Western Technical College

10606158 Design Analysis

Course Outcome Summary

Course Information

Description	Design principles of certain machine elements are considered and calculations made for the determination of their size and shape. The use of CAD and CAE software for mechanical analysis will be introduced. Topics include shafts, couplings, keys, bearings, gear, belt and chain drives.
Career Cluster	Science, Technology, Engineering and Mathematics
Instructional Level	Associate Degree Courses
Total Credits	3
Total Hours	90

Textbooks

Machine Elements in Mechanical Design - With CD. 6th Edition. Copyright 2018. Mott, Robert L. Publisher: Pearson. **ISBN-13**: 978-0-13-444118-4. Required.

Learner Supplies

Scientific calculator (recommend T1-36x Solar). **Vendor:** Campus Shop. Required.

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. Utilize the mechanical design process.

Assessment Strategies

1.1. Written Product
1.2. Written Objective Test
1.3. Portfolio

Criteria

Performance will be satisfactory when:

1.1. learner participates in classroom and lab activities
1.2. learner reads text/reference materials to be covered in lecture
1.3. learner completes assigned problems
1.4. learner is present for and writes quizzes and exams

Learning Objectives

1.a. Identify elements of the mechanical design process.
1.b. Review methods for the documentation of mechanical design.

2. Review materials for mechanical design.

Assessment Strategies

2.1. Written Product
2.2. Written Objective Test
2.3. Portfolio

Criteria

Performance will be satisfactory when:

2.1. learner participates in classroom and lab activities
2.2. learner reads text/reference materials to be covered in lecture
2.3. learner completes assigned problems
2.4. learner is present for and writes quizzes and exams

Learning Objectives

2.a. Define key terms associated with material properties.
2.b. Descibe uses and typical properties for various materials used in the design of mechanical components.

3. Perform stress and deformation analysis.

Assessment Strategies

3.1. Written Product
3.2. Written Objective Test
3.3. Portfolio

Criteria

Performance will be satisfactory when:

3.1. learner participates in classroom and lab activities
3.2. learner reads text/reference materials to be covered in lecture
3.3. learner completes assigned problems
3.4. learner is present for and writes quizzes and exams

Learning Objectives

3.a. Review principles for analyzing stress and deformation of structural members due to tensile, compressive, shear and bending loads.
3.b. Evaluate stress at a point for various structural members and load conditions.
3.c. Review concepts of centroids and moment of inertia of beams with various cross sections
3.d. Evaluate beam deflection formulas.
3.e. Review methods for constructing shear and bending moment diagrams.
3.f. Apply principle of superposition for states of combined stress.
3.g. Appy stress concentration factors to stress analyses.
3.h. Construct Mohr's circle diagram for various states of combined stress.

4. Design for different types of loading.

Assessment Strategies

4.1. Written Product
4.2. Written Objective Test
4.3. Portfolio

Criteria

Performance will be satisfactory when:

4.1. learner participates in classroom and lab activities
4.2. learner reads text/reference materials to be covered in lecture
4.3. learner completes assigned problems
4.4. learner is present for and writes quizzes and exams

Learning Objectives

4.a. Identify types of loading most often encountered by design components.
4.b. Define terms associated with the endurance strength for components made from various materials.
4.c. Determine the difference between theories of failure.

5. Analyze behavior of columns.

Assessment Strategies

5.1. Written Product
5.2. Written Objective Test
5.3. Portfolio

Criteria

Performance will be satisfactory when:

5.1. learner participates in classroom and lab activities
5.2. learner reads text/reference materials to be covered in lecture
5.3. learner completes assigned problems
5.4. learner is present for and writes quizzes and exams

Learning Objectives

5.a. Identify column features.
5.b. Classify columns using mathematical properties.
5.c. Identify and apply the appropriate formuli in the design and analysis of columns.

6. Design belt drives.

Assessment Strategies

6.1. Written Product
6.2. Written Objective Test
6.3. Portfolio

Criteria

Performance will be satisfactory when:

6.1. learner participates in classroom and lab activities
6.2. learner reads text/reference materials to be covered in lecture
6.3. learner completes assigned problems
6.4. learner is present for and writes quizzes and exams

Learning Objectives

6.a. Descibe the basic features of a belt drive system.
6.b. Descibe different types of belt drives.
6.c. Specify suitable types and sizes of belts and sheaves to transmit a given level of power at specified speeds for the input and output sheaves.
6.d. Specify the primary installation variables for belt drives including center distance and belt length.

7. Design chain drives.

Assessment Strategies

7.1. Written Product
7.2. Written Objective Test
7.3. Portfolio

Criteria

Performance will be satisfactory when:

7.1. learner participates in classroom and lab activities
7.2. learner reads text/reference materials to be covered in lecture
7.3. learner completes assigned problems
7.4. learner is present for and writes quizzes and exams

Learning Objectives

7.a. Descibe the basic features of a chain drive system.
7.b. Explore different types of chain drives.
7.c. Specify suitable types and sizes of sprockets and roller chain to transmit a given level of power at specified speeds.
7.d. Specify the primary installation variables for chain drives including center distance and chain length.
7.e. Compare and contrast belt and chain drives noting advantages and disadvantages.

