**MANUFACTURING SYLLABUS (Semester I)**

**Course Description**: The manufacturing curriculum lecture series offers an extensive set of training modules including types/categories of manufacturing, metal casting technology, metal forming methods, machining, plastic/composite manufacturing, joining/fastening, 3D printing/rapid prototyping, automation/assembly and computer aided manufacturing. The curriculum assumes the basis of material, metrology, math and methods of design exposure through education and/or experience. Emphasis is placed with advanced manufacturing technology existing and emerging. There are 9 topic areas described below;

* **Types of Manufacturing**: This module provides a comprehensive base in understanding overall differentiation of traditional and advanced manufacturing. Manufacturing methods are sub classified as subtractive, additive or hybrid technologies. Firm understanding of these concepts is required before other manufacturing topic areas are discussed. Industry applications, advantages and drawbacks are identified.
* **Casting**: Casting is one of the oldest methods of molding (7000 yrs). It is a process in which a liquid material is usually poured into a [mold](https://en.wikipedia.org/wiki/Mold_(manufacturing)), which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. Casting materials are metals or various solidifying materials that harden after mixing two or more parts together. Examples are [epoxy](https://en.wikipedia.org/wiki/Epoxy), [concrete](https://en.wikipedia.org/wiki/Concrete), [plaster](https://en.wikipedia.org/wiki/Plaster) and [clay](https://en.wikipedia.org/wiki/Clay). Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods. This module explains the types of casting technologies used in industry today as well as review of application examples as well as casting mold design.
* **Metal Forming & Fabrication**: Forming is the [metalworking](https://en.wikipedia.org/wiki/Metalworking) process of creating metal parts and objects through mechanical deformation; the workpiece is reshaped without adding or removing material and mass remains unchanged. Forming utilizes the [material science](https://en.wikipedia.org/wiki/Materials_science) principle of [plastic deformation](https://en.wikipedia.org/wiki/Plastic_deformation) where the physical shape of a material is permanently deformed due to inherent malleability and ductility. This module covers methods of roll forming, forging, extrusion, die forming and stamping. Methods of heat treatment are addressed for hardening and annealing operations. Tool design is explained in detail.
* **Machining**: Machining includes processes in which a material (metal, wood, plastic, ceramic or composites) is cut to a desired final shape and size by a controlled subtractive material-removal process. A comprehensive overview of turning, boring, drilling, milling, broaching, sawing, shaping, planing, tapping, grinding and finishing are presented. More advanced methods are also introduced; [electrical discharge machining](https://en.wikipedia.org/wiki/Electrical_discharge_machining), [electrochemical machining](https://en.wikipedia.org/wiki/Electrochemical_machining), [electron beam machining](https://en.wikipedia.org/wiki/Electron_beam_machining) and [photochemical machining](https://en.wikipedia.org/wiki/Photochemical_machining). The lecture series also covers, types of machining equipment, cutting tools, fixturing and the use of computer based numerical control (CNC).
* **Plastic & Composite MFG**: Plastic & Composite manufacturing is primarily additive in nature and includes unique construction and fabrication methods. Fundamental molding methods are introduced including injection molding, thermoforming, compression molding, resin transfer molding (RTM), extrusion, blow molding and specialized techniques. Methods of composite construction are then presented including layup, lamination, autoclaving as well as new technologies. Typical machinery and tool design concepts are described as well as differences in material types for thermoset and thermoplastic applications. Material/construction reinforcement strategies are covered.
* **Joining & Fastening**: This module reviews mechanical fastening, bonding and welding technologies with in-depth review of specific methods (e.g rivets, screws, bolting, adhesives, MIG/TIG, ultrasound/thermal welding…) to manufacturing processes and related product applications. Guidelines to use in how components are joined are described in detail. Advantages and drawbacks are highlighted.
* **3D Printing/Rapid Prototyping**: Extensive focus on 3D printing methods (e.g. FDM, SLA, SLS, metal DED…) highlighting types of materials, tradeoffs in print methods, digital preparation of product models and comprehensive review of applications in industry are illustrated. Additional methods of additive manufacturing which create concept and functional prototypes are described.
* **Automation & Assembly**: Cycle time and minimizing variation of manufactured products are the major benefits of automated assembly. It goes beyond the concept of mass production in making product volume. This module provides a comprehensive overview into robotics, work cells and associated methods on the plant floor that create low cost, high quality products minimizing inefficient tasks
* **Computer Aided Manufacturing**: CAM digital representation of virtual parts and assemblies comprises 85% of industry manufacturing applications. As an outcome of the engineering process stage in CAD/CAE modeling and analysis, CAM utilizes CNC technology as an “art to part” process. Described in this course are the fundamental steps to create a physical part, assembly or tool using digital designs.

**Course Schedule**: The 16 week course covers 2 units per week and two topics per unit. Successive 90 minute units are taught on Tuesdays at 8:00AM (MT) and Fridays at 9:45AM (MT). Students may enroll for the entire course or enroll for any specific unit or units. Please reference the overall program course schedule for complete scheduling information.

**Instructors**: lecturers delivering course training include; Dr. Christopher Griffen ( [christophertgriffen@gmail.com](mailto:christophertgriffen@gmail.com), Ph: 906-298-1642); Karl Haefner ([karl.haefner@littlehoop.edu](mailto:karl.haefner@littlehoop.edu), 872-600-5985); Kathyrn Hall ([kathrynhall@tm.edu](mailto:kathrynhall@tm.edu) 701-550-0308 and Dr. Ragavanantham Shanmugam ([rags@navajotech.edu](mailto:rags@navajotech.edu) 505-409-0663). Office hrs are 5-7PM (MT) Mon-Fri.

**Course Media**: Lectures will be through a virtual online live classroom format with all content and references supplied.

**Contact Info**: *Please feel free to call or email Dr. Christopher Griffen regarding questions or further detail*