Western Technical College

10606124 Statics and Strength Of Materials

Course Outcome Summary

Course Information

Description	Statics: The study and analysis of forces and loading conditions applied to structures and mechanical devices. Strength of Materials: An introduction to methods used to determine internal stresses present in machine parts when subjected to various loading conditions. Topics include: simple stresses, centroids, moments of inertia, torsion, shear and bending stresses.
Career Cluster	Science, Technology, Engineering and Mathematics
Instructional Level	Associate Degree Courses
Total Credits	4
Total Hours	108

Pre/Corequisites

Prerequisite	10804113 College Technical Math IA
Prerequisite	10420119 Manufacturing and Engineering Materials

Textbooks

Open Educational Resource: *Engineering Statics: Open and Interactive*. Copyright 2023. Baker, Daniel W. and William Haynes. https://engineeringstatics.org/pdf/statics.pdf Required.

Open Educational Resource: *Applied Strength of Materials for Engineering*. 23rd Edition. Copyright 2022. Dupen, Barry. Publisher: Purdue University. http://www.etcs.pfw.edu/~dupenb/ET_200/Applied%20Str%20of%20Mat%20for%20ET%20v23%20Dec%202022.pdf Required.

Success Abilities

1. Live Responsibly: Develop Resilience
2. Live Responsibly: Foster Accountability
3. Refine Professionalism: Improve Critical Thinking
4. Refine Professionalism: Participate Collaboratively

High Impact Practices

1. Technology-Enhanced Learning: this course will incorporate digital technologies like gamification, virtual reality experiences, or simulations. In addition, you will create technology-enhanced products such as ePortfolios, multimedia presentations, or other e-products to showcase your learning.

Program Outcomes

1. Design mechanical components and products
2. Analyze mechanic engineering problems
3. Select purchase parts
4. Produce and revise supporting engineering documentation
5. Evaluate manufacturing processes and materials for product development
6. Demonstrate awareness of product liability and industry standards
7. Meet design and production deadlines
8. Interpret and communicate technical concepts, designs, and documentation

Course Competencies

1. Solve resultant force system problems both analytically and graphically

Assessment Strategies

1.1. upon completion of various handouts, text assigned problems and a closed book quiz

Criteria

You will know you are successful when

1.1. you compute resultant force system problems using the appropriate problem guidelines and formats.
1.2. you produce neat, legible and accurate work while improving board drafting and/or computer skills.

Learning Objectives

1.a. Identify various types of force systems relating to statics
1.b. Differentiate between vector and scalar quantities
1.c. Determine if the units in a problem are consistent and correctly convert when necessary
1.d. Use the polygon and parallelogram methods of solution to determine the resultant of two concurrent forces
1.e. Use the summation of components method of solution to determine the resultant of concurrent forces

2. Analyze a concurrent force system and solve related problems

Assessment Strategies

2.1. upon completion of various handouts, text assigned problems, and a closed book quiz
2.2. through participation in a lab experiment

Criteria

You will know you are successful when

2.1. you compute the external forces on a mechanical system using the appropriate problem guidelines and formats.
2.2. you produce neat, legible and accurate work while improving board drafting and/or computer skills

Learning Objectives

2.a. Describe the concept of equilibrium and be familiar with Newtons third law
2.b. Solve equilibrium problems of concurrent coplanar force systems using a free-body diagram and force triangle
2.c. Use trigonometry to mathematically solve problems
2.d. Identify tension and compression members in a simple frame or structure
2.e. Perform lab experiment to better comprehend the concept of equilibrium

3. Demonstrate an understanding of moments as related to static equilibrium

Assessment Strategies

3.1. upon completion of various handouts, text assigned problems and a closed book quiz
3.2. by conducting a lab experiment and reporting the results using the required format

Criteria

Criteria - Performance will be satisfactory when:

3.1. learner computes moments about a point using the appropriate guidelines and formats
3.2. learner conducts the integrated lab exercise to experimentally check the mathematical results of moment problems

