Mt. San Jacinto College
Integrated Course Outline of Record

Form B

Submitted by: James Bae **Date:** 11/12/2020

Department	Subject	Course Number	Title
Engineering: Technologies	Engineering: Technologies ENGR	121	Introduction to Engineering Design

Units/Hours

Each lecture unit requires 1 hour per week of class time, and 2 hours per week of study outside of class.
Each laboratory unit requires 3 hours per week of class time.
Each activity unit requires 2 hours per week of class time and 1 hour per week of study outside of class.

Lecture Units	Lab Units	Total Units
2.00	1.00	3.00
Lecture Contact Hours	**Lab Contact Hours**	**Total Contact Hours**
32.00 - 36.00	48.00 - 54.00	80.00 - 90.00
Lecture Homework Hours	**Lab Homework Hours**	
64.00 - 72.00	0	

Stand Alone:

Program Applicable

AA/AS Degree General Ed Breadth Area(s):

-none-

General Education Justification:

Maximum Enrollment: 32

Maximum Enrollment Justification:

Course requires significant individualized instruction or assessment â€“ check all that apply:

* Course requires graded class discussion and graded class participation.
* Course requires 3 or more oral presentations by each student per semester.
* Course relies on small group dynamics as a means of instruction or assessment.

*** Course requires that each student be evaluated individually on a set of skills more than twice per semester.**

Justification: Computer programs are used. Specialized equipment is used. The course is heavily project and skill based. The course has group and individual projects that are presented orally in class, individual skill based demonstrations are performed and graded in class.

Grading Method: Letter Grade or P/NP

TOP code: 0953.00*

Can be Taken 1 **time(s) for credit** (max 4)

- ☐ - Visual or Performing Arts course that is required to meet major requirements for UC/CSU
- ☐ - Intercollegiate athletics course
- ☐ - Academic/vocational competition course

Catalog Description:

(Please do not refer to transferability or degree, certificate, or employment concentration applicability. Please only describe the course).
(**75 words** or less in gray box below).

This course provides a basic understanding of the design process used in engineering fields and the application of computer modeling software. Emphasis is placed on the design process, geometric relationships, visualization, technical sketching, modeling, model documentation, assemblies and production processes.

Schedule Description:

(Please do not refer to transferability or degree, certificate, or employment concentration applicability. Please only describe the course).
(**25 words** or less in gray box below).

This course covers topics such as the design process, computer modeling, technical sketching, assemblies and production processes.

Need for the course:

This course provides the student who is new to Engineering with foundational skills to be immediately able to join an engineering company at an entry level or to pursue further opportunities in Engineering including more advanced job-skills training or pursuit of transfer pathways to a 4-year institution. It is one course of a series of courses required for a student to be awarded an Engineering Technologist Support Certificate. The Center of Excellence for Labor Market Research (California Community Colleges) estimates that entry-level Engineering Technology jobs (Civil, Electrical, Industrial, Mechanical, amongst other Technicians) will continue to grow in the Inland Empire/San Bernardino area from 2018-2023 by 3%, while offering positions earning above estimated â€œliving wageâ€ rates. This estimated 300 annual jobs outpaced the awards given at the time by local community colleges. This indicates a major opportunity for MSJC to continue to provide entry level Engineering job training, while growing the program to more advanced training to support professional training in the future. Awards attached to: ENGR - Engineering Technologist Support - Certificate ENGR - Engineering: Drafting Technology - Certificate (Elective)

Prerequisite(s):

Prerequisites go through a separate approval process. See Forms E1-E6 for details.
(For further clarification, contact the Prerequisite Subcommittee)

-none-

Corequisite(s):

Corequisites go through a separate approval process. See Forms E1-E6 for details.

-none-

Recommend Preparation:

Recommended Preparation goes through a separate approval process. See Forms E1-E6 for details.

