Mechatronics Program
Mechanical Systems Course
Suggested Syllabus

Part 1: Course Information

Course Overview

Basic Information

College:
Department:
Semester:
Instructor:
Office:
Office Hours:
Office Telephone:
Email:

Description

Mechanical Systems is a study of the basic mechanical components in a complex mechatronics system. This course consists of 15 lessons along with corresponding labs and/or class activities. Topics covered include basic functions and physical properties of mechanical components and their roles, including materials, lubrication requirements, and surface properties. The course will cover troubleshooting techniques and strategies to identify, localize and correct malfunctions; systematic preventative maintenance; and electrical and mechanical component safety. Technical documentation such as data sheets and specifications of mechanical elements also are covered.

Prerequisites

No Mechatronics courses are required as prerequisites.

To succeed in this course, students should be proficient in English and basic Algebra.

Course Materials

Recommended Textbook

Chastain, L.. (2009). *Industrial Mechanics and Maintenance* (3rd edition). Upper Saddle River, NJ: Prentiss Hall. ISBN-13: 978-0135150962.

Additional Textbook

Davis, T., and Nelson, C. (2004). *Audel Millwrights and Mechanics Guide* (5th edition). Hoboken, NJ: Wiley. ISBN-13: 978-0764541711.

Course Structure

This course is designed to provide a hybrid experience, including both face-to-face and online activities. Activities to be completed online and face-to-face will be updated weekly and provided as a supplement to the course syllabus.

Contact time will be divided in the following way:

85% face-to-face
15% online

Face-to-face sessions

Laboratory exercises and in-class work will emphasize skill attainment and content mastery.

Online Sessions

Online sessions will include content and activities from Platform +, Wisc-Online, Tooling U, simulated lab activities, and other resources. To access online activities, students will need access to the Internet and a supported Web browser. Technical assistance can be obtained from local technical support.

Technical Requirements

- Internet connection.
- Access to college learning management system and Platform+.
- Access to college email account.
- Microsoft PowerPoint.
- Microsoft Word.

Part 2: Learning Outcomes

Following successful completion of the Mechanical Systems course, the student will be able to:

Safety

- Understand safety regulations and their importance.
- Use appropriate attire and protective equipment.
- Operate equipment according to safety protocols.

Technical Literacy

- Read, interpret, and use technical documents for equipment and components within a mechanical system.

Mathematics

- Use basic algebra to solve problems involving pressure, area, torque, work, power, efficiency, and power equations.

Mechanical Systems

- Explain the role of mechanical components in mechatronic systems, modules, and subsystems.
- Describe how a change to one part of a system can affect the rest of the system.
- Explain, trace, and describe the flow of mechanical energy in the mechatronic system.
- Describe the basic physical properties of mechanical components including materials, lubrication requirements, and surface properties.

Equipment

- Differentiate between different types of gear drives, drive trains and sprocket systems, and mechanical drives using belts; bushings, bearings, and seals; and oils and grease.
- Correctly apply mechanical material analysis on shafts, couplings, and sealing devices to determine proper lubrication.
- Describe the types, construction, and power limitations of clutches and brakes; types, styles, and maintenance requirements of linear drives and power transmission; and types, styles, and maintenance requirements of flexible elements.
- Analyze a malfunctioning mechanical system, apply failure modes and effects analysis, and evaluate the outcome.

- Explain the effect of a breakdown on a business's bottom line.

Part 3: Course Calendar

This course calendar provides a schedule of lessons and an outline of topics covered. Activities, assignments, and assessments will be explained in detail throughout the course. Please contact the instructor with questions.

Lesson 1: Introduction and Safety Date

This lesson will cover the following topics:

1. Course Syllabus, Policies, and Procedures
2. Safety
   a. The U.S. Occupational Safety and Health Administration (OSHA) and Its Role
   b. Material Safety Data Sheets (MSDS)
   c. Safe Dress
   d. Personal Protective Equipment (PPE)
   e. Confined Space
   f. Electrical Safety
   g. Mechanical Transmission Safety
   h. Machine Guarding
   i. Log Out Tag Out (LOTO)
3. Lab: Familiarization with Mechanical Trainers
   a. Basic Identification and Inventory of Parts