Learning Objectives

3.a. Define moments and couples, state characteristics of each and identify couples that are equivalent
3.b. Solve parallel force problems by finding the moments of forces about a point
3.c. Calculate the forces transmitted through the gearing of the bicycle and describe the relationship between statics and rotational dynamics in physics

4. Analyze a nonconcurrent-coplanar force system and solve related problems

Assessment Strategies

4.1. upon completion of various handouts, text assigned problems and a closed book quiz

Criteria

Criteria - Performance will be satisfactory when:

4.1. learner computes nonconcurrent-coplanar force system problems using the appropriate problem guidelines and formats
4.2. learner produces neat,legible and accurate work while improving board drafting and/or computer skills

Learning Objectives

4.a. Identify the known and unknown forces in a common nonconcurrent-coplanar force system
4.b. Illustrate equilibrium problems of nonconcurrent-coplanar force systems using a free-body diagram
4.c. Use the appropriate mathematical formulas, ie summation of x and y forces and the summation of moments, to solve the external forces on a mechanical and/or structural system
4.d. Be familiar with the method of joints and the method of sections techniques to analyze a simple truss
4.e. Utilize MDSolids or similar software to solve truss problems

5. Analyze a concurrent-noncoplanar force system and solve related problems

Assessment Strategies

5.1. upon completion of various handouts, text assigned problems and a closed book quiz

Criteria

Criteria - Performance will be satisfactory when:

5.1. learner computes concurrent-noncoplanar force system problems using the appropriate problem guidelines and formats
5.2. learner produces neat, legible and accurate work while improving board drafting and/or computer skills

Learning Objectives

5.a. Identify the known and unknown forces in a common concurrent-noncoplanar force system
5.b. Illustrate equilibrium problems of concurrent-noncoplanar force systems using a free-body diagram
5.c. Draw the concurrent-noncoplanar force system on the three principle projection planes and correctly label the x, y and z components
5.d. Use the appropriate mathematical formulas, ie summation of x, y and z forces and the summation of

moments, to solve the external forces on a mechanical and/or structural system

6. Solve problems involving static and kinetic friction

Assessment Strategies

6.1. upon completion of various handouts, text assigned problems and a closed book quiz (students will be allowed to compile and use a formula sheet)

Criteria

Criteria - Performance will be satisfactory when:

6.1. learner determines the magnitude and direction of force vectors acting on objects sliding or resting on smooth or rough friction surfaces using the appropriate methods and formats
6.2. learner produces neat, legible and accurate work while improving analytical, drafting and/or computer skills

Learning Objectives

6.a. Define static and kinetic friction
6.b. Identify relationship between friction forces acting on objects on either smooth or rough inclined planes
6.c. Determine the least amount of force needed to move a body

7. Define simple or direct stress

Assessment Strategies

7.1. upon completion of various handouts, text assigned problems and a closed book quiz (students will be allowed to compile and use a formula sheet)

Criteria

Criteria - Performance will be satisfactory when:

7.1. learner calculates simple tensile and shear stress using the appropriate guidelines and formats
7.2. learner produces neat, legible and accurate work while improving analytical, drafting and/or computer skills

Learning Objectives

7.a. Determine the magnitude and location of maximum stress, the force per unit area, in tension or shear, for various shapes
7.b. Calculate the effective cross-sectional area of the area in stress
7.c. Calculate simple tensile, compressive, shear and bearing stress

8. Use properties of materials in design

Assessment Strategies

8.1. upon completion of various handouts, text assigned problems and a closed book quiz (students will be allowed to compile and use a formula sheet)

Criteria

Criteria - Performance will be satisfactory when:

8.1. learner calculates the allowable stress for various materials using the appropriate guidelines and formats
8.2. learner produces neat, legible and accurate work while improving analytical, drafting and/or computer skills

