ME 451 COURSE PROFILE

DEGREE PROGRAM: Mechanical Engineering

COURSE NUMBER: ME 451	**COURSE TITLE:** Properties of Advanced Materials for Design Engineers
REQUIRED COURSE OR ELECTIVE COURSE: Elective	**TERMS OFFERED:** Fall
TEXTBOOK / REQUIRED MATERIAL: Analysis and Performance of Fiber Composites by B. D. Agarwal and L. J. Broutman	**PRE / CO-REQUISITES:** MECHENG 382. II (3 credits)
COGNIZANT FACULTY: J. Pan **BULLETIN DESCRIPTION:** Mechanical behavior and environmental degradation of polymeric-, metal-, and ceramic-matrix composites; manufacturability of advanced engineering materials; use of composite materials in novel engineering designs.	**COURSE TOPICS:** 1. Composite constituents, properties 2. Stiffness and strength of lamina 3. Laminate analysis 4. Shear Lag Analysis 5. Design examples 6. Processing
COURSE STRUCTURE/SCHEDULE: Lecture: 2 days per week at 1.5 hours	

COURSE OBJECTIVES: **for each course objective, links to the Program Outcomes are identified in brackets.**	1. To teach students the major constituents in engineering composites, how the different constituents are processed and what their mechanical and physical properties are [1] 2. To teach how to determine the anisotropic stiffness' and strengths of various composite lamina types [1, 2] 3. To teach how to determine the anisotropic stiffness' and strengths of various composite laminates [1, 2] 4. To teach how to design with composite laminae or laminates such that they gain an appreciation for the wide design flexibility composites afford and the cascading design effects associated with composites [1, 2, 4, 6] 5. To teach how to determine the failure processes of engineering composites [1, 2, 4, 6] 6. To teach traditional and modern composites manufacturing techniques [1, 2, 6]
COURSE OUTCOMES: **for each course outcome, links to the Course Objectives are identified in brackets.**	1. Knowledge of the types of ceramic, polymer and metal fibers available [1] 2. Knowledge of the different types of polymer matrices, how they are processed and their rate and temperature dependent properties [1] 3. Knowledge of the different metal and ceramic matrix materials used in engineering composites and their properties [1] 4. Derive and use equations for the upper and lower bounds of the elastic modulus of a composite lamina [2] 5. Determine the stiffness and strength of short fiber reinforced composites using the shear lag theory [2, 3] 6. Determine the stiffness of an anisotropic lamina along arbitrary directions using the concept of coordinate transformation [2, 3] 7. Understand the deformation and failure mechanisms in a composite lamina and laminate [2, 3] 8. Analyze the effects of various load or displacement boundary conditions by applying laminate analysis to composite structures [3] 9. Develop and use design equations for the stiffness and strength variation in composites as functions of constituent properties and amounts [4] 10. Understand how to use composites as substitute materials in design to meet several competing requirements when monolithic components can not [4] 11. Understand various degradation processes associated with composite materials and their implications for long service life [5] 12. Understand the differences in thermoplastic and thermoset polymers and the implications for composite processing [6] 13. Determine the manufacturing process for a given composite type and component [6]
ASSESSMENT TOOLS: **for each assessment tool, links to the course outcomes are identified**	1. Regular homework assignments 2. Exam(s) and/or project(s)

PREPARED BY: J. Pan

LAST UPDATED: 05/11/2023 – K. Oldham