Course Number and Title: MET 245 Machine Design

Campus Location:
Stanton

Effective Date:
2022-51

Prerequisite:
MET 242, MET 243, MET 264 or concurrent

Co-Requisites:
None

Course Credits and Hours:
3.00 credits
3.00 lecture hours/week
0.00 lab hours/week

Course Description:
This course covers design principles and calculations appropriate to various machine elements, including beams, bearings, bushings, shafts, power components, gears, cams, belts, and flywheels.

Required Text(s):
Obtain current textbook information by viewing the campus bookstore - https://www.dtcc.edu/bookstores online or visit a campus bookstore. Check your course schedule for the course number and section.

Additional Materials:
None

Schedule Type:
Classroom Course

Disclaimer:
None

Core Course Performance Objectives (CCPOs):

1. Analyze various types of friction applications, including friction requirements and selection of appropriate materials and lubricants. (CCC 2, 6; PGC 1, 10)
2. Differentiate among and specify various types of bearings for specific applications. (CCC 1, 2, 5, 6; PGC 1, 6, 10)
3. Calculate correct shaft sizes required for various loading, stress, and drive applications. (CCC 2, 6; PGC 1, 6, 8, 10)
4. Differentiate among various types of mechanical fasteners, and specify appropriate types and sizes for specific uses. (CCC 2, 5, 6; PGC 1, 6, 10)
5. Determine required type, size, number, and length of belt required for various mechanical drive situations. (CCC 1, 2, 6; PGC 1, 6, 8, 10)
6. Calculate appropriate braking parameters for both mechanical and electric braking systems applications. (CCC 2, 6; PGC 1, 6, 8, 10)
7. Specify appropriate types of power screws for differing applications and for calculating load, torque, efficiency, and various load and stress resultants. (CCC 2, 6; PGC 1, 6, 8, 10)
8. Analyze various gearing conditions, determining the appropriate gearing solutions for given applications using American Gear Manufacturers' Association (AGMA) + ratings. (CCC 1, 2, 6; PGC 1, 6, 8, 10)
9. Use industry software to analyze, and solve for various parameters on machine components. (CCC 1, 2, 6; PGC 1, 3, 6, 8, 10)

See Core Curriculum Competencies and Program Graduate Competencies at the end of the syllabus. CCPOs are linked to every competency they develop.

Measurable Performance Objectives (MPOs):
Upon completion of this course, the student will:

1. Analyze various types of friction applications including friction requirements and selection of appropriate materials and lubricants.
    1. Analyze the following types of friction applications solving for applicable parameters such as rubbing velocity, frictional force, horse power (HP) lost, rolling resistance, pivot friction, sleeve bearings, and collar friction.
    2. Define the following terms as they apply to lubricants: *flash point, pour point, fire point, Saybolt viscosity, American Petroleum Institute (API) gravity,* and *kinematic viscosity.*
    3. Determine various friction requirements, and select the proper materials and lubricants as required for specific applications.
2. Differentiate among and specify various types of bearings for specific applications.
    1. Specify suitable sleeve bearings for given application using calculations involving the following parameters: projected area, allowable pressure, bearing length, and length-to-diameter (L/D) ratio.
    2. Calculate the following parameters for sliding bearings: heat radiating capacity, operating temperature, rubbing velocity, and projected bearing area.
    3. Using appropriate manufacturers' data, specify proper ball bearings for specific applications by calculating the following parameters: B10 life, load ratio, axial and radial loads, and equivalent bearing load.
    4. Using appropriate manufacturers' data, specify proper roller bearings for specific applications by determining design load, life factor, speed factor, and B10 life.
3. Calculate correct shaft sizes required for various loading, stress, and drive applications.
    1. Calculate shaft sizes for both solid and hollow circular shafts under the following loading systems: pure torsion, torsional deflection, torsion and bending, torsion tension, and compression.
    2. Determine critical speeds of rotating shafts under various load conditions.
    3. Apply stress-concentration factors for various stress risers to shaft design calculations.
    4. Apply MDSolids computer applications for calculations on shaft torsion.
4. Differentiate among various types of mechanical fasteners, and specify appropriate types and sizes for specific uses.
    1. Using manufacturers' data, determine the allowable torsional and axial loads, transmittable HP and torsional and axial holding power of various types of set screws.
    2. Calculate required parameters such as bolt diameter, set screw sizes, drive pin diameters and shear pin diameters for specific applications of rigid couplings.
    3. Using manufacturers' data, determine required sizes for differing types of key fasteners.
    4. Apply MDSolids computer applications for calculations on shear forces on bolts/fasteners.
5. Determine required type, size, number, and length of belt required for various mechanical drive situations.
    1. Calculate the length of belt needed for various belt-drive applications.
    2. Determine centrifugal force, belt HP, and required width and thickness of flat belt drives.
    3. Determine the type, size, and number of V-belts needed for specific applications using the following parameters: design HP, belt cross-section, service factors, area-of-contact factors, length factors, and belt HP ratings.
6. Calculate appropriate braking parameters for both mechanical and electric braking systems applications.
    1. Calculate required braking force, HP capacity, brake diameter, and rotational velocity for mechanical friction braking applications.
    2. Calculate required braking torque, stopping time, brake diameter, and rotational velocity for electric braking applications.
7. Specify appropriate types of power screws for differing applications and for calculating load, torque, efficiency, and various load and stress resultants.
    1. Determine the frictional thread torque, collar torque, working force, and external torque for raising and lowering a load using various common types of thread designs.
    2. Calculate the efficiency of differing types of power screws.
    3. Determine the tensile or compressive stress, direct shear stress, and maximum combined stresses at the root cylinder.
    4. Calculate the shearing stresses on the thread and nut of power screws.
8. Analyze various gearing conditions, determining the appropriate gearing solutions for given applications using American Gear Manufacturers' Association (AGMA) + ratings.
    1. Define the following terms: *diametric pitch, base circle, circular pitch, addendum, dedendum, pressure angle, working depth, face width,* and *contact ratio.*
    2. Determine solutions to gear train problems involving gear ratios, pitch circle diameter, number of teeth, and rotational velocity.
    3. Calculate torque ratios and torsional shear stress in the input shaft and required size of output shaft.
    4. Based on AGMA strength and durability ratings, determine the allowable transmitted HP for a given gearing arrangement.
9. Use industry software to analyze and solve for various parameters on machine components.
    1. Generate parameter values using software, and compare against values calculated by hand.

Evaluation Criteria/Policies:
The grade will be determined using the Delaware Tech grading system:

90	–	100	=	A
80	–	89	=	B
70	–	79	=	C
0	–	69	=	F

Students should refer to the Student Handbook - https://www.dtcc.edu/handbook for information on the Academic Standing Policy, the Academic Integrity Policy, Student Rights and Responsibilities, and other policies relevant to their academic progress.

Final Course Grade:
Calculated using the following weighted average

Evaluation Measure	Percentage of final grade
Homework (formative) (equally weighted)	5%
3 Tests, problems-based, 4-5 problems per exam (summative) (equally weighted)	70%
Quizzes (formative) (equally weighted)	25%
TOTAL	100%

Core Curriculum Competencies (CCCs are the competencies every graduate will develop):

1. Apply clear and effective communication skills.
2. Use critical thinking to solve problems.
3. Collaborate to achieve a common goal.
4. Demonstrate professional and ethical conduct.
5. Use information literacy for effective vocational and/or academic research.
6. Apply quantitative reasoning and/or scientific inquiry to solve practical problems.

Program Graduate Competencies (PGCs are the competencies every graduate will develop specific to his or her major):

1. Use effective problem-solving skills and make appropriate decisions relative to the technical field.
2. Design basic mechanical systems with the use of computer-aided drafting equipment.
3. Demonstrate basic computer literacy and knowledge of computer software applications in both the business and technical fields.
4. Use hand and power tools for standard manufacturing operations.
5. Conduct basic machining and welding operations; and perform basic programming of computer/numerically-controlled machines.
6. Calculate forces, properly size structures and mechanical components, and perform standard materials testing procedures.
7. Demonstrate an understanding of basic AC and DC electrical control circuits.
8. Select appropriate materials for basic mechanical applications.
9. Review and/or design basic hydraulic/pneumatic power systems.
10. Select basic machine components for mechanical systems.
11. Exhibit professional traits, including the ability to work with minimal supervision, willingness to learn new skills, and contributing to team project efforts.

Disabilities Support Statement:
The College is committed to providing reasonable accommodations for students with disabilities. Students are encouraged to schedule an appointment with the campus Disabilities Support Counselor to request an accommodation needed due to a disability. A listing of campus Disabilities Support Counselors and contact information can be found at the disabilities services - https://www.dtcc.edu/disabilitysupport web page or visit the campus Advising Center.