ENGT M32: ELECTRICAL AND MECHANICAL DEVICES

Originator
srelle

College
Moorpark College

Attach Support Documentation (as needed)
1- Advisory Committee Board Meeting.pdf

Discipline (CB01A)
ENGT - Engineering Technology

Course Number (CB01B)
M32

Course Title (CB02)
Electrical and Mechanical Devices

Banner/Short Title
Elect and Mech Devices

Credit Type
Credit

Honors
No

Start Term
Fall 2022

Catalog Course Description
Introduces the design and the architecture of electromechanical systems including robotics through the use of the engineering design process. Examines fundamentals and functions of various electrical and electronic components, mechanical components, and micro-computers, and their incorporation into a functioning electromechanical system. Develops skills to troubleshoot a malfunctioning electromechanical component or system.

Taxonomy of Programs (TOP) Code (CB03)
0935.00 - *Electro-Mechanical Technology

Course Credit Status (CB04)
D (Credit - Degree Applicable)

Course Transfer Status (CB05) (select one only)
B (Transferable to CSU only)

Course Basic Skills Status (CB08)
N - The Course is Not a Basic Skills Course

SAM Priority Code (CB09)
C - Clearly Occupational

Course Cooperative Work Experience Education Status (CB10)
N - Is Not Part of a Cooperative Work Experience Education Program

Course Classification Status (CB11)
Y - Credit Course

Educational Assistance Class Instruction (Approved Special Class) (CB13)
N - The Course is Not an Approved Special Class

Course Prior to Transfer Level (CB21)
Y - Not Applicable

Course Noncredit Category (CB22)
Y - Credit Course

Funding Agency Category (CB23)
A - Primarily Developed Using Economic Development Funds

Course Program Status (CB24)
1 - Program Applicable

General Education Status (CB25)
Y - Not Applicable

Support Course Status (CB26)
N - Course is not a support course

Field trips
May be required

Faculty notes on field trips; include possible destinations or other pertinent information
Naval Base in Point Mugu or in Port Hueneme; local engineering companies

Grading method
(L) Letter Graded

Alternate grading methods
(O) Student Option- Letter/Pass
(E) Credit by exam, license, etc.
(P) Pass/No Pass Grading

Does this course require an instructional materials fee?
No

Repeatable for Credit
No

Is this course part of a family?
No

Units and Hours

Carnegie Unit Override
No

In-Class

Lecture
Minimum Contact/In-Class Lecture Hours
35
Maximum Contact/In-Class Lecture Hours
35

Activity

Laboratory
Minimum Contact/In-Class Laboratory Hours
52.5

Maximum Contact/In-Class Laboratory Hours
52.5

Total in-Class

Total in-Class
Total Minimum Contact/In-Class Hours
87.5
Total Maximum Contact/In-Class Hours
87.5

Outside-of-Class

Internship/Cooperative Work Experience

Paid

Unpaid

Total Outside-of-Class

Total Outside-of-Class
Minimum Outside-of-Class Hours
70
Maximum Outside-of-Class Hours
70

Total Student Learning

Total Student Learning
Total Minimum Student Learning Hours
157.5
Total Maximum Student Learning Hours
157.5

Minimum Units (CB07)
3
Maximum Units (CB06)
3

Prerequisites
ENGT M02, ENGT M04, ENGT M06

Entrance Skills

Entrance Skills
ENGT M02, ENGT M04, ENGT M06

Prerequisite Course Objectives
ENGT M02-demonstrate the operation of electronic lab equipment to test components and circuits by properly connecting and operating the following standard test equipment: power supplies, function generators, ammeters, voltmeters, ohmmeters, digital multimeters, and oscilloscopes.
ENGT M02-explain the operation of digital logic gates.
ENGT M02-identify the more commonly used integrated circuit families used in digital equipment and discuss their operation and characteristics.
ENGT M02-use Boolean algebra to express logic operations and minimize logic circuits in design.
ENGT M02-discuss the operation and application of counters, shift registers, and other combinational and sequential logic circuits.
ENGT M04-solve basic electronic problems related to direct current involving resistance, current, voltage, and power applied to both simple and complex combinations of series and parallel circuit components, comprised of resistors, capacitors and coils, in a given network configuration.

