CFT A120: COMPOSITE STRUCTURES: PROTOTYPE DEVELOPMENT, ASSEMBLY, REPAIR AND TESTING

Item	Value
Curriculum Committee Approval Date	11/04/2020
Top Code	095600 - Manufacturing and Industrial Technology
Units	4 Total Units
Hours	108 Total Hours (Lecture Hours 54; Lab Hours 54)
Total Outside of Class Hours	0
Course Credit Status	Credit: Degree Applicable (D)
Material Fee	No
Basic Skills	Not Basic Skills (N)
Repeatable	No
Open Entry/Open Exit	No
Grading Policy	Standard Letter (S)

Course Description

This lecture/laboratory course introduces the student to more advanced manufacturing characterization methods unique to isotropic and anisotropic properties found in intermediate composite materials. Mapping of the performance characteristics unique to objects featuring wood, polymers, and high-performance fibers is used to optimize material selection in hybrid manufacturing. This course includes the practical application of intermediate processes and tooling unique to small to medium-sized fabrication organizations. It also reviews the concepts, principles, and methods employed for the destructive and nondestructive evaluation (NDE) of composite structures and materials to comply with industry certification objectives. Transfer Credit: CSU.

Course Level Student Learning Outcome(s)

1. Create a full scale 1:1 prototype of a project made with composite materials
2. Complete a performance evaluation of the built structure and provide documentation of the intermediate fabrication process.
3. Gain an intermediate understanding of composite fabrication which includes materials, adhesives, mold making, vacuum bagging, and various methods of curing.

Course Objectives

- 1. Fundamentals of molding techniques using cold form one and two-part molds
- 2. Understand the use and operation of open and closed form molds
- 3. Derive and use equations for the destructive testing of a composite lamina
- 4. Determine the stiffness and strength of short and long fiber reinforced composites using the shear lag theory.
- 5. Determine the performance characteristics of an anisotropic lamina built with a variety of core materials using the concept of coordinate transformation
- 6. Understand the machining properties of polymer and organic matrix composites found in industrial use.
- 7. Analyze the effects of use responses of composites in a variety of environmental scenarios
- 8. Develop and use design equations for the stiffness and strength variation in composites as functions of constituent properties and amounts, more specifically in the area of chemical cure resins and long fiber composite textiles
- 9. Understand how to use composites as substitute materials in design to meet several competing requirements when monolithic components can not
- 10. Understand various degradation processes associated with composite materials and their implications for long service life
- 11. Determine the optimum manufacturing process for a given composite type and component

Lecture Content

Composites lab orientation and tool use survey CNC digital control and conventional machinery Layout and measuring equipment Calibration tools Automated and hand-applied finishing equipment Creation of molds using intermediate prototyping skills Understanding basic core materials in mold making Layout and milling of molds and lasts for composites manufacture Understanding release agents Using shop-built laminates and light timber structures Milling and precision geometry of organic composites Hybrid assemblies using organic and polymer core materials Adhesives and binder selection Curing and testing of adhesives in a variety of environments Intermediate use of Pre-preg composites for structure construction Vacuum bagging and infusion techniques One-part molds used in vacuum bag manufacturing Vacuum infusion of flat and curved components Survey of infusion mesh and breather cloth for parts manufacture Test and evaluate simple mechanical and mechatronic components for performance and failure behavior using physical and virtual prototypes Composites repair methods Gel coating and polymer finishing methods Safety guidelines when using liquid and gel coatings Chemical cure finishes and pigments Air cure finishes and pigments Oven cure finishes and pigments Performance and durability considerations of finishing agents Project planning Cost estimating Design and fabrication timelines Sequencing of job tasks Structural non-destructive and destructive testing Environmental considerations in the fabrication workspace. Material handling Disposal of waste products Emerging trends in the use of polymers and membrane technology impact on the environment

Lab Content

Laboratory and tool orientation Power tools and CNC equipment Hand tools orientation Automated and conventional finishing equipment Mold making Demonstrate layout and milling Releasing agents Milling using laminates and light timber Hybrid assemblies Adhesives Vacuum bagging and infusion techniques Testing and evaluating simple mechanical and mechatronic components for performance and failure behavior using physical and virtual prototypes Composites repair methods Gel coating and polymer finishing methods Documentation for project planning Cost estimates Timelines Job sequencing Testing - non-destructive and destructive Demonstration of environmentally conscientious processes Material handling disposal of waste products Emerging trends (polymers and membrane technology)

Method(s) of Instruction

- Lecture (02)
- DE Live Online Lecture (02S)
- Lab (04)
- DE Live Online Lab (04S)

Instructional Techniques

Lecture, demonstration, videos, class discussions, experiments, material testing.

Reading Assignments

Students will spend approximately 3 hours a week reading from the textbook and from instructor-generated materials that support specific topics covered in the class lectures.

Writing Assignments

Students will be required to complete approximately 2 hours a week working on writing assignments. Students will be required to document all of the relevant steps in each of the fabrication processes and then document the results of destructive and non-destructive testing of the completed sub-assemblies.

Out-of-class Assignments

Students will spend approximately 2 hours a week completing field research assignments that require students to identify and apply concepts learned in class to real-life uses of composites. They will also be required to work and complete small fabrication projects.

Demonstration of Critical Thinking

Students will determine which composite is appropriate for creating specific projects, including adhesive selection and mixing. This will require that students complete mathematical computations based on mixing ratios and structure performance characteristics.

Required Writing, Problem Solving, Skills Demonstration

Students will participate in a selected building project which will provide a platform for developing and demonstrating the basic design of the use of composites in general fabrication. The foundational skills learned will be incorporated into future design and building efforts undertaken by a designer/maker.

Eligible Disciplines

Manufacturing technology (quality control, process control): Any bachelor's degree and two years of professional experience, or any associate degree and six years of professional experience.

Textbooks Resources

1. Required Fochtman, F.. Comprehensive Guide to Composites: Processes and Procedures from the Professionals, 2 ed. Aviation Supplies Academics, Inc, 2015 Rationale: .

Other Resources

1. The instructor will provide handouts and materials.