-none-

Other Enrollment Criteria:

-none-

Learning Objectives:

(please number each objective and express in behavioral terms)

Upon the completion of the course the student will be able to do the following:

1. Formulate all principles and elements of the design process with appropriate documentation of design ideas.
2. Develop proper sketching techniques and styles in the creation of engineering drawings.
3. Construct dimensions and tolerances in accordance with industry standards.
4. Identify geometric constraints in three-dimensional models.
5. Modify features on engineering drawings and models.
6. Evaluate and represent data using statistical analysis, with the aid of a spreadsheet program.
7. Use statistics to quantify information, support design decisions, and justify problem solutions.
8. Produce two-dimensional drawings and three-dimensional models using Computer Aided Design and Drafting (CADD) software.
9. Perform a functional analysis of a product using reverse engineering.
10. Compare and contrast geometric relationships; use a Cartesian coordinate system and physical properties to solve design problems.
11. Identify key components of a successful design team and techniques to maximize team collaboration.
12. Organize and present information about design problems and their solutions to a specific target audience.

Course Content:

(please number the outline of main topics and subtopics)

1. Design Process
    1. Orientation & safety
    2. Innovation vs invention
    3. Principles and elements of design
        1. Characteristic set of practices and steps
        2. Research methods, tools, outputs
        3. Identification, definition and justification of design problem
        4. Solution development and selection
        5. Visualization and design analysis
        6. Solution prototyping and evaluation
    4. CADD Software
    5. Orthographic construction
    6. Presentation principles
        1. Tailoring presentations to specific objectives for the audience
        2. Include drawings, diagrams, models for high impact visual aids
2. Technical Sketching and Drawing

1. Create drawings or diagrams as representations of objects, ideas, events, or system
2. Two- and three-dimensional objects and proportion
3. Drawing -
    1. Sketching methods and tools
    2. Technical drawings methods and tools
    3. Intended purpose determines style, requirements, views, elements to include
4. Visual principles and elements of design
    1. Natural or man-made object
    2. Commercial products

3. Measurement and Statistics
    1. Statistical analysis -
        1. Purpose
        2. Calculating statistics - central tendency, variation, sample vs population
        3. Visual representation
        4. Use in information, design decisions, solution selection
        5. Statistics calculations and graphics with spreadsheets
    2. Measurement
        1. Units, SI and US – conversions
        2. Accuracy vs precision – variation and measuring devices
        3. Repeatability and Reproducibility
4. Modeling Skills
    1. Modeling and Assembly Types
        1. Conceptual, graphical , mathematical
        2. Computer modeling, adding components
        3. Assembly modeling, assembly constraints
        4. Parts libraries
    2. Model Documentation
        1. Working drawings
        2. Dimensioning
        3. Annotation
    3. Assembly constraints (including mate, flush, insert, and tangent), its role in an assembly model, and the degrees of freedom that it removes from the movement between parts.
        1. Representing constraints with equations and inequalities
    4. Comparing the efficiency of the modeling method of an object using different combinations of additive and subtractive methods
5. Geometry of Design
    1. Geometric relationships
        1. Forms, shapes, angles, geometric constraints
        2. Cartesian coordinate system
        3. Physical properties- properties of length, volume, mass, density, surface area, centroid, principle axes, and center of gravity
        4. Solving real world and mathematical problems involving volume, area and surface area of two- and three-dimensional objects
        5. Calculating a physical property indirectly using available data or measurements
6. Reverse Engineering
    1. Purpose discovery, documentation, investigation, and product improvement
    2. Process and approach
    3. Performing a functional analysis to determine the purpose, inputs and outputs, and the operation of a product or system
7. Documentation
    1. Organization of information
    2. Support of design ideas
    3. Aligning with audience and purpose
    4. Utilizing an engineering notebook

