

Prepared by: J. Carrithers  
Reviewed by: D. Layne  
Reviewed by: K. Bandy  
Date Revised: Spring 2017  
C&GE approved: May 8, 2017  
Board approved: June 14, 2017  
Semester Effective: Spring 2018

Energy (ENER) 1610 Mechanical Systems (3 Units) CSU

Prerequisite: None

Advisory: None

Total Hours: 32 Hours Lecture; 48 Hours Lab (80 hours total)

Catalog Description: This course is a comprehensive study of the mechanical systems, machining, and the essential mechanical processes used to produce, process, and distribute energy. Topics include the operation and selection for application of mechanical drives, mechanical fasteners, shafts, bearings, lubrication systems, hydraulics, pneumatics, materials, tanks and vessels, welding strategy, basic controls schemes, and how to establish a preventative maintenance program. Troubleshooting, problem solving, and decision making tools and skills are presented. Safety, measurement, hand tool operations, and preventative maintenance protocols are examined. Field trips maybe required.

Type of Class/Course: Degree/Credit

Textbook: Kibbe, R. *Mechanical Systems for Industrial Maintenance*, Prentice Hall, 2001.

Lab Manuals Online: Donald J. Simenak, Lock Haven University, other university and industrial sites

Additional Instructional Materials: none

Course Objectives:

By the end of the course the successful student will be able to:

1. demonstrate proper tool selection, safe operation, maintenance, and troubleshooting techniques to identify and repair mechanical system anomalies and failures,
2. understand different types of mechanical systems; i.e. belts, gears, pulleys, clutches, couplers, etc.,
3. analyze troubleshooting scenarios and identify and apply solutions for mechanical, hydraulic, and pneumatic systems,
4. demonstrate the accurate use of measurement devices for determining mechanical requirements and performance of mechanical systems such as micrometers, rulers, calipers, and pressure gauges,
5. calculate specifications, select, and justify the needed horsepower, RPM, and torque for mechanical drives, chain - gear, gear-gear, and belt-pulley systems, and pumps and motors, with emphasis on mechanical systems used for energy production, distribution, and processing,
4. identify and select appropriate bearings, bushings, seals, gaskets, diaphragms o-rings, pressure packing materials, and the appropriate lubrication type and application for each,

5. demonstrate the ability to perform preventative maintenance planning, repair, and re-installation tasks on regulators, pumping units, packing glands, chain drives, and motor valves,
6. identify and select the appropriate mechanical fasteners and welding, brazing, or soldering techniques for various mechanical joining applications,
7. demonstrate ability to read and interpret drawings of mechanical systems,
8. locate and research technical information,
9. locate and order spare or replacement parts, and
10. maintain a preventative maintenance schedule including equipment history.

Course Scope and Content (Lecture):

Unit I Basic Principles of Mechanical Systems

- A. History of Mechanical Systems
- B. Getting Power: Water, Wind, Engines, and Motors
- C. Mechanical Systems Fundamentals
- D. Mechanical System Applications
- E. Mechanical Systems in Energy Production

Unit II Hand Tools and Power Tools

- A. History of Hand Tools
- B. Common Hand Tools: Their Application and Safe Use
- C. Drilling Devices, Twist Drills, Punch Presses
- D. Hand Grinders and Bench Grinders
- E. Abrasives
- F. Saws and Shears
- G. Hydraulic Jacks and Presses
- H. Pneumatic Tools

Unit III Measurement and Measuring Tools

- A. History of Measurement
- B. Measurement Tools and Uses in Dimensional, Mechanical, Hydraulic, Pneumatic system measurement and performance
- C. Measurement Systems including fractions, decimals, metric and conversions between each
- D. Dimensional Measuring Tools: Rules, Calipers, Micrometers, Depth Gauge, etc.
- E. Measuring Mechanical Performance
- F. Measuring Pneumatic and Hydraulic System Performance