Lesson 2: Hand Tools and Fasteners Date

1. Hand Tools
   a. Screwdrivers
   b. Pliers
   c. Wrenches
   d. Socket Tools
   e. Hammers
   f. Chisels and Punches
   g. Hacksaws and Files

   h. Taps and Dies
   i. Measuring Tools
2. Fasteners
   a. Thread Definitions
   b. Fits and Grades
   c. Types of Threaded Fasteners
   d. Types of Nuts
   e. Classes of Washers
   f. Removing Damaged Fasteners
   g. Key Fasteners

Lesson 3: Mechanical Principles I: Potential and Kinetic Energy, Torque, Speed Date

1. Torque and Torque Wrenches
2. Principles of Mechanical Systems
   a. Energy
   b. Force
   c. Rotational Speed
   d. Work

Lesson 4: Mechanical Principles II: Basic Machines, Efficiency, and Friction Date

1. Mechanical Principles II
   a. Basic Mechanical Machines
   b. Mechanical Efficiency
   c. Mechanical Rate
   d. Power
   e. Friction

Lesson 5: Introduction to Troubleshooting; Lubrication Date

1. Introduction to Troubleshooting
2. Lubrication

Lesson 6: Bearings Basics: Bearing Principles and Bearing Types Date

1. Basic Mechanical Principles of Bearings
    a. Friction
        i. Friction as a Waste of Energy
        ii. Friction and the Role of Heat
    b. Shafts
        i. Materials
        ii. Stresses
        iii. Vibration and Critical Speed
        iv. Fits and Clearances
    c. General Bearing Classification and Selection
        i. Load Ratings
        ii. Life
        iii. Tolerances
        iv. Speed
        v. Temperature
        vi. Lubrication
        vii. Numbering systems
2. Types of Bearings
    a. Plain (Journal) Bearings
        i. Classification
        ii. Material
        iii. Load Ratings
        iv. Lubrication
    b. Ball and Roller Bearings
        i. Classification
        ii. Material
        iii. Load Ratings
        iv. Lubrication

Lesson 7: Bearing Maintenance, Troubleshooting, and Installation Date

1. Lubrication
    a. Oil vs. Grease
    b. Temperature and Viscosity

   c. Determining the Correct Lubricant for a Particular Application
2. Working with Bearings
   a. Basic Rules
      i. Cleaning
      ii. Moisture Avoidance
      iii. Handling
      iv. Spinning with Compressed Air
3. Bearing Troubleshooting
   a. Indicators of Failure
4. Bearing Failures
   a. Failure Modes of Different Types of Bearings
5. Replacing Bearings
   a. Removal
   b. Installation
      i. Mechanical Methods
      ii. Thermal Methods

Lesson 8: Couplings: Coupling Types, Installation, and Coupling/Shaft Alignment Date

1. Coupling Types
   a. Rigid
   b. Flexible
   c. Chain and Gear
   d. Jaw and Slider
   e. Elastomeric
2. Choosing the Correct Coupling
3. Installing Couplings
   a. Review Types of Fit
   b. Heating Couplings
   c. Key Size
   d. Torqueing Bolts
   e. Location of Lubrication Fittings
   f. Runout
   g. Soft Foot
   h. Shims and Shim Size

4. Coupling/Shaft Alignment
    a. Types of Misalignment
    b. Straightedge
    c. Single Dial Indicator
    d. Dual Dial Indicator
    e. Reverse Dial Indicator
    f. Laser

Lesson 9: Belt Drive Systems I Date

1. Mechanical Power Transmission Systems
    a. Generic Components
    b. Power Flow
    c. Safety
2. Belt Drive Systems I
    a. Terminology
        i. Driver Sheave
        ii. Driving Sheave
        iii. Belt Pitch
        iv. Arc of Contact
        v. Center of Distance
        vi. Speed Ratio
    b. Types of Belts
    c. Belt Standardization
    d. Belt Length Calculations
    e. Replacing a V-Belt
    f. Belt Alignment

Lesson 10: Belt Drive Systems II Date

1. Belt Drive Systems II
    a. Sheave Replacement and Alignment
    b. Belt Tension Measurement and Adjusting
    c. Flat Belt Splicing
    d. V-Belt Maintenance
    e. Timing Belt Drives

