

# STRANDS AND STANDARDS

## COMPOSITES 2



### Course Description

This course is the second in a series of two courses on the manufacture of goods and items made of composites. This course will focus mainly on the material properties and manufacturing principles of advanced composites (generally carbon-fiber parts for the aerospace industry).

|                                      |                  |
|--------------------------------------|------------------|
| <b>Intended Grade Level</b>          | 10-12            |
| Units of Credit                      | 0.5              |
| Core Code                            | 38.02.00.00.252  |
| Concurrent Enrollment Core Code      | None             |
| Prerequisite                         | None             |
| Skill Certification Test Number      | None             |
| Test Weight                          | N/A              |
| <b>License Area of Concentration</b> | CTE or Secondary |
| <b>Required Endorsement(s)</b>       | Composites       |

## STRAND 1

**Students will follow safety practices.**

### Standard 1

Identify potential safety hazards and follow general laboratory safety practices.

- Assess workplace conditions regarding safety and health.
- Identify potential safety issues and align with relevant safety standards to ensure a safe workplace/jobsite.
- Locate and understand the use of shop safety equipment.
- Select appropriate personal protective equipment.

### Standard 2

Use safe work practices.

- Use personal protective equipment according to manufacturer rules and regulations.
- Practice a culture of safety, maintain an attitude of safety in daily operations.
- Follow correct procedures when using any hand or power tools.
- Ref: <https://schools.utah.gov/file/4de1dd59-0425-4f76-9e33-fdcf5de45dbf>

### Standard 3

Complete a basic safety test without errors (100%) before using any tools or shop equipment.

## STRAND 2

**Students will enhance their understanding of the composites industry by learning and demonstrating appropriate safety procedures that apply specifically to composites fabrication.**

### Standard 1

Know how to find and interpret Safety Data Sheets (SDS).

- Be able to read and understand the product labeling.
- Know how to react to exposure of dangerous products.

### Standard 2

Develop appropriate safety rules for the laboratory.

- Understand the safety rules for storage and disposal of resins, solvents, and other volatile liquids.
  - Peroxides and other dangerous fluids and solvents.
  - Highly contaminating substances (including mold release).

### Standard 3

Maintain a high standard of work area cleanliness and order.

- Industrial – clean as you go, assign a place for all tools and supplies and then replace them to their assigned place.
- Personal – use PPE to protect yourself from chemicals and chemical reactions.

- Understand the requirements and purposes of protecting against foreign object damage/debris (FOD).
- Practice effective clean room and dust room procedures (isolation).

### STRAND 3

**Students will demonstrate familiarity with the basic materials used in the composites industry.**

#### Standard 1

Review the differences between fiberglass reinforced plastics (FRP) and advanced composites. For example:

- In FRP the properties of the plastic dominate, and the reinforcement adds strength and stiffness, whereas advanced composites are dominated by reinforcement properties and the matrix is secondary.
- FRP sometimes uses random fiber orientation, whereas advanced composites fibers are carefully placed.
- The material properties of the components are higher in advanced composites.
- Fiberglass or natural fibers are used in FRP whereas carbon or other very strong and stiff fibers are typically used in advanced composites.

#### Standard 3

Identify the reinforcement materials used in advanced composites. For example:

- Carbon (including metal-coated)
- Aramid (Kevlar)
- Polyethylene (Spectra)
- Boron, basalt, and other specialty fibers
- Ceramic
- Metal

#### Standard 4

Identify the reinforcement material forms that are available for use in advanced composites. For example:

- Filaments, tow, strands, yarns
- Prepreg (unidirectional) tape (include a discussion of why prepreg must be stored at low temperature)
- Woven and non-woven
- Preforms (braids, knits, stitched)

#### Standard 5

Identify and briefly discuss the matrices used in advanced composites. For example:

- Epoxies
- Bismaleimide (BMI)

**Standard 6**

Identify core materials and their purpose.

- The I-beam effect (stiffness).
- Types of sandwich materials (rigid foams, honeycomb, Balsa wood, others).
- Bonding sandwich materials to composite face sheets.

**STRAND 4**

**Students will gain experience performing wet layup and vacuum bagging processes with advanced composites materials.**

**Standard 1**

Discuss and illustrate the wet (thermoset) manufacturing methods used with advanced composites.