Unit IV Mechanical Hardware and Joinery

- A. History of Joinery in Mechanical Devices
- B. Overview of Types of Mechanical Fasteners – Screws, Bolts/Nuts, Rivets, Set Screws, Keys and Keyways, Cam Lock, Latches, Detents, Hinges, etc.
- C. Screw and Bolt Thread Types and Applications
- D. Adhesive Applications in Mechanical Systems
- E. Overview of Welding, Brazing, Soldering Applications
- F. Inspection and Preventative Maintenance for Mechanical Fasteners
- G. Inspection and Preventative Maintenance of Welded Components

Unit V Machining and Machine Tool Operations

- A. History of Machine Tools
- B. Types of Machine Tools Available
- C. Machining Processes and Applications
- D. Numerical Control of Machining
- E. Reading Mechanical Blueprints
- F. Operating Machine Tools Safely and Effectively
- G. Reading Mechanical Blueprints

Unit VI Working on Machinery and Mechanical Systems

- A. Risk Reduction and Mitigation – Engineering Controls, Guards, and Interlock Devices
- B. Role of Preventative Maintenance Programs: Why, What, How, Who, When, Where
- C. Types of Mechanical Failures and Operating Anomalies
- D. Mechanical Troubleshooting Processes
- E. Preventative Maintenance Tasks including Lockout/Tag out
- F. Repair and/or Replacement Tasks including Lockout/Tag out

Unit VII Bushing and Bearings: Handling a Load Reliably

- A. History of Bearing and Bushing Applications
- B. Sleeve Bearings – Metallurgy, Application, Lubrication, and Maintenance
- C. Sleeve Bushing – Metallurgy, Application, Lubrication, and Maintenance
- D. Ball Bearings – Metallurgy, Application, Lubrication, and Maintenance
- E. Roller Bearings – Metallurgy, Application, Lubrication, and Maintenance
- F. Shaft Couplings – Types, Application, Selection

Unit VIII Pipe, Tubing, Hose

- A. Historical Applications of Piping, Tubing and Hose
- B. Safely Moving Air, Water, Chemicals, Steam, Gas, and Petroleum
- C. Bernoulli's Equation
- D. Principles of Pressure, Temperature, Hydrostatics, Corrosion, Hydraulics, and Steam Dynamics
- E. Pipe Sizing and Selection Resources, including well and drilling tubulars
- F. Calculating Specifications and Sizing Air Piping, Tubing, and Hose
- G. Calculating Specifications and Sizing Water Piping, Tubing, and Hose
- H. Calculating Specifications and Sizing Chemical Piping Tubing and Hose
- I. Calculating Specifications and Sizing Steam Pipe and Tubing
- J. Calculating Specifications and Sizing Gas Pipe and Tubing
- K. Calculating Specifications and Sizing Petroleum Pipe and Tubing
- L. Calculating Specifications and Sizing Drill Pipe and Tubing
- M. Corrosion Prevention and Control in Piping, Tubing, and Hoses

Unit IX Valves, Regulators, Measurement, End Devices and Controls

- A. History of Valves and Controls
- B. Valves: Types and Applications
- C. Pressure Regulators: Types and Applications
- D. Measurement Devices used in energy production and processing
- E. End Devices: Types and Application
- F. Process Logic Control basics

Unit X Tanks, Pressure Vessels and Water Treatment

- A. History of vessels and tanks
- B. Hydraulic head calculations- tank level, pressure, specific gravity relationship
- C. Types of Tanks and Applications
- D. Tank Selection Resources
- E. Tank Regulatory Requirements and Compliance
- F. Tank Design, Construction, and Operations
- G. Types of Pressure Vessels and Applications
- H. Pressure Vessel Coding, Certification, and Construction
- I. Pressure Vessel Operations and Regulatory Compliance
- J. Pressure Vessel Inspections and Testing – Hydrostatic Testing
- K. Pressure Vessel Selection Resources
- L. Water Treatment – Vessels, Tanks, and Treatment Processes

