(8600520) Principles of Engineering

Version: 2024

Course Attributes

- **Course Number:**
- **Grade Level:**
- **Course Length:**

8600520

3

1 Hours

Course Structure

Principles of Engineering

The outline below shows the structure of this Course, including all its requirements and optional components.

Parent
8600520 Principles of Engineering
0 Child Components - 0 Required

Standards and Benchmarks

National Standards:

8600520 Principles of Engineering

This course helps students understand the field of engineering/engineering technology and prepares them for postsecondary engineering programs by developing a more in-depth mastery of the required knowledge and skills in mathematics, science, and technology. Through problem-based learning strategies, students study key engineering topics, including mechanisms, energy sources, energy applications, machine control, fluid power, statics, material properties, material testing, statistics, and kinematics. Exploring various technology systems and manufacturing processes help students learn how engineers and technicians use math, science and technology in an engineering problem solving process to benefit people. The course also includes concerns about social and political consequences of technological change.

CTE-TECED.912.8600520.1 - Demonstrate an understanding of the engineering field.
Demonstrate an understanding of the engineering field.

CTE-TECED.912.8600520.1.1

Differentiate between engineering and engineering technology.

CTE-TECED.912.8600520.1.2

Identify and differentiate among different engineering disciplines.

CTE-TECED.912.8600520.2 - Demonstrate an understanding of engineering complexities ranging from simple machines to compound machine design.

Demonstrate an understanding of engineering complexities ranging from simple machines to compound machine design.

CTE-TECED.912.8600520.2.1

Measure forces and distances related to mechanisms.

CTE-TECED.912.8600520.2.2

Distinguish between the six simple machines, their attributes, and components.

CTE-TECED.912.8600520.2.3

Calculate mechanical advantage and drive ratios of mechanisms.

CTE-TECED.912.8600520.2.4

Design, create, and test gear, pulley, and sprocket systems.

CTE-TECED.912.8600520.2.5

Calculate work and power in mechanical systems.

CTE-TECED.912.8600520.2.6

Determine efficiency in a mechanical system.

CTE-TECED.912.8600520.2.7

Design, create, test, and evaluate a compound machine design.

CTE-TECED.912.8600520.3 - Demonstrate an understanding of energy sources, their characteristics, and their renewability.

Demonstrate an understanding of energy sources, their characteristics, and their renewability.

CTE-TECED.912.8600520.3.1

Identify and categorize energy sources as nonrenewable, renewable, or inexhaustible.

CTE-TECED.912.8600520.3.2

Create and deliver a presentation to explain a specific energy source.

CTE-TECED.912.8600520.4 - Perform mathematical operations specific to electrical systems.

Perform mathematical operations specific to electrical systems.

CTE-TECED.912.8600520.4.1
Define the possible types of power conversion.

CTE-TECED.912.8600520.4.2
Calculate work and power.

CTE-TECED.912.8600520.4.3
Demonstrate the correct use of a digital multimeter.

CTE-TECED.912.8600520.4.4
Calculate power in a system that converts energy from electrical to mechanical.

CTE-TECED.912.8600520.4.5
Determine efficiency of a system that converts an electrical input to a mechanical output.

CTE-TECED.912.8600520.4.6
Calculate circuit resistance, current, and voltage using Ohm's law.

CTE-TECED.912.8600520.4.7
Understand the advantages and disadvantages of parallel and series circuit design in an application.

CTE-TECED.912.8600520.5 - Demonstrate an understanding of the applications of alternative energy solutions.
Demonstrate an understanding of the applications of alternative energy solutions.

CTE-TECED.912.8600520.5.1
Test and apply the relationship between voltage, current, and resistance relating to a photovoltaic cell and a hydrogen fuel cell.

CTE-TECED.912.8600520.5.2
Experiment with a solar hydrogen system to produce mechanical power.

CTE-TECED.912.8600520.6 - Demonstrate an understanding of insulation, the suitability of specific materials for use as insulation, and associated mathematics.
Demonstrate an understanding of insulation, the suitability of specific materials for use as insulation, and associated mathematics.