Learning Objectives

8.a. Examine set of material properties generated using standard tensile test
8.b. Determine the relationship between stress and strain for various materials
8.c. Compare the proportional and elastic limits, the yield point and the ultimate strength for brittle versus ductile materials
8.d. Calculate the total deformation in materials when subjected to tensile or thermal loads
8.e. Compute the allowable stress for various conditions
8.f. Explain how the mechanical properties of materials affect their strength under various loading conditions
8.g. Select the best material for a given application

9. Calculate stresses for bolted and riveted joints.

Assessment Strategies

9.1. upon completion of various handouts, text assigned problems and a closed book quiz (students will be allowed to compile and use a formula sheet)

Criteria

Criteria - Performance will be satisfactory when:

9.1. learner determines the magnitude and direction of stresses acting on different types of bolted or welded joints using the appropriate guidelines and formats
9.2. learner produces neat, legible and accurate work while improving analytical, drafting and/or computer skills

Learning Objectives

9.a. Identify standard types of joints
9.b. Determine the magnitude of tensile, shear and bearing stresses in various types of joints
9.c. Determine the efficiency of a bolted joint
9.d. Identify standard types of welded joints

10. Calculate the center of gravity, centroids and moments of inertia of various cross sectional areas

Assessment Strategies

10.1. by conducting a lab experiment and reporting the results using the required format
10.2. upon completion of various handouts, text assigned problems and a closed book quiz (students will be allowed to compile and use a formula sheet)

Criteria

Criteria - Performance will be satisfactory when:

10.1. learner determines the location of the center of gravity and magnitude of the moments of inertia using the appropriate guidelines and formats
10.2. learner conducts the integrated lab exercise to experimentally check calculated displacements of beams with different moments of inertia
10.3. learner produces neat, legible and accurate work while improving analytical, drafting and/or computer skills

Learning Objectives

10.a. Identify the location of the center of gravity (or centroid) for various simple areas.
10.b. Determine the location of the centroid for composite 2D areas
10.c. Identify the location of the center of gravity for simple 3D solids
10.d. Calculate areas and volumes
10.e. Determine the moment of inertia for various simple areas
10.f. Determine the moments of inertia of composite areas using the parallel axis theorem
10.g. Utilize MDSolids or similar software to solve related problems

11. Calculate shear forces and bending moments for beams

Assessment Strategies

11.1. upon completion of various handouts, text assigned problems and a closed book quiz (students will be allowed to compile and use a formula sheet)

Criteria

Criteria - Performance will be satisfactory when:

11.1. learner constructs shear and moment diagrams for beams with various loads using the appropriate guidelines and formats
11.2. learner produces neat, legible and accurate work while improving analytical, drafting and/or computer skills

Learning Objectives

11.a. Identify and solve for forces and moments acting on various types of beams
11.b. Determine the location of maximmum, minimum and zero stress
11.c. Develop shear and moment diagrams for various loading and end conditions of beams
11.d. Differentiate shape of shear and moment diagrams with point versus distributed loading

11.e. Utilize MDSolids or similar software to solve beam problems

12. Understand beam design theory

Assessment Strategies

12.1. by conducting a lab experiment and reporting the results using the required format
12.2. upon completion of various handouts, text assigned problems and a closed book quiz (students will be allowed to compile and use a formula sheet)

Criteria

Criteria - Performance will be satisfactory when:

12.1. learner determines the magnitude and location of maximum deflection of beams subjected to various loads using the appropriate methods and guidelines
12.2. learner conducts the integrated lab exercise to experimentally check the mathematical results of beam displacement problems
12.3. learner produces neat, legible and accurate work while improving analytical, drafting and/or computer skills

Learning Objectives

12.a. Calculate bending stresses in beams of various cross-sections
12.b. Define horizontal and vertical shear stress
12.c. Determine the location of the maximum shear stress for common beam cross-sections
12.d. Use the moment-area method to determine the maximum deflection of a beam for various load conditions
12.e. Identify the fundamental factors for beam design

13. Explore shafts, torsion loads, horsepower

Assessment Strategies

13.1. upon completion of various handouts, text assigned problems and a closed book quiz (students will be allowed to compile and use a formula sheet)