#### Unit XI Hydraulics and Fluid Power

- A. History of Hydraulic Systems
- B. Bernoulli's Equation in Hydraulic Systems
- C. Hydraulic System Components – pumps, accumulators, filters, cylinders, pistons, etc.
- D. Hydraulic Power System Operations
- E. Hydraulic Power System Preventative Maintenance
- F. Hydraulic Power System Anomalies and Failures
- G. Hydraulic Power System Troubleshooting
- H. Hydraulic Power System Repair and Replacement

#### Unit XII Pneumatic Systems

- A. History of Pneumatics
- B. Bernoulli's Equation in Pneumatic Systems
- C. Pneumatic system components – pumps, accumulators, filters, cylinders, pistons, etc.
- D. Pneumatic Power System Operations
- E. Pneumatic Power System Preventative Maintenance
- F. Pneumatic Power System Anomalies and Failures
- G. Pneumatic Power System Troubleshooting
- H. Pneumatic Power System Repair and Replacement
- I. Advanced Pneumatic Components and Circuits

#### Unit XIII Lubricants and Lubrication Systems

- A. Functions and History of Lubricants
- B. Types of Lubricants used in mechanical systems
- C. Lubricant Weights and Ratings
- D. Specific Gravity and API Gravity Calculations and Measurement
- E. Lubricant Testing and Analysis
- F. Selecting Lubricants – Mineral vs. Synthetics
- G. Lubricant Application in Mechanical Systems
- H. Lubricant and Engine Oil Filtering Applications
- I. Pumped Distribution Lubricant Systems – Maintenance, Troubleshooting, Repair
- J. Lubrication and Drilling Fluids

#### Unit XIV Properties and Strength of Materials

- A. History of Materials and their Properties

- B. Atomic Structure and the Periodic Chart overview
- C. Basic Engineering: Vectoring, Shear, Section Modulus, Modulus of Elasticity, Moment Arm
- D. Metals used in Mechanical System Construction and Operations, including well drilling
- E. Specialty Metals- springs, valve plates, valve components, steam fittings, corrosive service
- F. Polymers- power belts, seals, packings, gaskets, o-rings, and ropes
- G. Ceramics- electrical insulation, heat control, instruments, and hi-tech fibers
- H. Composite materials- housings, measurement, wind turbines, and solar panels
- I. Concrete- applications, quality, slump testing, forming, pouring, troweling, and curing

Unit XV Welding, Brazing, Soldering, and Cutting

- A. History of Metalworking
- B. Selecting the right metal joining technology
- C. Soldering Applications- process, safety, and practice
- D. Brazing and Hard Facing- applications, process, and safety
- E. Stick Welding- applications, process, and safety
- F. Wire Feed Welding- applications, process, and safety
- G. Flame Cutting- applications, process, and safety
- H. Carbon Arc- applications, process, and safety

Unit XVI Related Skills for Operating and Maintenance Technicians

- A. Operating and Maintenance Philosophies
- B. Reading Engineering Drawings
- C. Locating Technical Information
- D. Identifying, finding, and ordering spare parts
- E. Preventative Maintenance Programs
- F. Maintaining equipment operating history
- G. Regulatory Permit Compliance- IC engines, steam generators, tanks, and vessels
- H. Minimizing the environmental footprint of machinery
- I. Optimizing Machinery Performance
- J. Avoiding and Preventing Major Failures
- K. Clean-up Operations
- L. Incident Investigation and Follow-up
- M. Root Cause Failure Analysis
- N. Continuous Improvement following an incident

Course Scope and Content (Laboratory):

Unit I Basic Tools and Measurements

- A. Introduction to Lab Safety
- B. Demonstrate safe tool handling with various hand tools
- C. Use various systems and tools for measuring
- D. Reading blueprints and mechanical blueprints

Unit II Basic Hydraulics

- A. Examine typical components in hydraulic systems
- B. Construct basic hydraulic systems
- C. Explore basic circuits to control basic hydraulic systems
- D. Troubleshoot typical problems occurring in hydraulic systems

**Unit III Basic Pneumatics**

- A. Examine pneumatic components
- B. Construct pneumatic systems
- C. Explore basic circuits to control basic pneumatic systems
- D. Troubleshoot typical problems occurring in basic systems

