropic Lamina, Failure of Laminates, Maximum-Stress Theory, Maximum-Strain Theory, Maximum-Work Theory, Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Initial Failure Laminate Analysis after Initial Failure, Hygrothermal Stresses in Laminates</p>						
<b>Module:6</b>	<b>Experimental Characterization of Composites</b>					<b>4 hours</b>
<p>Introduction, Measurement of Physical Properties, Density, Constituent Weight and Volume Fractions, Void Volume Fraction, Thermal Expansion Coefficients, Moisture Absorption and Diffusivity Moisture Expansion Coefficients</p>						

<b>Module:7</b>	<b>Mechanical Properties and Damage assessment of composites</b>	<b>6 hours</b>
Properties in Tension, Properties in Compression, In-Plane Shear Properties, Flexural Properties, Interlaminar Shear Strength and Fracture Toughness, In-Plane Fracture Toughness Tests, Dynamic properties, Impact Tests, Tests for Aerospace Applications, Damage Identification Using Non-destructive Evaluation Techniques, Ultrasonics Acoustic Emission X-Radiography Thermography Laser Shearography		
<b>Module:8</b>	<b>Contemporary Issues</b>	<b>2 hours</b>
<b>Total Lecture hours:</b>		<b>45 hours</b>
<b>TextBook</b>		
1.	Autar K. Kaw, Mechanics of Composite Materials, 2006, 2 <sup>nd</sup> Edition, Taylor & Francis	
<b>Reference Books</b>		
1.	Robert Millard Jones Mechanics of Composite Materials 2 <sup>nd</sup> Edition CRC Press.	
2.	Jack R. Vinson, Robert L. Sierakowski The behavior of structures composed of composite materials, 2006, Springer, Dordrecht	
3.	M. W. Hyer, Scott R. White Stress Analysis of Fiber-reinforced Composite Materials, 2009 DEStech Publications.	
Mode of Evaluation: CAT, Written assignment, Quiz, FAT		
Recommended by Board of Studies	09-03-2022	
Approved by Academic Council	No. 65	Date 17-03-2022