ENGT M04-diagram and discuss the relationship between electricity and magnetism as related to a direct current permanent magnet motor, a solenoid or an electromechanical relay.
ENGT M04-describe and contrast the construction, operation, and purpose of resistors, potentiometers, switches, fuses, relays, and batteries.
ENGT M04-discuss the purpose and effects of resistors, capacitors, inductors and/or transformers in a given AC network problem, analyze it and diagram the solution to a posed problem by using J-Factors (complex numbers) appropriately and accurately.
ENGT M06-explain the basic functions, operations, and architecture of microprocessors and microcontrollers.
ENGT M06-analyze the behavior of particular microprocessors and microcontrollers studied in class according to fundamental laws and formulas.
ENGT M06-develop a flowchart to define a problem and map a solution based on analytical and experimental techniques learned in class. Write a program that implements this flowchart for a microprocessor/microcontroller-based function.
ENGT M06-design, construct, and evaluate the efficacy of a microprocessor/microcontroller-based circuit or system according to a given set of requirements and constraints including, but not limited to, power consumption, speed, and cost.

Requisite Justification

Requisite Type
Prerequisite

Requisite
ENGT M02

Requisite Description
Course in a sequence

Level of Scrutiny/Justification
Closely related lecture/laboratory course

Requisite Type
Prerequisite

Requisite
ENGT M04

Requisite Description
Course in a sequence

Level of Scrutiny/Justification
Closely related lecture/laboratory course

Requisite Type
Prerequisite

Requisite
ENGT M06

Requisite Description
Course in a sequence

Level of Scrutiny/Justification
Closely related lecture/laboratory course

Student Learning Outcomes (CSLOs)

	Upon satisfactory completion of the course, students will be able to:
1	explain the basic functions, operations, and architecture of various electromechanical systems.
2	design an electromechanical system for a specified application or to achieve a specified outcome.
3	troubleshoot a malfunctioning electromechanical system using analytical techniques learned in class.

Course Objectives

	Upon satisfactory completion of the course, students will be able to:
1	explain the basic functions, operations, and architecture of various sensors, actuators, and power transmission components.
2	incorporate various sensors, actuators, and power transmission components into a working electromechanical system.
3	explain the basic functions, operations, and architecture of microcomputers and Input/Output devices.
4	program microcomputers and Input/Output devices for a specified application.
5	demonstrate knowledge of design and control of robotics devices as electromechanical systems.
6	demonstrate knowledge in shielding and grounding of various electromechanical systems and creating feedback loops.
7	troubleshoot a malfunctioning electromechanical component or system.

Course Content

Lecture/Course Content

(15%) - Design Process

- Recognition of the problem
- Translation of the problem into a meaningful set of engineering specifications
- Realization of the design goals, capabilities, and risks

(10%) - Actuators

- Design and dynamic properties of:
  - hydraulic actuators
  - pneumatic actuators
  - electric actuators
  - internal combustion engines

(10%) - Sensors

- Design, accuracy, capability, dynamic range, and stability of various sensors:
  - resistive
  - inductive
  - capacitive
  - optical
  - solid state
  - piezoelectric
  - ultrasonic

(10%) - Electronic and Electrical Devices

- Operation and usage of:
  - power supplies, diodes, transformers, filters, choppers, relays
- Setup and application of:
  - signal processing, shielding, grounding, and multiplexing

(20%) - Embedded Microprocessor Systems and Controls

- CPU operation, system bus, memories, interrupt processing, input and output (I/O) devices, I/O programming (serial, parallel, Analog to Digital and Digital to Analog), Programmable Logic Controller

(10%) - Real Time Software Design and Implementation Methodology

- Software design models, specifications and documentation, computer language

(10%) - Power Transfer Components

- Motors, shafts, transmission systems, brakes, clutches, fasteners, belts, chains, traction drives, indexing systems, cams, pulleys, ball screw systems, bearings, springs

