**ME 451 COURSE PROFILE**  
DEGREE PROGRAM: Mechanical Engineering  

<table>
<thead>
<tr>
<th>COURSE NUMBER: ME 451</th>
<th>COURSE TITLE: Properties of Advanced Materials for Design Engineers</th>
</tr>
</thead>
<tbody>
<tr>
<td>REQUIRED COURSE OR ELECTIVE COURSE: Elective</td>
<td>TERMS OFFERED: Fall</td>
</tr>
<tr>
<td>TEXTBOOK / REQUIRED MATERIAL: Analysis and Performance of Fiber Composites by B. D. Agarwal and L. J. Broutman</td>
<td>PRE / CO-REQUISITES: MECHENG 382. II (3 credits)</td>
</tr>
<tr>
<td>COGNIZANT FACULTY: J. Pan</td>
<td>COURSE TOPICS:</td>
</tr>
</tbody>
</table>
| 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. | 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