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	182	Strength of Materials (formerly Strength and Materials)

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	Total Units
3.00	3.00
Lecture Contact Hours	**Total Contact Hours**
48.00 - 54.00	48.00 - 54.00
Lecture Homework Hours	
96.00 - 108.00	

Stand Alone:

Program Applicable

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

-none-

General Education Justification:

Maximum Enrollment: 40

Maximum Enrollment Justification: Justification:

Grading Method: Letter Grade or P/NP

TOP code: 0901.00

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 teaches engineers how to analyze material selection and calculate physical stress parameters. Analyses will include plane stress-strain, axial, torsional, bending and shear stresses, including combined loads, Mohrâ€™s Circle, principal stresses and strains, and pressure vessels. Students will study Hookeâ€™s Law and material properties; allowable stress and factor of safety; statically indeterminate members; shear and moment diagrams; moment-area; slope by double integration; singularity functions; superposition; Catigliano methods; thermal expansion; indeterminate forms; and column buckling.

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).

Methods and standards in analysis of material selection and calculation of material strength, failure, and design requirements under wide varieties of physical stress.

Need for the course:

This course provides the student with foundational engineering knowledge in support of further education in Engineering, Drafting, and Mechanical Engineering. It is one course of a series of electives for a student to be awarded AS or Certificate in Engineering: Drafting Technology. 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. This course supports and is attached to: ENGR - Engineering: Drafting Technology - Certificate (Elective) However, this course is a common course required in Engineering curriculum for Bachelors and Masters programs - and should be considered for stand alone offering as well along with ENGR181 Statics.

Prerequisite(s):

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

- ENGR 181 with a Grade of C or better.

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. Calculate normal stresses, shearing stresses and bearing stresses on members of mechanical systems.
2. Calculate stresses and strains caused by axial loading, including statically indeterminate systems.
3. Determine the forces (torques and/or moments) applied on each structural member of a system
4. Determine internal forces and couples at internal sections of a structural system.
5. Design cylindrical shafts and calculate torsion , including statically indeterminate systems.
6. Design simple member of structures subjected to bending and shear forces.
7. Perform coordinate transformations of the state of stress and strain at a point, including using Mohrâ€™s Circle.
8. Illustrate and apply Mohrâ€™s cycle for transformation of planes stress and strain.
9. Construct shear and moment diagrams; calculate bending and shear stresses.
10. Evaluate double integration to calculate moments of areas and find deflection of beams.
11. Calculate buckling of columns by applying energy methods.
12. Compare a structural system to design specifications and determine how a system will fail.

Course Content:

(please number the outline of main topics and subtopics)

1. Review of Statics/Equilibrium/Factor of Safety
2. Stress and Strain
    1. Normal Stress(Bearing Stress) /Strain Curves, Young’s Modulus, Poisson’s Ratio, Energy Density
    2. Shear Stress/Strain Curves, Shear Modulus, Shear Energy Density
    3. Plane Stress and Plane Strain
    4. General 3-D Stress-Strain relationships (optional)
3. Axial Members
    1. Concept of axial stress and strain
    2. Members with constant internal force/area/material
    3. Members with varying (discontinuous/continuous) internal force/area
    4. Displacement Methods to determine movement of a point
    5. Energy Methods
    6. Statically Indeterminate Systems (optional)
4. Pressure Vessels (Thin-walled)
5. Torsion Members
    1. Members with constant internal force/area/material – rectilinear and cylindrical
    2. Members with varying (discontinuous/continuous) internal force/area
    3. Displacement Methods to determine movement of a point
    4. Statically Indeterminate Systems (optional)
6. Beams
    1. Shear and Moment Diagrams
    2. Bending Stress
    3. Beam Displacement
    4. Beam Deflection
    5. Shear Stress
    6. Shear Flow
    7. Shear Center (optional)
    8. Statically Indeterminate Systems (optional)
7. Combined Loads and Stresses – design, proof, ultimate
8. Stress Transformation
    1. Plane stress
    2. Transformation Equations

3. Principal Stresses/Maximum Shear Stress
4. Mohr's Circle
5. Strain Transformation

9. Failure Criteria
    1. Brittle Failure (Maximum Normal Stress)
    2. Maximum Shear Stress (Tresca)
    3. Maximum Strain Energy (von Mises)
10. Buckling of Columns
11. Design of Structural Systems – Practical
    1. Factors (Internal and External)
    2. Safety Margins
    3. Application

Lab Content:

(please number the outline of main topics and subtopics)

Calculation and prediction of:

1. Member of Structure
    1. Axial loading
    2. Normal stress
    3. Strain on
2. Torsion
    1. Cylindrical shafts
    2. Power transmission.
3. Forces
    1. Bending
    2. Bearing
    3. Shear
4. Diagrams
    1. Shear diagrams
    2. Bending moment diagrams
5. Beams
    1. Bending
    2. Buckling
    3. Deflection

Methods of Instruction:

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

- **Method:** Lecture
  Integration: Multimedia presentations used to teach the concepts, calculation and application of Mohr's cycle, energy methods, buckling, stresses and torsion.
- **Method:** Discussion
  Integration: Discussion to review, practice and provide feedback on the various topics covered; Mohr's cycle, energy methods, buckling, stresses, and torsion.
- **Method:** In-class Exercises
  Integration: Exercises will allow for practice in analysis, diagramming, application of equations and calculation of methods used to understand stress, strain, energy methods, buckling, Mohr's circle, transformations.
- **Method:** Observation and Demonstration
  Integration: Demonstrations of the effect of stresses and strains on various physical systems including deflection, displacement, buckling, fracture, and failure
- **Method:** Experiments
  Integration: Laboratory experiments will allow students to calculate and predict the effect of strain, stress and torsion on various materials and compare prediction to real world testing of materials.

- **Method:** Homework
  Integration: Homework will focus students on calculation and diagramming of theoretical loading on beams, cylinders, pressure vessels and other structural systems to practice use of equations and calculations.
- **Method:** Group Projects
  Integration: Group projects will have students collaborate together to analyze complex structural systems for design factors, safety, failure modes and analysis.
- **Method:** Papers and Reports
  Integration: Students will practice writing standard engineering reports on structural systems under load and likely outcomes and engineering papers on design concepts related to load, strain and stress.

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:** Design paper
  Integration: Students will write design papers in which students will be assessed on the illustration and labeling an experiment that was conducted in class; Mohrâ€™s cycle, energy methods, buckling, stresses and torsion. Papers will be assessed on the accuracy in application of principles and calculations, logic of conclusions, and compliance with professional standards.
- **Method:** Homework
  Integration: Students will work on weekly problem sets on calculating various material stresses will be assessed on application of diagrams and equations and accuracy of calculation and description of systems.
- **Method:** Class Participation
  Integration: Student participation in in-class experiments including turning in calculations, worksheets and reports associated will demonstrate understanding of stress, torsion, energy methods, Mohr's circle transformations. Students will be assessed on understanding of principles and application of calculations.
- **Method:** Class Work
  Integration: Class work will allow students to demonstrate understanding of diagrams and calculation of structural systems under load. Class work will be evaluated on completeness of calculations, accuracy of application of principles, and application of professional standards.
- **Method:** Projects
  Integration: Project reports and laboratory reports will demonstrate application of concepts on material stress and torsion and load; design considerations; and calculation of structural systems under load, and results of experiments. Project reports will be evaluated on completeness and accuracy of calculations, professional standards, and application of principles.
- **Method:** Exams/Tests
  Integration: Quizzes, mid-term and final exams will assess the students knowledge of the material that was covered in the areas of stress, loading, torsion, forces, transformation, beams, energy and systems. Exams and tests will be evaluated on accuracy of calculations and application of principles.

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. Write an engineering report that develops theory to evaluate various shapes and materials combinations for a beam of a given length and strength. From the list of shape and material combinations provide, determine which shape/material combination gives the lightest structure (remember, all beams must carry the same load). Include recommendations to further decrease the weight.
- 2. Solve the following problem; A solid steel shaft ABC is driven by a s240kW motor at 1800 rpm. The gears at B and C drive machines requiring 80 and 160 kW, respectively. The lengths of the two segments o f the shafts are LAB = 1.0 m and LBC = .5 m. G = 75 GPA. Determine the required diameter D of the Shaft (Constant from A to C) if the allowable shear stress is 70 MPa, and the allowable angel is twisted between sections A and C is 3.0.

- 3. Solve the following problem; A two L = 6 ft long wood 4X4 beam, are glued together to form a solid beam. The weight density of the wood is .02 lb/in3. The beam is simply supported. If the glued joint has an allowable shear stress of 200 psi, determine the allowable load, Pallow, which may be applied to the midpoint of the span (take into account the weight of the beam).
- 4. Explain the difference between Design Load, Proof Load, and Ultimate Load.
- 5. Write a minimum of two page paper on: Why is a factor of safety applied to structural system? Explain how a Factor of Systems is chosen for a given type of application. How do you determine if the system meets the criteria established by the Factor of Safety?

Textbooks:

- Follansbee, P. S. (2014). *Fundamentals of Strength: Principles, Experiment, and Applications of an Internal State Variable Constitutive Formulation* Wiley, John & Sons, Incorporated. ISBN: 9781118413418
- Singh, D.K. (2014). *Strength of Materials* CRC Press. ISBN: 9781482245714
- Goodno, B, Gere J. (2017). *Mechanics of Materials 9th Edition* Cenage Learning. ISBN: 1337093343
- Hibbeler, R. C. (2016). *Mechanics of Materials (10th Edition)* Pearson. ISBN: 0134319656
- Mott, R., J. Untener (2016). *Applied Strength of Materials 6th Edition* CRC Press. ISBN: 9781498716758

Other Resources:

Minimum Qualification

- Engineering (Masters Required)