**METROLOGY SYLLABUS (Semester I)**

**Course Description**: Metrology is the “Science of Measurement”. It is applied in virtually every technical field ranging from medicine to manufacturing. Any physical entity existing in our world can be measured and quantified. The focus in this course prepares students in how measurements are correctly made, what quantities are measured and why they are being measured. The metrology semester I curriculum building block modules (10 subjects-32 training modules) provides basic knowledge and skills to perform metrology measurements as they relate to the area of materials, engineering design and manufacturing and described below;

* **Measurement Units & Standards**: Metrology units of measure cover an extensive range of testing methods (e.g. physical, chemical, thermal, dimensional, electrical, mass/density) that are associated with International Standards by which they are scaled (e.g Metric (SI), English (Imperial)) which proper conversion factors (e.g. kg vs lbm, Celsius vs Kelvin…).
* **Calibration & Traceability**: Calibration is the process of configuring an instrument to provide a result for a sample within an acceptable range. Eliminating or minimizing factors that cause inaccurate measurements is a fundamental aspect of calibration. It can be performed externally or internally. Traceability is the quantitative comparative value to what the instrument measures to establish the degree of accuracy. It validates the instrument for proper use.
* **Principles of Testing**: Metrology testing can be quantitative and/or qualitative. Selection of the right instrumentation for the desired measurement outcome is key. Methods of analyzing the data must be established for proper interpretation of results. Proper controls and associated influencing factors affecting the measurement need to be accounted for.
* **Proper Testing Procedures**: Test Procedures are specifications that “roadmap” how to conduct measurement. In order to ensure accurate and relevant test results, a test procedure should be explicit, clearly defined, experimentally feasible and reproducible. It involves sample prep/setup, calibration, data acquisition, analysis and data reporting.
* **Types of Testing**: In engineering and manufacturing, the types of testing are applied to materials, products and processes capturing a broad spectrum of quantified data results (e.g. mass, density, strength, melt temperature, hardness dimensional tolerancing….). An in-depth review is covered in this module for major technical fields.
* **Data Analysis & Reporting**: Raw data acquired in metrology testing may require post processing and analysis to extract the most relevant information. Instrument capabilities have limitations in the quantitative interpretation. Statistical analysis is also part of this step to establish data confidence and true representation of sample populations. Reporting the data in proper format is also expected.
* **Designing Test Experiments**: Design of Experiments (DOE) is a method to understand the effects of dependent variables (interaction effects) as well as main effects. Sources of error can also be quantified. Factors and levels affecting the measurement are captured. This approach is frequently employed in metrology.
* **Non-Destructive Methods**: Non-Destructive Metrology Testing (NDT) has evolved significantly in the last 30 years to quantify properties without altering their basic characteristics in preparation/test. Leading this technology are optical and immersive imaging methods (e.g. X-ray/CT/MRI, interferometry, ultrasound scanning…), This module deep dives current and emerging techniques in advancing metrological instrument technology.
* **Quality Control & SPC**: Metrology measurements are the primary tool in identifying product manufacturing variation as the indicator of quality. It also identifies process control issues in establishing robust capability to assure product performance within limits. This module provides a comprehensive review of metrology QC methods, analysis methods, tools in statistical process capability and diagnosis of variation sources to achieve quality control and assurance.

**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 9:45AM (MT) and Thursdays at 8:00AM (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*