CTE-TECED.912.8600520.6.1
Design, construct, and test recyclable insulation materials.

CTE-TECED.912.8600520.6.2
Test and apply the relationship between R-values and recyclable insulation.

CTE-TECED.912.8600520.6.3
Complete calculations for conduction, R-values, and radiation.

CTE-TECED.912.8600520.7 - Analyze an energy-related problem and design a solution to the problem.

Analyze an energy-related problem and design a solution to the problem.

CTE-TECED.912.8600520.7.1
Brainstorm and sketch possible solutions to the design problem.

CTE-TECED.912.8600520.7.2
Create a decision-making matrix for the design problem.

CTE-TECED.912.8600520.7.3
Select an approach that meets or satisfies the constraints provided in the design brief.

CTE-TECED.912.8600520.7.4
Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team's decision matrix.

CTE-TECED.912.8600520.7.5
Present a workable solution to the design problem.

CTE-TECED.912.8600520.8 - Demonstrate an understanding of machine control systems, logic, and devices.

Demonstrate an understanding of machine control systems, logic, and devices.

CTE-TECED.912.8600520.8.1
Create detailed flow charts utilizing a computer software application.

CTE-TECED.912.8600520.8.2
Create control system operating programs utilizing computer software.

CTE-TECED.912.8600520.8.3
Create system control programs that utilize flowchart logic.

CTE-TECED.912.8600520.8.4
Choose appropriate inputs and outputs devises based on the need of a technological system.

CTE-TECED.912.8600520.8.5
Differentiate between the characteristics of digital and analog devices.

CTE-TECED.912.8600520.8.6
Judge between open and closed loop systems in order to choose the most appropriate system for a given technological problem.

CTE-TECED.912.8600520.8.7
Design and create a control system based on given needs and constraints.

CTE-TECED.912.8600520.9 - Demonstrate an understanding of the characteristics, devices, components, limitations, and associated mathematics of hydraulic and pneumatic systems.

Demonstrate an understanding of the characteristics, devices, components, limitations, and associated mathematics of hydraulic and pneumatic systems.

CTE-TECED.912.8600520.9.1

Identify devices that utilize fluid power.

CTE-TECED.912.8600520.9.2

Identify devices that utilize fluid power.

CTE-TECED.912.8600520.9.3

Differentiate between the characteristics of pneumatic and hydraulic systems.

CTE-TECED.912.8600520.9.4

Distinguish between hydrodynamic and hydrostatic systems.

CTE-TECED.912.8600520.9.5

Design, create, and test a hydraulic device.

CTE-TECED.912.8600520.9.6

Design, create, and test a pneumatic device.

CTE-TECED.912.8600520.9.7

Calculate values in a fluid power system utilizing Pascal's Law.

CTE-TECED.912.8600520.9.8

Distinguish between pressure and absolute pressure.

CTE-TECED.912.8600520.9.9

Distinguish between temperature and absolute temperature.

CTE-TECED.912.8600520.9.10

Calculate values in a pneumatic system utilizing the perfect gas laws.

CTE-TECED.912.8600520.9.11

Calculate flow rate, flow velocity, and mechanical advantage in a hydraulic system.

CTE-TECED.912.8600520.10 - Demonstrate an understanding of the analysis of loads on physical systems in static equilibrium (statics).

Demonstrate an understanding of the analysis of loads on physical systems in static equilibrium (statics).

CTE-TECED.912.8600520.10.1

Create free body diagrams of objects, identifying all forces acting on the object.

CTE-TECED.912.8600520.10.2
Define centroid.

CTE-TECED.912.8600520.10.3
Mathematically locate the centroid of structural members.

CTE-TECED.912.8600520.10.4
Define moment of inertia.

CTE-TECED.912.8600520.10.5
Calculate moment of inertia of structural members.

CTE-TECED.912.8600520.10.6
Differentiate between scalar and vector quantities.

CTE-TECED.912.8600520.10.7
Identify magnitude, direction, and sense of a vector.

CTE-TECED.912.8600520.10.8
Calculate the X and Y components given a vector.

CTE-TECED.912.8600520.10.9
Calculate moment forces given a specified axis.

