# 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
3. The U.S. Occupational Safety and Health Administration (OSHA) and Its Role
4. Material Safety Data Sheets (MSDS)
5. Safe Dress
6. Personal Protective Equipment (PPE)
7. Confined Space
8. Electrical Safety
9. Mechanical Transmission Safety
10. Machine Guarding
11. Log Out Tag Out (LOTO)
12. Lab: Familiarization with Mechanical Trainers
13. Basic Identification and Inventory of Parts

## Lesson 2: Hand Tools and Fasteners Date

1. Hand Tools
2. Screwdrivers
3. Pliers
4. Wrenches
5. Socket Tools
6. Hammers
7. Chisels and Punches
8. Hacksaws and Files
9. Taps and Dies
10. Measuring Tools
11. Fasteners
12. Thread Definitions
13. Fits and Grades
14. Types of Threaded Fasteners
15. Types of Nuts
16. Classes of Washers
17. Removing Damaged Fasteners
18. Key Fasteners

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

1. Torque and Torque Wrenches
2. Principles of Mechanical Systems
3. Energy
4. Force
5. Rotational Speed
6. Work

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

1. Mechanical Principles II
2. Basic Mechanical Machines
3. Mechanical Efficiency
4. Mechanical Rate
5. Power
6. 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
2. Friction
3. Friction as a Waste of Energy
4. Friction and the Role of Heat
5. Shafts
6. Materials
7. Stresses
8. Vibration and Critical Speed
9. Fits and Clearances
10. General Bearing Classification and Selection
11. Load Ratings
12. Life
13. Tolerances
14. Speed
15. Temperature
16. Lubrication
17. Numbering systems
18. Types of Bearings
19. Plain (Journal) Bearings
20. Classification
21. Material
22. Load Ratings
23. Lubrication
24. Ball and Roller Bearings
25. Classification
26. Material
27. Load Ratings
28. Lubrication

## Lesson 7: Bearing Maintenance, Troubleshooting, and Installation Date

1. Lubrication
2. Oil vs. Grease
3. Temperature and Viscosity
4. Determining the Correct Lubricant for a Particular Application
5. Working with Bearings
6. Basic Rules
7. Cleaning
8. Moisture Avoidance
9. Handling
10. Spinning with Compressed Air
11. Bearing Troubleshooting
12. Indicators of Failure
13. Bearing Failures
14. Failure Modes of Different Types of Bearings
15. Replacing Bearings
16. Removal
17. Installation
18. Mechanical Methods
19. Thermal Methods

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

1. Coupling Types
   1. Rigid
   2. Flexible
   3. Chain and Gear
   4. Jaw and Slider
   5. Elastomeric
2. Choosing the Correct Coupling
3. Installing Couplings
   1. Review Types of Fit
   2. Heating Couplings
   3. Key Size
   4. Torqueing Bolts
   5. Location of Lubrication Fittings
   6. Runout
   7. Soft Foot
   8. Shims and Shim Size
4. Coupling/Shaft Alignment
   1. Types of Misalignment
   2. Straightedge
   3. Single Dial Indicator
   4. Dual Dial Indicator
   5. Reverse Dial Indicator
   6. Laser

## Lesson 9: Belt Drive Systems I Date

1. Mechanical Power Transmission Systems
2. Generic Components
3. Power Flow
4. Safety
5. Belt Drive Systems I
6. Terminology
7. Driver Sheave
8. Driving Sheave
9. Belt Pitch
10. Arc of Contact
11. Center of Distance
12. Speed Ratio
13. Types of Belts
14. Belt Standardization
15. Belt Length Calculations
16. Replacing a V-Belt
17. Belt Alignment

## Lesson 10: Belt Drive Systems II Date

1. Belt Drive Systems II
2. Sheave Replacement and Alignment
3. Belt Tension Measurement and Adjusting
4. Flat Belt Splicing
5. V-Belt Maintenance
6. Timing Belt Drives
7. Timing Belt Sheaves
8. Installing Timing Belts
9. Tensioning Timing Belts