- Wet layup/hand layup
- Compression molding (discuss BMC and SMC)
- Filament winding
- Pultrusion
- Resin transfer molding (RTM)
- Tape laying

**Standard 2**

Follow a drawing as it relates to the placement and orientation of the fibers to counteract the loads that will be applied.

- Be able to read and interpret layup drawings/manufacturing plans.
  - Plies
  - Orientation
  - Dimensions
  - Alignments
- Locate and proper interpret the layup tools for the orientation clock.
- Demonstrate the ability to apply laminates according to the documentation.

**Standard 3**

Use common manufacturing practices employed for composites and documentation.

For example:

- Read the resin label.
- Select the resin that meet the specifications.
- Select the reinforcement materials that meet the specifications.
- Control the reinforcement to resin ratio (fiber volume).
- Resin system components are mixed by weight, not volume.
- Understand the cure profile (heat cycle).
- Consolidate the composite during cure to ensure that the layers are properly adhering, fiber resin content is correct, and the voids are reduced.

**Standard 4**

Create wet layups with and without bagging procedures.

- Discuss automated cutting (include nesting concept).
- Use accepted industry clean-room procedures.
- Discuss vacuum bagging (discuss all bagging materials, illustrate bag side and mold side, discuss use of caul plates or pressure pads).
- Discuss autoclave curing.
- Discuss out-of-autoclave curing.
- Discuss tooling (molds) for layup (including materials and support structures).
- Discuss roll wrapping.

**Standard 5**

Compare and contrast the material properties of composite samples.

- Wet layup without a vacuum bag
- Wet layup with a vacuum bag.
- Prepreg with a vacuum bag or mold.
- Prepreg without a vacuum bag or mold.

**Standard 6**

Discuss and illustrate automated processes for advanced composites.

- Discuss and illustrate resin transfer molding (RTM) and other liquid infusion processes.
- Discuss the need for fiber placement and tape laying and the limitations (part size, complexity) for these methods.
- Discuss the economics of manufacturing processes for advanced composites.

**STRAND 5**

**Students will enhance their understanding of the composites industry by learning and demonstrating appropriate and safe processes for parts fabrication.**

**Standard 1**

Understand how the flow of parts through the plant is monitored and improved.

- Part travelers or computer.
- Understand the concepts of work in progress (WIP) and bottlenecks.

**Standard 2**

Investigate how unused or waste raw materials and waste molded parts are disposed of and/or recycled.

- Expired or scrap prepreg.
- Waste solvents.
- Expired peroxides.
- Dust and solid composite molded parts.
- Rejected composite molded parts.

**Standard 3**

Practice accurately machining cured composites.

- Set a reference point for the cutting machine.
- Use fixtures and jigs for drilling and countersinking holes.
- Investigate specialized cutting tools for composites.
- Choosing a tool (depends on the type of reinforcement and the type of cut to be made), usually grinding rather than cutting.
- Consider dust control and tool wear.

**STRAND 6**

**Students will enhance their understanding of the composites industry by learning and demonstrating appropriate and safe processes for parts fabrication.**

**Standard 1**

Install fasteners properly.

- Demonstrate and understanding of the corrosion potential between carbon composites and aluminum.
- Identify various types of fastener materials – steel, titanium, Inconel.
- Install fasteners in composites.

**Standard 2**

Demonstrate how to make proper adhesive bonds on composites.

- Prepare the surface.
- Choose an appropriate adhesive.
- Cure the adhesive.

**Standard 3**

Describe what sandwich structures are, their purpose, and how to make them.

- Types of sandwich materials (rigid foams, honeycomb, others).
- Bonding of sandwich materials to composite face sheets.
- Cutting and drilling sandwich structures.

**Standard 4**

Demonstrate how to effectively use sealant.

- Define what sealant is and where is it used in composite assemblies.
- Apply a sealant appropriately.

**Performance Skills**

1. Identify the advanced materials used in the composites industry.
2. Demonstrate appropriate and safe composites fabrication using advanced composites materials while performing wet layup and vacuum bagging processes to industry standard.

3. Demonstrate practice of the *Technology & Engineering Professional Workplace Skills*.  
<https://schools.utah.gov/cte/engineering/resources>
4. Participate in a significant activity that provides each student with an opportunity to render service to others, employ leadership skills, or demonstrate skills they have learned through this course, preferably through participation in a Career & Technical Student Organization (CTSO) such as SkillsUSA.