CTE-TECED.912.8600520.10.10
Use equations of equilibrium to calculate unknown forces.

CTE-TECED.912.8600520.10.11
Use the method of joints strategy to determine forces in the members of a statically determinate truss.

CTE-TECED.912.8600520.11 - Demonstrate an understanding of analyzing the material properties of products.
Demonstrate an understanding of analyzing the material properties of products.

CTE-TECED.912.8600520.11.1
Investigate specific material properties related to a common household product.

CTE-TECED.912.8600520.11.2
Conduct investigative non-destructive material property tests on selected common household products. Property testing conducted to identify continuity, ferrous metal, hardness, and flexure.

CTE-TECED.912.8600520.11.3
Calculate weight, volume, mass, density, and surface area of selected common household product.

CTE-TECED.912.8600520.11.4

Identify the manufacturing processes used to create the selected common household product.

CTE-TECED.912.8600520.11.5

Identify the recycling codes.

CTE-TECED.912.8600520.12 - Perform tensile and stress tests on sample material.

Perform tensile and stress tests on sample material.

CTE-TECED.912.8600520.12.1

Obtain measurements of material samples.

CTE-TECED.912.8600520.12.2

Tensile test a material test sample.

CTE-TECED.912.8600520.12.3

Identify and calculate test sample material properties using a stress strain curve.

CTE-TECED.912.8600520.13 - Analyze problem related to materials and structures, and design a solution to the problem.

Analyze problem related to materials and structures, and design a solution to the problem.

CTE-TECED.912.8600520.13.1

Brainstorm and sketch possible solutions to the design problem.

CTE-TECED.912.8600520.13.2

Create a decision making matrix for the design problem.

CTE-TECED.912.8600520.13.3

Select an approach that meets or satisfies the constraints given in the design brief.

CTE-TECED.912.8600520.13.4

Create a simulation, detailed pictorial sketch, or use 3D modeling software to document the best choice, based upon your team's decision matrix.

CTE-TECED.912.8600520.13.5

Present a workable design solution.

CTE-TECED.912.8600520.14 - Design and create a control system based on given needs and constraints.

Design and create a control system based on given needs and constraints.

CTE-TECED.912.8600520.14.1
Create detailed flow charts utilizing a computer software application.

CTE-TECED.912.8600520.14.2
Create control system operating programs utilizing computer software.

CTE-TECED.912.8600520.14.3
Create system control programs that utilize flowchart logic.

CTE-TECED.912.8600520.14.4
Choose appropriate inputs and output devices based on the need of a technological system.

CTE-TECED.912.8600520.14.5
Differentiate between the characteristics of digital and analog devices.

CTE-TECED.912.8600520.14.6
Judge between open and closed loop systems in order to choose the most appropriate system for a given technological problem.

CTE-TECED.912.8600520.15 - Design, create, test, and present a workable solution to a design problem involving hydraulic and/or pneumatic technology.

Design, create, test, and present a workable solution to a design problem involving hydraulic and/or pneumatic technology.

CTE-TECED.912.8600520.15.1
Brainstorm and sketch possible solutions to the design problem.

CTE-TECED.912.8600520.15.2
Create a decision-making matrix for the design problem.

CTE-TECED.912.8600520.15.3
Select an approach to satisfy the constraints provided in the design brief.

CTE-TECED.912.8600520.15.4
Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the team's decision matrix.

CTE-TECED.912.8600520.15.5
Present a workable solution to the design problem.

CTE-TECED.912.8600520.16 - Apply principles of statistics to calculate the theoretical probability that an event will occur.

Apply principles of statistics to calculate the theoretical probability that an event will occur.

CTE-TECED.912.8600520.16.1
Calculate the experimental frequency distribution of an event occurring.

CTE-TECED.912.8600520.16.2
Apply the Bernoulli process to events that only have two distinct possible outcomes.

CTE-TECED.912.8600520.16.3
Apply AND, OR, and NOT logic to probability.

CTE-TECED.912.8600520.16.4
Apply Bayes' theorem to calculate the probability of multiple events occurring.

