MET-2700: MACHINE DESIGN

Cuyahoga Community College

Viewing: MET-2700 : Machine Design

Board of Trustees:
2016-05-26

Academic Term:
Fall 2018

Subject Code
MET - Mech Eng/Manuf Ind Eng Tech

Course Number:
2700

Title:
Machine Design

Catalog Description:
Capstone course in Mechanical Engineering Technology. Study of mechanical motion and design of machine elements. Includes displacement, velocity and acceleration in linkages, cams and power transmission devices. Design of machine elements include checking of assembled machines, fasteners, weldments, springs, bearings, belts, chains, shafts, clutches and brakes. Laboratory consists of using CAD, computer programming and manufacturer`s catalogs, and professional journals to aid in design. Proper completion of the project depends on the team as a whole.

Credit Hour(s):
4

Lecture Hour(s):
3

Lab Hour(s):
2

Other Hour(s):
0

Requisites

Prerequisite and Corequisite
MET-1621 Technical Dynamics or MET-2620 Dynamics; and MET-2041 CAD II & GD&T, or concurrent enrollment; and MET-2200 Strength of Materials or MET-2630 Engineering Strength of Materials.

Outcomes

Course Outcome(s):
Analyze the various steps involved in actually creating a product for use by consumers, industry, or government.

Objective(s):
1. Recognize examples of mechanical design to which the principles of this course apply.
2. Examine the steps involved in the mechanical design process and the importance of creating functional requirements.
3. Prepare an engineering calculation.
4. Analyze how the creative process works and how we can stimulate that process.
5. Explain how patents and copyrights are issued and rights of the inventor.

Course Outcome(s):
Analyze how stress and deformation affect the design and performance of structural and machine elements.

Objective(s):
1. Apply beam deflection formulas to design problems.
2. Analyze columns using the Euler and Johnson methods.

3. Describe the meaning of factor of safety and correctly apply safety factors in the design process.
4. Combine different types of stresses and use appropriate combined stress theories.
5. Identify the various types of loading on an element and apply them as required in the design process.
6. Apply fatigue equations when designing parts subject to repeated loads.
7. Determine if levels of deformation are acceptable to design being analyzed

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Course Outcome(s):

Differentiate between the many types of fastening systems and their uses.

Objective(s):

1. Describe stress area, pitch diameter, and thread types and forms.
2. Describe the common designations of thread forms and grades

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Course Outcome(s):

Analyze common types of springs and select standard springs from manufacturers' catalogs.

Objective(s):

1. Identify, describe, and understand the principles of common spring types.
2. Design and analyze helical compression springs.
3. Select springs from manufacturers' catalogs and incorporate them into machine designs.

Course Outcome(s):

Assess the physical properties of gears and design and select gears for specific applications.

Objective(s):

1. Investigate the different types of gearing systems and their relative advantages and disadvantages.
2. Understand the geometry of different types of gears and their dimensional properties.
3. Design actual gear systems, including specifying materials and manufacturing accuracy.
4. Select standard gears from manufacturers or distributors.

Course Outcome(s):

Apply knowledge of the various types of flexible drive system and basic principles of operation.

Objective(s):

1. Analyze flexible drive systems principles of operation.
2. Assess the basic features of belt – drive systems.
3. Explain principles of operation of chain drives.
4. Specify flexible drive systems.

Course Outcome(s):

Apply knowledge of power transmission couplers.

Objective(s):

1. Examine the basic geometries of clutch and brake systems.
2. Calculate the torque transfer available for clutch systems.
3. Explain the principles of friction, heat generation, and heat removal in brake systems.

Course Outcome(s):

Design power transmitting shafting to include the determination of loads acting on the shafts.

Objective(s):

1. Design for strength.
2. Design for deflection
3. Determine critical speeds in shafts

Course Outcome(s):

Analyze bearing performance and select bearings for specific applications.

Objective(s):

1. Specify appropriate plain surface bearings for design applications.
2. 2. Compare the different types of rolling contact bearings and suitable applications.
3. 3. Discuss the principles of rolling contact bearings versus sleeve or journal bearings.
4. Select appropriate types of bearing.

Course Outcome(s):

Apply the principles of force, work, and power to mechanisms and machines in motion.

Objective(s):

1. Explain the basic principles of hydraulic and pneumatic drive systems.
2. Differentiate between force, work, and power.
3. Describe the basic principles of fluid mechanics as they apply to hydraulic and pneumatic actuators.
4. Explain how forces are developed on machine parts.

Methods of Evaluation:

1. Class projects
2. Final examination

Course Content Outline:

1. Mechanical design process
   a. Properties of materials.
   b. The design calculation.
   c. Codes and standards.
2. Force, work, power.
   a. Work and power.
   b. Pressure, force, and area.
   c. Moments of inertia and section modulus.
3. Stress and deformation.
   a. Stress types.
   b. Stresses and deflection due to axial and bending loads.
   c. Columns
   d. Design factors and factors of safety.
   e. Combined stress and failure theories.
4. Repeated loading.
   a. Mechanisms of fatigue
   b. Endurance limit and endurance strength.
   c. Stress concentration factors.
5. Fasteners and fastening methods.
   a. Types of threads and terms.
   b. Tightening methods and initial tension.
6. Spring design
   a. Types of springs.
   b. Helical compression spring design.
   c. Design process.
7. Electric Motors.
8. Pneumatic and hydraulic drives.
   a. Gear design.
   b. Categories of gears.
   c. Velocity ratios and gear trains.
   d. Gear train configuration.
   e. Spur gear design and selection
9. Belt and chain drives.
   a. Belt drives.
   b. Chain drives.
10. Keys and couplings.
    a. Design of keys.
    b. Coupling and universal joints.

11. Clutches and brakes.
    a. Types of clutches and brakes.
    b. Brake and clutch design.
12. Shaft design.
    a. Combined stresses in shafts.
    b. Comparison of stresses to allowable values and endurance limits.
    c. Critical speed.
13. Bearings
    a. Plain surface bearings.
    b. Selection criteria.
    c. Materials.
    d. Rolling contact bearings.
14. The design process.
    a. Machine design process review.
    b. The creative process.
    c. Patents, copyrights, and protection of the creative process.

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Resources

Norton, Robert. *Machine Design: An Integrated Approach.* 3rd. Ed. Upper Saddle River, NJ.: Prentice Hall, 2006.

Bethune, James. *Engineering Design and Graphics with Autodesk Inventor 2009.* 1e. Upper Saddle River, NJ.:Prentice Hall, 2009.

Onwubiko, Chinyere. *Introduction to Engineering Design Optimization.* Upper Saddle River, NJ: Prentice Hall, 2000.

Groover, Mikell D. *Automation, Production Systems, and Computer Integrated Manufacturing.* 3rd ed. Upper Saddle River, NJ: Prentice Hall, 2008.

Fogler, Scott and LeBlanc, Steven. *Strategies for Creative Problem Solving.* 3e. Upper Saddle River, NJ: Prentice Hall, 2014.

Wentzell, Timothy H. *Machine Design.* Clifton Park, NY: Thomson Delmar Learning, 2004.

Ehmann, Kornel F. "Journal Of Mechanical Design"

McCarthy, J. Michael. "Mechanical Engineering: The Journal of the American Society of Mechanical Engineers"

Resources Other

1. Scientific calculator.

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