(15%) - Mechanism Design

- Kinematics and dynamics of robotic type devices:
  - Articulation, speed, accuracy, bandwidth, inertia, vibration, static and dynamic loading, materials, integration of design requirements

Laboratory or Activity Content

(30%) - Sensors and Actuators in Electromechanical Systems

- Design and develop solutions to engineering problems using various sensors and actuators
- Interpret the acquired data and measured results
- Troubleshoot a system that uses sensors and actuators

(20%) - Control Design/Analysis/Implementation

- Program industry standard microcontrollers for a specific outcome
- Build circuits that receive signals, digital or analog, process them and manipulate them for a system implementation
- Build circuits that use DC (Direct Current) motors as power generators and as turbines with motor speed controls
- Modify a DC Motor into a servo motor
- Create feedback loops using PID (proportional-integral-derivative) control to correct the error between the current state and desired state of a system

(10%) - Exposure to Various Commercial Software for Rapid Control Prototyping

- Data acquisition and analysis
- Role of error and uncertainty in measurements
- Spectral analysis of digital data and its limitations
- Matlab, Simulink, RTW, WinLib, and WinCon software

(40%) - Robotics and Controls

- Design and build robots using the skills and concepts learned in the previous laboratory experiments utilizing the engineering design process and the concepts of mechanism design learned in the lecture

Methods of Evaluation

Which of these methods will students use to demonstrate proficiency in the subject matter of this course? (Check all that apply):

Problem solving exercises
Skills demonstrations

Methods of Evaluation may include, but are not limited to, the following typical classroom assessment techniques/required assignments (check as many as are deemed appropriate):

Computational homework
Group projects
Individual projects
Laboratory activities
Laboratory reports
Objective exams
Problem-solving exams
Problem-solving homework
Quizzes
Simulations
Skills demonstrations
Skills tests or practical examinations

Instructional Methodology

Specify the methods of instruction that may be employed in this course

Class activities
Class discussions
Collaborative group work
Computer-aided presentations
Demonstrations
Field trips
Group discussions
Guest speakers
Instructor-guided interpretation and analysis
Instructor-guided use of technology
Internet research
Laboratory activities
Lecture
Practica
Problem-solving examples
Small group activities

Describe specific examples of the methods the instructor will use:

The instructor will use PowerPoint presentations, problem solving exercises, and demonstrations to explain the concepts of the course. The instructor will divide students into small groups of 2-4 students, task them with a design objective or a system maintenance and operational issue, then using concepts learned in the course guide them through the engineering design and troubleshooting process.

Representative Course Assignments

Writing Assignments

1. Compare and contrast the dynamic properties of various actuators and explain the design parameters which would dictate the appropriate actuator choice in an electromechanical system.
2. Use the engineering design process as a guide to translate an electromechanical system problem into a meaningful set of engineering specifications and outline a solution.

Critical Thinking Assignments

1. Design a circuit that uses a sensor and a controller to inform the operation of an actuator. For example, design a mechanism that will operate with a certain amount of pressure exerted at a particular location on a surface to raise it and reveal a hidden storage area.

2. Troubleshoot a faulty electromechanical system. For example, troubleshoot a servo motor that does not hold the angular position of its shaft.

Reading Assignments

1. Read assigned chapters from the textbook to prepare for lectures and laboratory experiments which will reinforce the ability to recognize the various architecture, functions, and operations of sensors and actuators, predict their performance analytically, and verify their function and operation experimentally.

2. Read scientific and technical journal articles relevant to advances in robotics to expand understanding of their usage in various industrial operations.

Skills Demonstrations

1. Demonstrate the ability to program industry standard microcontrollers for a specific outcome. For example, program an Arduino to display temperature on the serial port monitor which gets updated every second.