## Lesson 11: Chain Drive Systems I Date

1. Chain Drive Power Transmission Systems
2. Catastrophic Chain Failures
3. Power Flow
4. Safety
5. Chain Drive Systems I
6. Advantages and Disadvantages of Chain Drives
7. Types of Chain Drive Systems
8. Horizontal
9. Vertical
10. Systems with Idlers
11. Multi-shaft Drives
12. Chain Construction
13. Links
14. Offset Pins
15. Cotter Pins
16. Rollers
17. Bushings
18. Spring Clips
19. Link plates
20. Types of Industrial Chains
21. Roller Chain
22. Silent Chain
23. Engineered-class Chain
24. Cast Chain
25. System Terminology
26. Driver Sprocket
27. Driven Sprocket
28. Chain Pitch
29. Center Distance
30. Chain Length
31. Chain Rating
32. Ultimate Strength
33. Pitch Diameter
34. Roller Chain Numbering Systems
35. Sprockets and Sprocket Hub Design
36. Arm
37. Solid
38. Hub Classes
39. Sprocket Mounting
40. Calculate Shaft Speed and Torque

## Lesson 12: Chain Drive Systems II Date

1. Chain Drive Systems II
2. Roller Chain Drive Selection
3. Speed Ratio
4. Service Factors
5. Calculate Chain Length
6. Drive Chain Installation
7. Chain Tensioning
8. Measuring Chain Sag
9. Removing chains with Master Links
10. Test Running
11. Lubrication
12. Preventive Maintenance
13. Care of Stored Chain
14. Troubleshooting Chain Drives

## Lesson 13: Gear Drive Systems I Date

1. Gear Drives
2. Generic Components
3. Power Flow
4. Safety
5. Advantages and Disadvantages
6. Gear Drive Systems I
7. Terminology
8. Open and Enclosed Drives
9. Gear Definitions
10. Types of Gears
11. Spur
12. Helical
13. Bevel
14. Worm
15. Types of Gear Drives
16. Shaft-mounted
17. Worm Gear
18. Miter Boxes
19. Calculation of Speed Ratios, Shaft Speeds, and Torque
20. Open Gear Lubrication
21. Open Gear Troubleshooting

## Lesson 14: Gear Drive Systems II Date

1. Gear Drive Systems II
2. Enclosed Gear Drives
3. Definitions
4. Advantages and Disadvantages
5. Safety
6. Types of Drives
7. Configurations
8. Terminology
9. Gear Drive Efficiency and Horsepower
10. Gear Drive Service Factors
11. Gearbox Installation
12. Foundation
13. Lubrication
14. Test Run
15. Run In
16. Gearbox Alignment
17. Preventive Maintenance and Overhaul

## Lesson 15: Seals and Gaskets Date

1. Types of Seals
2. Static
3. Dynamic
4. Gaskets
5. Types
6. Flat
7. Envelope Gasket
8. Spiral-wound Metal-filled
9. Grooved Metal
10. Solid Flat Metal
11. Metal Ring Joint
12. Choosing a Gasket Material
13. Stuffing Boxes
14. Three Basic Parts
15. Packing Material
16. Packing Installation
17. Automatic or Molded Packing
18. Radial Lip Seals
19. Installing Radial Lip Seals
20. Mechanical Seals
21. Installing Mechanical Seals
22. Labyrinth Seals
23. 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

## Copyright

© 2014 by the National STEM Consortium.

The National STEM (Science, Technology, Engineering, and Mathematics) Consortium (NSC), a collaborative of ten colleges in nine states, was funded by a Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant from the U.S. Department of Labor to develop new certificate training programs in technical fields. For more information about NSC, visit the NSC website: [http://www.nationalstem.org](http://www.nationalstem.org/).

## License

[This icon displays "CC" for Creative Commons and "BY" for the Attribution 4.0 International License, and is hyperlinked to the Creative Commons webpage on attribution licenses.](http://creativecommons.org/licenses/by/4.0/) Unless otherwise specified, this work is licensed under a [Creative Commons Attribution 4.0 International License](http://creativecommons.org/licenses/by/4.0/).

## Attribution and Citation

To attribute this work, use: Margie Porter.

To cite this work, use:

Margie Porter (2014). Course Introduction Guide. *Mechanical Systems*. Mechatronics Technology Program of the National STEM Consortium. Retrieved from <http://oli.cmu.edu>.

## Disclaimer

This workforce solution was funded by a grant awarded by the U.S. Department of Labor’s Employment and Training Administration. The solution was created by the grantee and does not necessarily reflect the official position of the U.S. Department of Labor. The Department of Labor makes no guarantees, warrantees, or assurances of any kind, express or implied, with respect to such information, including any information on linked sites and including, but not limited to, accuracy of the information or its completeness, timeliness, usefulness, adequacy, continued availability, or ownership.