f. Timing Belt Sheaves
g. Installing Timing Belts
h. Tensioning Timing Belts

Lesson 11: Chain Drive Systems I **Date**

1. Chain Drive Power Transmission Systems
   a. Catastrophic Chain Failures
   b. Power Flow
   c. Safety
2. Chain Drive Systems I
   a. Advantages and Disadvantages of Chain Drives
   b. Types of Chain Drive Systems
      i. Horizontal
      ii. Vertical
      iii. Systems with Idlers
      iv. Multi-shaft Drives
   c. Chain Construction
      i. Links
      ii. Offset Pins
      iii. Cotter Pins
      iv. Rollers
      v. Bushings
      vi. Spring Clips
      vii. Link plates
   d. Types of Industrial Chains
      i. Roller Chain
      ii. Silent Chain
      iii. Engineered-class Chain
      iv. Cast Chain
   e. System Terminology
      i. Driver Sprocket
      ii. Driven Sprocket
      iii. Chain Pitch
      iv. Center Distance

v. Chain Length
vi. Chain Rating
vii. Ultimate Strength
viii. Pitch Diameter

f. Roller Chain Numbering Systems
g. Sprockets and Sprocket Hub Design
   i. Arm
   ii. Solid
   iii. Hub Classes
h. Sprocket Mounting
i. Calculate Shaft Speed and Torque

Lesson 12: Chain Drive Systems II Date

1. Chain Drive Systems II
   a. Roller Chain Drive Selection
      i. Speed Ratio
      ii. Service Factors
      iii. Calculate Chain Length
   b. Drive Chain Installation
      i. Chain Tensioning
      ii. Measuring Chain Sag
      iii. Removing chains with Master Links
      iv. Test Running
      v. Lubrication
   c. Preventive Maintenance
   d. Care of Stored Chain
   e. Troubleshooting Chain Drives

Lesson 13: Gear Drive Systems I Date

1. Gear Drives
   a. Generic Components
   b. Power Flow
   c. Safety
   d. Advantages and Disadvantages

2. Gear Drive Systems I
    a. Terminology
    b. Open and Enclosed Drives
    c. Gear Definitions
3. Types of Gears
    a. Spur
    b. Helical
    c. Bevel
    d. Worm
4. Types of Gear Drives
    a. Shaft-mounted
    b. Worm Gear
    c. Miter Boxes
5. Calculation of Speed Ratios, Shaft Speeds, and Torque
6. Open Gear Lubrication
7. Open Gear Troubleshooting

Lesson 14: Gear Drive Systems II Date

1. Gear Drive Systems II
    a. Enclosed Gear Drives
        i. Definitions
        ii. Advantages and Disadvantages
        iii. Safety
        iv. Types of Drives
        v. Configurations
        vi. Terminology
    b. Gear Drive Efficiency and Horsepower
    c. Gear Drive Service Factors
    d. Gearbox Installation
        i. Foundation
        ii. Lubrication
        iii. Test Run
        iv. Run In
    e. Gearbox Alignment

f. Preventive Maintenance and Overhaul

Lesson 15: Seals and Gaskets Date

1. Types of Seals
   a. Static
   b. Dynamic
2. Gaskets
   a. Types
      i. Flat
      ii. Envelope Gasket
      iii. Spiral-wound Metal-filled
      iv. Grooved Metal
      v. Solid Flat Metal
      vi. Metal Ring Joint
   b. Choosing a Gasket Material
3. Stuffing Boxes
   a. Three Basic Parts
   b. Packing Material
   c. Packing Installation
4. Automatic or Molded Packing
5. Radial Lip Seals
   a. Installing Radial Lip Seals
6. Mechanical Seals
   a. Installing Mechanical Seals
7. Labyrinth Seals
8. Installation Precautions

Part 4: Grading Information

Graded Activities

Module Exams

There will be three module exams, each worth 10% of the final grade.

Final Exam

There will be a comprehensive final exam worth 25% of the final grade.

Laboratory Exercises

Laboratory exercises measure skills and abilities relating to knowledge learned in class and will be worth 20% of the final grade.

Quizzes

Quizzes on assigned material will be designed for review and evaluation of learning and will be worth 10% of the final grade.

Homework

Doing work outside of class is critical to success. Homework is graded and will be worth 10% of the final grade.

Class Participation

Class participation is important and will be worth 5% of the final grade.

Grading Breakdown

Module Exams = 30%
Final Exam = 25%
Laboratory Exercises = 20%
Quizzes = 10%
Homework = 10%
Class Participation = 5%

Grading Scale

A = 90-100
B = 80-89
C = 70-79
D = 60-69
F = 59 and below

Late Work

Late work will not be accepted unless it is pre-approved by the instructor. All graded work will be posted in the college learning management system with 48 hours of due date.

Part 5: College Policies and Resources

Policies

Attendance

Academic Integrity

Campus Civility

Resources

Counseling

Veterans

Students with Disabilities

About These Materials

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