2. Design and build robots using the skills and concepts learned in the course. For example:

- PC controlled human detection robot: detect the humans through a robotic vehicle by using IR (Infrared) sensors and microcontroller unit - helpful in the time of earth quakes
- Metal detector robot: sense the metals in the path ahead using appropriate sensors and microcontroller unit - helpful in detecting land mines
- Automatic wall painting robot: paint walls of given dimensions using IR sensors, a microcontroller and a DC motor - helpful for industrial projects and very tall buildings
- Surface cleaning robot: clean surfaces by collecting floating garbage in rivers, coastal waters and lakes using controllers and sensors - helpful for environmental engineering projects

Outside Assignments

Representative Outside Assignments

1. Prepare an oral presentation to explain the progression of thought and action, as prescribed by the Engineering Design Process, in designing, testing, and troubleshooting a malfunctioning electromechanical system such as a robot.

2. Research on the Internet the evolution of computer based controllers and their use in today's industry.

Articulation

Equivalent Courses at other CCCs

College	Course ID	Course Title	Units
Laney College	ECT 11	Mechanical and Electrical Devices	2
Cuyamaca College	CS 175	Mechatronics: Introduction to Microcontrollers and Robotics	3
Santa Ana College	ENGR 134	Intermediate Mechatronics	3

District General Education

A. Natural Sciences

B. Social and Behavioral Sciences

C. Humanities

D. Language and Rationality

E. Health and Physical Education/Kinesiology

F. Ethnic Studies/Gender Studies

Course is CSU transferable
Yes

CSU Baccalaureate List effective term:
FALL 2022

CSU GE-Breadth

Area A: English Language Communication and Critical Thinking

Area B: Scientific Inquiry and Quantitative Reasoning

Area C: Arts and Humanities

Area D: Social Sciences

Area E: Lifelong Learning and Self-Development

Area F: Ethnic Studies

CSU Graduation Requirement in U.S. History, Constitution and American Ideals:

IGETC

Area 1: English Communication

Area 2A: Mathematical Concepts & Quantitative Reasoning

Area 3: Arts and Humanities

Area 4: Social and Behavioral Sciences

Area 5: Physical and Biological Sciences

Area 6: Languages Other than English (LOTE)

Textbooks and Lab Manuals

Resource Type
Textbook

Classic Textbook
No

Description
Krause, Paul C., Oleg Wasynczuk, et al. *Electromechanical Motion Devices: Rotating Magnetic Field-Based Analysis with Online Animations. 3rd ed.*, Wiley-IEEE Press Series on Power and Energy Systems, 2020.

Resource Type
Textbook

Classic Textbook
Yes

Description
Kamm, Lawrence J. *Understanding Electro-Mechanical Engineering: An Introduction to Mechatronics.* IEEE Press, 1996.

Resource Type
Textbook

Classic Textbook
No

Description
Carryer, J. Edward, Matthew Ohline, and Thomas Kenny. *Introduction to Mechatronic Design.* Pearson, 2011.

Resource Type
Textbook

Classic Textbook
Yes

Description
Honeycutt, Richard A. *Electromechanical Devices: Theory, Applications, and Troubleshooting.* Prentice Hall, 1985.

Resource Type
Textbook

Classic Textbook
Yes

Description
Lyshevski, Sergey E. *Electromechanical Systems and Devices.* CRC Press, 2008.

Resource Type
Software

Description
Multisim Software. Multisim is one of the few circuit design programs to employ the original Berkeley SPICE based software simulation. Multisim was originally created by a company named Electronics Workbench Group, which is now a division of National Instruments. It is available from https://www.multisim.com (https://www.multisim.com/faq/).

Resource Type
Other Instructional Materials

Description
Current editions of laboratory manuals that are typically developed on-site.

Library Resources

Assignments requiring library resources
Writing, reading, critical thinking, outside assignments

Sufficient Library Resources exist
Yes

Example of Assignments Requiring Library Resources
Using Library's online or print resources conduct a search and find 3 possible engineering projects that use sensors and actuators, then choose one of them to replicate in the laboratory using the available electromechanical devices.

Primary Minimum Qualification
ENGINEERING TECHNOLOGY

Review and Approval Dates

Department Chair
11/19/2021

Dean
11/19/2021

Technical Review
12/02/2021

Curriculum Committee
12/07/2021

DTRW-I
12/09/2021

Curriculum Committee
MM/DD/YYYY

Board
01/18/2022

CCCCO
MM/DD/YYYY

DOE/accreditation approval date
MM/DD/YYYY