**Unit IV Advanced Pneumatics**

- A. Design and create advanced pneumatic systems
- B. Design and create circuits to control advanced pneumatic systems
- C. Troubleshoot problems in advanced pneumatic systems

**Unit V Materials and Applications**

- A. Examine specialty metals: springs, valves, steam fittings, corrosive service
- B. Examine polymers: power belts, seals, packings, gaskets, o-rings, ropes
- C. Examine ceramics: electrical insulation, heat control, instruments, hi-tech fibers
- D. Examine composite materials: housings, wind turbines, and solar panels
- E. Examine tanks and vessels
- F. Cutting, bending, and shaping materials for specific field applications

**Unit VI Specialty Systems**

- A. Align motor and shaft assemblies
- B. Develop systems to reduce and control vibrations
- C. Perform hydrostatic tests on various systems

**Learning Activities Required Outside of Class:**

The students in this class will spend a minimum of 4 hours per week outside regular class time doing the following:

- 1. Studying class notes
- 2. Answering questions
- 3. Completing required reading
- 4. Performing problem solving activities or exercises
- 5. Doing written work
- 6. Visiting locations relevant to the course content

**Methods of Instruction:**

- 1. Case Studies and Scenarios
- 2. Demonstrations
- 3. Discussion
- 4. Laboratory
- 5. Lecture
- 6. Troubleshooting
- 7. Problem Solving
- 8. Research and Reporting
- 9. Multi-media Presentations
- 10. Field Trips

**Methods of Evaluation:**

- 1. Writing assignments, including

- a. reports
  - b. topic paper written under American Psychological Association (APA) style guide
  - c. chapter critical analysis reflections
  - d. case studies
  - e. scenarios
  - f. simulations
2. Problem-solving demonstrations, including:
- a. exams
  - b. homework problems
  - c. troubleshooting
  - d. scenarios
  - e. case study recommendations and solutions
3. Other summative examinations using combinations of:
- a. multiple choice questions
  - b. matching items
  - c. true/false questions
  - d. short answer questions
  - e. fill in the blank responses
4. Participation including:
- a. group activities
  - b. oral presentations and demonstrations
  - c. discussion responses
  - d. scenario reflections
5. Projects including:
- a. multimedia presentations
  - b. scenario responses
  - c. action plans
  - d. formal written reports
  - e. building new case studies

Laboratory Category: Extensive Laboratory

Pre delivery criteria: All of the following criteria are met by this lab.

1. Curriculum development for each lab.
2. Published schedule of individual laboratory activities.
3. Published laboratory activity objectives.
4. Published methods of evaluation.
5. Supervision of equipment maintenance, laboratory setup, and acquisition of lab materials and supplies.

During laboratory activity of the laboratory: All of the following criteria are met by this lab.

1. Instructor is physically present in lab when students are performing lab activities.
2. Instructor is responsible for active facilitation of laboratory learning.
3. Instructor is responsible for active delivery of curriculum.
4. Instructor is required for safety and mentoring of lab activities.

5. Instructor is responsible for presentation of significant evaluation.

Post laboratory activity of the laboratory: All of the following criteria are met by this lab.

1. Instructor is responsible for personal evaluation of significant student outcomes (lab exercises, exams, practicals, notebooks, portfolios, etc.) that become a component of the student grade that cover the majority of lab exercises performed during the course.
2. Instructor is responsible for supervision of laboratory clean-up of equipment and materials.

Supplemental Data:

T.O.P. Code:	0935.00 Electro-Mechanical Tech
Sam Priority Code:	C: Clearly Occupational
Funding Agency:	Y: Not Applicable
Program Status:	1: Program Applicable
Noncredit Category:	Y: Not Applicable, Credit Course
Special Class Status:	N: Course is not a special class
Basic Skills Status:	N: Course is not a basic skills course
Prior to College Level:	Y: Not Applicable
Cooperative Work Experience:	N: is not part of a cooperative work experience education program



Eligible for Credit by Exam:	No
Eligible for Pass/No Pass:	Yes