8. Analyze and design gear drive systems. (Kinematics of gears)

Assessment Strategies

8.1. Written Product
8.2. Written Objective Test
8.3. Portfolio

Criteria

Performance will be satisfactory when:

8.1. learner participates in classroom and lab activities
8.2. learner reads text/reference materials to be covered in lecture
8.3. learner completes assigned problems
8.4. learner is present for and writes quizzes and exams

Learning Objectives

8.a. Define the main features for spur, helical, bevel and worm gears ie. the number of teeth, the root, pitch and outside diameters, whole depth, dedendum, addendum, circular vs chordal thickness, circular pitch, and face width.
8.b. Recognize and describe the main features of spur gears.
8.c. Describe a helical gear and its function.
8.d. Describe a worm/wormgear set and its function.
8.e. Describe a bevel gear and its function.
8.f. Define a miter gear.
8.g. Given the formulas, calculate any required value for a spur gear, bevel, or worm gear.
8.h. Indicate the maximum pitch-line velocities for spur gears with pressure angles of 20 degrees (14.5 degrees if necessary).

9. Explore spur gear design.

Assessment Strategies

9.1. Written Product
9.2. Written Objective Test
9.3. Portfolio

Criteria

Performance will be satisfactory when:

9.1. learner participates in classroom and lab activities
9.2. learner reads text/reference materials to be covered in lecture
9.3. learner completes assigned problems
9.4. learner is present for and writes quizzes and exams

Learning Objectives

9.a. Compute the forces exerted on gear teeth aas they rotate and transmit power.

9.b. Specify a suitable level of quality of gears according to intended use.
9.c. Use appropriate stress analysis to determine relationships among the forces, geometry and precision of the gear teeth and other factors specific to a given application, in order to make final decisions about those variables.
9.d. Explore the bending stress and contact stress, resulting in pitting of the tooth, in order to determine adequate hardness of the gear material.

10. Identify functions and design requirements for keys, couplings and seals and properly apply them.

Assessment Strategies

10.1. Written Product
10.2. Written Objective Test
10.3. Portfolio

Criteria

Performance will be satisfactory when:

10.1. learner participates in classroom and lab activities
10.2. learner reads text/reference materials to be covered in lecture
10.3. learner completes assigned problems
10.4. learner is present for and writes quizzes and exams

Learning Objectives

10.a. Describe different types of keys.
10.b. Specify a suitable size and material for a key to be used on a given size shaft.
10.c. Describe splines and determine their torque capacity.
10.d. Explore alternate methods of fastening machine elements to shafts.
10.e. Describe rigid and flexible couplings.
10.f. Explore universal joints.
10.g. Describe retaining rings and other means of locating elements on a shaft.
10.h. Describe types, uses and materials of seals.

11. Design and analyze shafts.

Assessment Strategies

11.1. Written Product
11.2. Written Objective Test
11.3. Portfolio

Criteria

Performance will be satisfactory when:

11.1. learner participates in classroom and lab activities
11.2. learner reads text/reference materials to be covered in lecture
11.3. learner completes assigned problems
11.4. learner is present for and writes quizzes and exams

Learning Objectives

11.a. Propose reasonable geometries for shafts to carry a variety of power transmitting elements, providing for the secure location of each element and reliable transmitting of power.
11.b. Compute the forces exerted on shafts by gears, chain sprockets and belt sheaves.
11.c. Determine the torque distribution on shafts.
11.d. Create shear and bending moment diagrams for shafts in two planes.
11.e. Apply shaft design procedure.

12. Specify dimensional tolerances for the proper fit of mating parts of an assembly.

Assessment Strategies

12.1. Written Product
12.2. Written Objective Test
12.3. Portfolio

Criteria

Performance will be satisfactory when:

12.1. learner participates in classroom and lab activities
12.2. learner reads text/reference materials to be covered in lecture
12.3. learner completes assigned problems
12.4. learner is present for and writes quizzes and exams

Learning Objectives

12.a. Define the terms tolerance, allowance, unilateral and bilateral tolerance.
12.b. Explore the relationship among tolerance, production processes and costs.
12.c. Specify basic sizes for dimensions according to a set of sizes.
12.d. Define and specify transitional, interference and force fits.
12.e. Compute the pressure created between parts subjected to interference fits and the resulting stresses in the mating parts using spreadsheets.

13. Analyze and select appropriate commercially available bearings for a variety of applications.

Assessment Strategies

13.1. Written Product
13.2. Written Objective Test
13.3. Portfolio

Criteria

Performance will be satisfactory when:

13.1. learner participates in classroom and lab activities
13.2. learner reads text/reference materials to be covered in lecture
13.3. learner completes assigned problems

Learning Objectives

13.a. Identify and describe a variety of roller element .
13.b. Specify suitable bearings for a given application.

14. Explore various types of motors, their performance characteristics and applications.

Assessment Strategies

14.1. Written Product
14.2. Written Objective Test
14.3. Portfolio

Criteria

Performance will be satisfactory when:

14.1. learner participates in classroom and lab activities
14.2. learner reads text/reference materials to be covered in lecture
14.3. learner completes assigned problems
14.4. learner is present for and writes quizzes and exams

Learning Objectives

14.a. Describe factors that must be specified to select a suitable motor.
14.b. Describe the principle of operation of AC motors.
14.c. Identify classifications of AC electric motors according to rated power.
14.d. Describe single-phase and three-phase power.
14.e. Explore typical frame design, sizes and enclosure styles of AC motors.
14.f. Describe three-phase squirrel-cage AC motors.
14.g. Describe the principle of operation for DC motors.
14.h. List advantages and disadvantages of DC motors compared to AC motors.
14.i. Explore torque motors, servomotors, brushless motors.

15. Design plain surface bearings. (Time permitting)

16. Evaluate power and ball screws. (Time permitting)

17. Design and analyze compression, extension and torsion springs. (Time permitting)

18. Design and analyze machine structures and compare bolted vs welding methods for joining

structural members. (Time permitting)

19. Design and analyze various types of clutches and brakes. (Time permitting)

Learning Objectives

19.a. Define and describe a pawl.
19.b. List and describe several common applications for ratchets and pawls.