CTE-TECED.912.8600520.16.5
Create a histogram to illustrate frequency distribution.

CTE-TECED.912.8600520.16.6
Calculate the central tendency of a data array, including mean, median, and mode.

CTE-TECED.912.8600520.16.7
Calculate data variation, including range, standard deviation, and variance.

CTE-TECED.912.8600520.17 - Apply principles of kinematics and statistics to design and present a workable solution to a design problem associated with bodies in motion.
Apply principles of kinematics and statistics to design and present a workable solution to a design problem associated with bodies in motion.

CTE-TECED.912.8600520.17.1
Calculate distance, displacement, speed, velocity, and acceleration from data.

CTE-TECED.912.8600520.17.2
Design, build, and test a vehicle that stores and releases potential energy for propulsion.

CTE-TECED.912.8600520.17.3
Calculate acceleration due to gravity given data from a free fall device.

CTE-TECED.912.8600520.17.4
Calculate the X and Y components of a projectile motion.

CTE-TECED.912.8600520.17.5
Determine the needed angle to launch a projectile a specific range given the projectile's initial velocity.

CTE-TECED.912.8600520.17.6
Brainstorm and sketch possible solutions to an existing design problem.

CTE-TECED.912.8600520.17.7
Create a decision-making matrix for their design problem.

Select an approach that meets or satisfies the constraints provided in a design brief.

Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team's decision matrix.

Related CTE Program

0821010102:   Engineering Pathways

This course helps students understand the field of engineering/engineering technology and prepares them for postsecondary engineering programs by developing a more in-depth mastery of the required knowledge and skills in mathematics, science, and technology. Through problem-based learning strategies, students study key engineering topics, including mechanisms, energy sources, energy applications, machine control, fluid power, statics, material properties, material testing, statistics, and kinematics. Exploring various technology systems and manufacturing processes help students learn how engineers and technicians use math, science and technology in an engineering problem solving process to benefit people. The course also includes concerns about social and political consequences of technological change.

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State Adopted Instructional Materials

[Author(s)], ([Copyright]), [Title] ([Edition] ed.), [Publisher].

CPALMS Educational Resources

Click HERE to access more than [XXXX] CPALMS-approved educational resources aligned to the standards and benchmarks in this CTE program.

(9410120) Robotic Design Essentials

Version: 2024

Course Attributes

- **Course Number:**
- **Grade Level:**
- **Course Length:**

9410120

3

1 Hours

Course Structure

Robotic Design Essentials

The outline below shows the structure of this Course, including all its requirements and optional components.

Parent
9410120 Robotic Design Essentials
0 Child Components - 0 Required

Standards and Benchmarks

National Standards:

9410120 Robotic Design Essentials

This course provides students with content and skills essential to the design and operation of robotics, including artificial intelligence, sensors, electronic devices, engineering technologies, motion physics, electrical motors, programming, simulation and modeling, and critical thinking skills.

CTE-TECED.912.9410120.1 - Correlate elements of artificial intelligence to their functions in robotics.
Correlate elements of artificial intelligence to their functions in robotics.

CTE-TECED.912.9410120.1.1
Describe the types of sensor output required for various algorithms used in robotics.

CTE-TECED.912.9410120.1.2
Formulate a schema (e.g. logic flow diagram.) for robotic control based on sensor data interpretation.

CTE-TECED.912.9410120.1.3
Explain how artificial intelligence and motion sequences are impacted by controlling sensor data and interpretation.

CTE-TECED.912.9410120.1.4
Describe the design implications and options for sensor data and interpretation algorithms employed for autonomous robotic applications.

CTE-TECED.912.9410120.2 - Describe the various classification schemes of sensors applicable to robotics.
Describe the various classification schemes of sensors applicable to robotics.

CTE-TECED.912.9410120.2.1
Compare and contrast the characteristics, benefits, constraints, and cost implications of analog and digital sensors.

CTE-TECED.912.9410120.2.2
Differentiate between passive and active sensors relative to their applicability and suitability for various robotic applications.

CTE-TECED.912.9410120.2.3
Compare and contrast open and closed loop feedback/control systems.

