MATERIALS SYLLABUS (Semester I)

**Course Description**: The exploration of new materials is often referred to as the “field of dreams” in both engineering and manufacture of products covering all of the global industry markets. Research & development exploration in the material sciences is continuing to find solutions in properties and processes that increase performance. The materials curriculum first covers 3 major classifications including metals, ceramics, polymers and the inherent properties that differentiate those material classes. Processes that alter those properties are then discussed. Critical performance attributes are described for specific applications. An in-depth review of composites is conducted to understand the benefit of using multiple materials in both formulation and construction. The emerging science of bio-materials and impact on the environment and sustainability is presented as a major exploration topic in material science. There are 6 major subject categories covered per below;

* **Metals**: All metals are inorganic (not derived from living organisms). They are found in the earth’s crust as metal ores mined from rock formation mineral deposits. 92 elemental forms exist today which provide an almost endless ability to combine them both chemically and physically. Electrical conductivity, thermal conductivity, chemical reactivity along with ductility are 4 of many distinguishing properties. Ferrous (iron) & non-ferrous metals branch out to the common metals and their alloys including exotic forms with specific properties, processing capability and performance. Metals are the most common materials used today in global industries because of application versatility.
* **Ceramics**: Ceramics are inorganic as well as nonmetallic. They are brittle, hard and strong in compression only. They offer high chemical and thermal resistance as well as dielectric properties. Due to highly ordered crystalline physical structure (non-malleable), shape forming can be difficult without a thermal powder/sintering molding process as one approach. Glass shares ceramic processing methods however is amorphous and not a true ceramic. Ceramics come from clays within the earth combined with other base elements (carbon, silicon, alumina) and through mixing/heat reach their final form (e.g. brick, porcelain, concrete, china…). This series of modules covers the classes of ceramics defined by both process and chemistry, properties/process characteristics and key industry applications.
* **Polymers**: Unlike metals and ceramics; polymers do not have the ancient/modern historic legacy and have only developed over the last century. They can be organic or inorganic existing in nature or manmade (synthetic). The molecular length and complexity varies significantly however starts with a base “monomer” building block. Plastics are the result of polymer chemical formulation and processing. This series of teaching modules begins with understanding the atomic and molecular structure of polymers. The two classifications of thermosetting (hardened with heat) and thermoplastic (hardened with cooling) polymers explores their unique properties and performance characteristics. Detailed presentation of their applications in industry are described along with emerging technology.
* **Composites**: The combination of two or more base materials with complementing properties/performance creates products with superior performance. How they are physically combined in construction is an essential factor as well. These constructions have both a matrix used to transfer load uniformly and a reinforcement component to carry load and strengthen/stiffen the material. Three types of composites are covered in four lecture series reviewing polymer matrix composites (PMC’s), metal matrix composites (MMC’s) and ceramic matrix composites (CMC’s). Property and performance attributes are compared with focus on their applications in industry as well as future needs.
* **Biomaterials**: Biomaterials in this series of modules extends beyond the conventional use in the biomedical sciences. It encompasses materials existing in nature or synthetically produced that provide one or more benefits to sustainability, energy conservation, green environment and recycling/reuse. Studies cover existing as well as emerging polymers/resins, and reinforcement materials and methods that provide circular economy/environmental solutions when combined with proper process and manufacturing technology. Particular emphasis is placed on performance challenges in replacing conventional materials.
* **Material Properties-Process-Performance**: In this teaching series the properties used to characterize materials and process influence on performance provide a comprehensive overview. Metals, ceramics, polymers, composites and biomaterials are critically and comparatively assessed with respect to base properties, process differences and ranking of performance. The content presented is a detailed guideline in how to select materials for specific applications. The lectures also look at the emerging technology needs within global industries to address aerospace, transportation, defense, construction, consumer goods, medical and overall socioeconomic/environment/energy challenges in the future. The use of proper metrology methods of material characterization are addressed.

**Course Schedule**: The 16 week course covers 2 units per week and two topics per unit. Successive 90 minute units are taught on Mondays at 8:00AM (MT) and Thursdays 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*