5. Appropriate citing of information sources

8. Advanced Computer Modeling
    1. Creating three-dimensional solid models of parts within CAD from sketches or dimensioned drawings with constraints
    2. Generating CAD multi-view technical drawings, appropriate view selection and orientation according to standard engineering practice
    3. Using parametric formulas on part features and dimensions
    4. Dimension and annotate (including specific and general notes) working drawings according to accepted engineering practice.
    5. Creating sketch elements and relationships among part features in CAD using precise input (and an applicable coordinate system)
    6. Creating assemblies of parts in CAD that allows correct realistic movement among parts
9. Design Team & Challenges
    1. Team behaviors, roles and responsibilities
    2. Conflict resolution strategies
    3. Cross functional teams with engineering subfields (mechanical, electrical, civil, chemical)
    4. Assessing the development of an engineered product and its impact on society and the environment
    5. Project plans, monitoring progress and design project completion
    6. Team solution selection tools and approaches

Lab Content:

(please number the outline of main topics and subtopics)

1. The Design Process
    1. Computer Use
    2. CADD Software
    3. Visualization activity
    4. Orthographic Projection exercise
    5. Complete a design project utilizing all steps of a design process, and find a solution that meets specific design requirements
2. Technical Sketching and Drawing
    1. Perspective & Orthographic sketching
        1. Identify and correct errors and omissions in technical drawings including the line work, view selection, view orientation, appropriate scale, and annotations
    2. Choose and justify the choice for the best orthographic projection of an object to use as a front view on technical drawings
    3. Hand sketch exercises with detailed descriptions - simple objects with descriptions
        1. 1-point and 2-point perspective pictorial views
        2. isometric views
        3. Orthographic projections at a given scale
3. Measurement and Statistics
    1. Collect data, use formulas, creating and displaying a histogram and use function tools to calculate statistics on a spreadsheet program
    2. Measure linear distances using a scale, ruler, or dial caliper and report the measurement using an appropriate level of precision
4. Modeling Skills
    1. Computer modeling exercise - Modal assembly, drawing generation and annotation
    2. Explain the role of each assembly constraint and the degrees of freedom impact
    3. Create and manipulate assemblies of parts in CAD with assembly constraints and deomonstrate correct realistic movement.
5. Geometry of Design
    1. Use physical properties to solve design problems (e.g., design an object or structure to satisfy physical constraints or minimize cost).
    2. Use CAD to Create three-dimensional solid models from sketches or dimensioned drawings using

appropriate geometric and dimensional constraints.
3. Manipulate materials in the CAD Library and Not-In-Library and calculate physical properties of parts

6. Reverse Engineering
    1. Perform a structural analysis of a product in order to determine the materials used and the form of component parts as well as the configuration and interaction of component parts when assembled (if applicable).
    2. Analyze information gathered during reverse engineering to identify shortcoming of the design and/or opportunities for improvement or innovation
7. Advanced Computer Modeling
    1. Dimension and annotate working drawings according to accepted engineering practice.
    2. Create a CAD assembly drawing. Identify each component of the assembly with identification numbers and create a parts list to detail each component using CAD.
    3. Create an exploded view of a given assembly. Identify each component of the assembly with identification numbers, and create a parts list to detail each component using CAD.
8. Design Team & Challenges
    1. Identify and discuss a Grand Challenge for Engineering (as identified by the National Academy of Engineering) and its potential impact on society and the environment.
    2. Jointly develop a decision matrix based on accepted outcome criteria and constraints.
    3. Clearly justify and validate a selected solution path.
    4. Identify limitations in the design process and the problem solution and recommend possible improvements or caveats.
    5. Utilize journaling as a means of documentation and reflection to demonstrate original thought and reasoning.
    6. Utilize project portfolios to present and justify design projects.

Methods of Instruction:

Methods of instruction may include, but are not limited to the following:

- **Method:** Lecture
  Integration: Multimedia presentations and computer simulations introduce the design process, geometric relationships, visualization, technical sketching, modeling, model documentation, assemblies and production processes.
- **Method:** Observation and Demonstration
  Integration: Observation and Demonstration with supporting visual materials and computer programs introduce topics such as visualization and design analysis, presentation principles, principles and elements of design, technical sketching and drawing, geometry of design, and CADD.
- **Method:** Projects
  Integration: Projects require analysis and description of the design process, including research, and data collection. Students present project findings to the class, individually and within groups.
- **Method:** Directed Study
  Integration: Group presentations of problem solving exercises will be made regarding a Grand Challenge for Engineering, including developing a decision matrix, using the design process, technical sketching and drawing, modelling skills and reverse engineering.