Criteria

Criteria - Performance will be satisfactory when:

13.1. learner determines the power transmission capability of shafts, couplings and keys using the appropriate reference guides and formulas
13.2. learner produces neat, legible and accurate work while improving analytical, drafting and/or computer skills

Learning Objectives

13.a. Solve for the torsional load of a shaft
13.b. Determine the location and magnitude of the maximum torsional shearing stress
13.c. Determine the maximum deflection (angle of twist) of a shaft subjected to torsional loading
13.d. Explore the power transmission capability of various shaft cross-sections
13.e. Explore the torque carrying capacity for shaft couplings and keys

14. Analyse the response of a structure or part subjected to combined loading (if time allows)

Assessment Strategies

14.1. by conducting a lab experiment and reporting the results using the required format
14.2. upon completion of various handouts, text assigned problems and a closed book quiz (students will be allowed to compile and use a formula sheet)

Criteria

Criteria - Performance will be satisfactory when:

14.1. learner determines the maximum stresses in structures due to combined loading using the appropriate methods and equations
14.2. learner conducts the integrated lab exercise to experimentally check the mathematical results of combined stress problems
14.3. learner produces neat, legible and accurate work while improving analytical, drafting and/or computer skills

Learning Objectives

14.a. Define various states of stress
14.b. Apply the principle of superposition to solve for combined axial and bending stress in a beam
14.c. Determine the location and magnitude of the maximum combined stress for eccentric loaded machine members
14.d. Determine the location and magnitude maximum stress in eccentrically loaded bolted joints
14.e. Develop a Mohr's Circle for normal and shear stresses due to axial loading
14.f. Develop Mohr's Circle diagrams for various states of combined stress
14.g. Calculate principal stresses for various loading conditions

15. Calculate stresses for various catagories of columns (if time allows)

Assessment Strategies

15.1. by conducting a lab experiment and reporting the results using the required format
15.2. upon completion of various handouts, text assigned problems and a closed book quiz (students will be allowed to compile and use a formula sheet)

Criteria

learner conducts the integrated lab exercise to experimentally check the mathematical results of moment problemsCriteria - Performance will be satisfactory when:

15.1. learner determines the maximum loading of slender columns using appropriate guidelines and formulas
15.2. learner conducts the integrated lab exercise to experimentally check the mathematical results of column deflection problems
15.3. learner produces neat, legible and accurate work while improving analytical, drafting and/or computer skills

Learning Objectives

15.a. Explain the difference between a beam and a column
15.b. Calculate the slenderness ratio and radius of gyration for a beam cross-section
15.c. Explain the difference between short, intermediate and long slender columns
15.d. Determine the effective slenderness ratio for columns with various end conditions
15.e. Determine the safe load that can be applied using the design equations for axially loaded columns

16. Accept responsibility for attending class and completing all learning activities

Assessment Strategies

16.1. After attending class and lab
16.2. using an checklist and attendence sign-in sheet

Criteria

Criteria - Performance will be satisfactory when:

16.1. learner will have perfect attendance during statics lecture
16.2. learner hand in all assignments on time
16.3. learner has a maximum of two unexcused absences from lab

Learning Objectives

16.a. Develop good work habits
16.b. Fulfill job expectations and requirements

17. Prepare clear and concise written reports

Assessment Strategies

17.1. after review and discussion of the reporting requirements
17.2. upon completion of the required lab experiments

Criteria

Criteria - Performance will be satisfactory when:

17.1. learner writes a lab report that meets the established criteria

Learning Objectives

17.a. Organize information in a written format
17.b. Produce a lab report using a word processor and a printer

18. Cooperate and establish a good working relationship with other students in the class

Assessment Strategies

18.1. in the completion of lab activities
18.2. in presenting reports to the class

Criteria

Criteria - Performance will be satisfactory when:

18.1. learner successfully works in small groups

Learning Objectives

18.a. Help group members understand and complete assigned tasks
18.b. Identify roles and responsibilities of individual group members
18.c. Respect the ideas and opinions of others