**METHODS & MECHANICS OF DESIGN SYLLABUS (Semester I)**

**Course Description**: Engineering of products fall into two categories; innovation of new products or improvement of existing products. Product development has four major steps involving design, analysis, build and test. Each phase involves critical inputs and outputs that are supported by engineering tools and knowledge to achieve the final product. This curriculum takes the student through both key tasks within each stage of development and introduces the fundamental engineering tools and methods applied at every step. There are 9 subjects taught in this curriculum as described below;

* **Design Engineering Process**: The engineering design process is a common series of steps that [engineers](https://en.wikipedia.org/wiki/Engineer) use in creating functional products and processes. The progression is highly [iterative](https://en.wikipedia.org/wiki/Iterative) - parts of the process often need to be repeated many times before the next stage/gateway can be initiated in meeting milestones. The scope of concepts that get iterated and the number of such cycles in any given project may vary. It employs applied fundamental sciences, mathematics, and engineering technologies to leverage resources in meeting product/process performance. Among the fundamental elements of the [design process](https://en.wikipedia.org/wiki/Design_process) are the establishment of objectives and criteria, ideation/creation concept synthesis, analysis, construction, testing and evaluation. This module explains from objective to validation the gateways and milestones from art to part.
* **Engineering Concept Development and Design Tools**: Concept alternatives early in the design/development process address options in overall geometry/volume that have potential to meet product performance expectations. Historically; early concepts were represented as sketches and full scale/subscale physical models (e.g. clay). In this module methods of representing concepts from basic digital rendering software, 2D digital drawing detail/assembly representations and 3D solid modeling CAD methods are described. Current digital software is introduced as well as basic training in building concept models. Engineering tools (e.g. Pugh Analysis) to evaluate concept designs are also described.
* **Engineering Designer Comprehensive Training**: This series of modules provides the student a strong foundation in 2D to 3D skills by first becoming proficient in creating 2D dimensional data and then the ability in solid model proficiency. Common operations in CAD software are emphasized (e.g. 2d digital sketching, 3d extrusion, boolean logic in volumetric shape integration, featuring, assembly drawings) which strongly prepare the student in this critical industry competency need.
* **Engineering Tools for Analysis**: Concept evaluation analysis tools range from manual computation (e.g. free body analysis, shear/moment diagrams, statics…) representation to digital models derived from CAD in Finite Element, Finite Difference, Boundary element or Statistical Energy form. This series of modules exposes the student to analysis modeling methods with emphasis on digital model approaches and common software used (e.g. Solid works, Autodesk, Hyper works, Creo) today sharing the same approach in how analysis models are built and evaluated.
* **Design Optimization**: Optimization is a process of maximizing functional performance objectives that also comply with design variable constraints. This module teaches how to use baseline CAE analysis results of a concept design using state of the art tools (e.g. topology, generative design, min/max solvers) to achieve the best fit solution.
* **Mechanics of Design**: The bridge between product concepts and functional performance are the physics and math governing laws to develop an optimal solution. This involves the integration of material properties and product geometry through understanding fundamental laws of statics, dynamics, fluid mechanics and thermodynamics as principles at a basic level. This series provides the student with the ability to move from design to analysis with critical underlying theory.
* **Prototyping**: Virtual & physical prototyping can exist at both the concept and functional level. This module presents in-depth methods of prototype constructions/fabrications to demonstrate feasibility from concept to optimized solutions covering digital models and rapid prototyping methods with focus on subscale and 3D printing technology.
* **Design for Manufacturing**: DFM is the general engineering practice of [designing](https://en.wikipedia.org/wiki/Product_design) products in such a way that they are easy to manufacture. The concept exists in almost all engineering disciplines, but the implementation differs widely depending on the manufacturing technology. DFM describes the process of designing or engineering a product in order to facilitate the [manufacturing](https://en.wikipedia.org/wiki/Manufacturing) process reducing manufacturing investment/piece cost, increase quality and maximizing throughput. DFM will allow potential problems to be fixed in the design phase which is the least expensive stage to address them. DFM, Design for Six Sigma (DFSS) and Failure Mode Analysis (DFMEA/PFMEA) are used to together in integration of design with manufacturing.
* **Product Validation**: Verifying product performance involves meeting functional customer requirements as well as assurance in manufacturing a quality product. This module reviews the industry standards used in conducting validation testing in performance and quality prelaunch acceptance prior to commercial customer introduction. Post launch customer support, satisfaction and warranty are discussed as well as continuous improvement initiatives.

**Course Schedule**: The 16 week course covers 2 units per week and two topics per unit. Successive 90 minute units are taught on Wednesdays at 9:45AM (MT) and Fridays 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*