Methods of Evaluation:

A student's grade shall be determined by the instructor using multiple measures of performance related to the course objectives. Methods of evaluation may include but are not limited to the following:

- **Method:** Class Participation
  Integration: Class Participation will be during topical discussions, problem solving activities and demonstrations (computational or non-computational), and simulated exercises within the design process. Evaluation is based on level of participation, reasoning processes, demonstrated skill set and accuracy of results.
- **Method:** Exams/Tests
  Integration: Quizzes will be periodic short objective tests of course related concepts. Test and quiz question

format may include multiple choice, short answer/essay, and diagram identification. A mid-term and final examination will be given which show student understanding of the design process, industry standards for designs, and drawing and sketching techniques and tools, terminology, and clarity and thoroughness of explanations.

- **Method:** Group Projects
  Integration: Group oral presentations of problem solving exercises will be made regarding the design process, visualization and design analysis, presentation principles, principles and elements of design, technical sketching and drawing, geometry of design, and utilizing CADD.
- **Method:** Other
  Integration: Laboratory reports - In written format, students will describe and report on the major stages involved in design process, demonstrating effective communication and documentation. This is evident by clarity, organization, thoroughness of content, with appropriate application of course material to processes used, as well as correct grammar and spelling.
- **Method:** Portfolios
  Integration: A portfolio including all of the assignments from class, including technical drawings, non-technical drawings, computer designs, data collections, calculations, engineering notebooks prototypes and finish designs will be submitted for evaluation. Assessment based on clarity, thoroughness, aesthetic presentation and accuracy.
- **Method:** Projects
  Integration: Individual projects will demonstrated and presented orally to the class and will be graded using skills assessment, mechanistic choice, organization and thoroughness.
- **Method:** Oral Presentation
  Integration: Individual projects will demonstrated and presented orally to the class and will be graded on skill assessment, appropriate mechanistic choice, organization and thoroughness.

Examples of Assignments:

Students will be expected to understand and critique college level texts or the equivalent. Reading and writing, as well as out of class assignments are required. These assignments may include but are not limited to the following:

1. The handouts depicts two isometric views and two orthographic views of four three dimensional objects. Sketch the missing third orthographic view for each model in the space provided. Submit sketches to the instructor for evaluation.
2. Examine the three-dimensional solid model of an assembly link. Create a two-dimensional working drawing from this model including dimensions. Submit the drawing to the instructor for evaluation.
3. Make an orthographic sketch of the idler arm and measure the features with digital calipers. Create a three-dimensional solid model based on the sketch and recorded dimensions. Save the model to a storage device and submit to the instructor for evaluation.

Textbooks:

- Madsen, David A; Madsen David P (2016). *Engineering Drawing and Design 6th Edition* Cenage Learning. ISBN: 1305659724
- Giesecke, Frederick; Mitchell, Alva; Spencer, Henry C.; Hill, Ivan L.; Dygdon, John T.; Novak, James E.; Loving, R. O.; Lockhart, Shawna E. (2016). *Technical Drawing with Engineering Graphics (15th Edition)* Peachpit Press. ISBN: 9780134306414
- Voland, Gerard (2004). *Engineering by Design, 2nd Edition* Pearson. ISBN: 9780131409194
- Horenstein, Mark (2016). *Design Concepts for Engineers, 5th Edition* Pearson. ISBN: 9780134001876
- Moaveni, Saeed (2019). *Engineering Fundamentals* Cenage Learning. ISBN: 1337705012

Other Resources:

Minimum Qualification

- Engineering (Masters Required) **or**
- Engineering Support **or**
- Engineering Technology (Masters Required)