CTE-TECED.912.9410120.3 - Explain how electronic devices are used in the operation of a robotic assembly.
Explain how electronic devices are used in the operation of a robotic assembly.

CTE-TECED.912.9410120.3.1
Design and build breadboard or printed circuit boards for a robotic assembly.

CTE-TECED.912.9410120.3.2
Describe the advantages, limitations, and operation of electronic control and feedback systems.

CTE-TECED.912.9410120.3.3
Describe the operation and design considerations of electronic devices used to control robotic assemblies.

CTE-TECED.912.9410120.3.4
Describe the kinds of electronic devices used as input/output devices in a robotic assembly and explain the rationale for their use.

CTE-TECED.912.9410120.4 - Demonstrate an understanding of various technologies used in the design of robotic assemblies.
Demonstrate an understanding of various technologies used in the design of robotic assemblies.

CTE-TECED.912.9410120.4.1
Describe the underlying principles associated with pneumatic and hydraulic devices used in the design of a robotic assembly.

CTE-TECED.912.9410120.4.2
Describe the underlying principles of electricity and electrical components, to include power sources, consumption, and heat

issues.

CTE-TECED.912.9410120.4.3

Interpret manufacturer's specification documentation for selected components.

CTE-TECED.912.9410120.4.4

Compare and contrast the operation, advantages, and constraints of wired and wireless strategies for communicating with robotic assemblies.

CTE-TECED.912.9410120.4.5

Identify the design considerations associated with materials used in robotic assemblies and describe how the intended operational environment plays a role in the design.

CTE-TECED.912.9410120.4.6

Discuss the methodologies and tools used in resolving systems integration challenges in robotic systems.

CTE-TECED.912.9410120.5 - Demonstrate an understanding of advanced mathematics and physics associated with the design of a robotic assembly.

Demonstrate an understanding of advanced mathematics and physics associated with the design of a robotic assembly.

CTE-TECED.912.9410120.5.1

Employ the concepts of acceleration and velocity as they relate to the kinematic design of robotic assemblies.

CTE-TECED.912.9410120.5.2

Describe the term "degrees of freedom" and relate it to the design of joints used in robotic assemblies.

CTE-TECED.912.9410120.5.3

Describe angular velocity/momentum and its role in the design of robotic joint motion, balance, and mobility.

CTE-TECED.912.9410120.5.4

Explain impulse-momentum theory and illustrate its applicability to the design of robotic assemblies.

CTE-TECED.912.9410120.5.5

Explain translational, rotational, and oscillatory motion in terms of their applicability to the design of robotic assemblies.

CTE-TECED.912.9410120.6 - Create a program to control a robotic mechanism.

Create a program to control a robotic mechanism.

CTE-TECED.912.9410120.6.1

Demonstrate an understanding of coding semantics, syntax, and implementation.

CTE-TECED.912.9410120.6.2

Apply programming best practices for commenting and documentation.

CTE-TECED.912.9410120.6.3

Describe how logic structures (conditional execution, loops, etc.) control the flow of a program.

CTE-TECED.912.9410120.6.4

Write pseudocode using logic structures to solve a problem.

CTE-TECED.912.9410120.6.5

Write code for evaluating a condition and performing an appropriate action using If/then statements.

CTE-TECED.912.9410120.6.6

Write code for performing actions within a code segment (using do/while statements) for as long as a given condition exists.

CTE-TECED.912.9410120.6.7

Write code that loops through a series of actions for a specified increment.

CTE-TECED.912.9410120.6.8

Write code that evaluates sensor data to provide feedback control.

CTE-TECED.912.9410120.7 - Describe the operation and use of various forms of electrical motors in robotic assemblies.

Describe the operation and use of various forms of electrical motors in robotic assemblies.

CTE-TECED.912.9410120.7.1

Explain the operation and use of stepper motors to control or limit movement of a robotic assembly.

CTE-TECED.912.9410120.7.2

Explain the operation and primary use of AC and DC motors in robotic assemblies.

CTE-TECED.912.9410120.7.3

Explain the operation, use, and advantages of brushless motors used in robotics.

CTE-TECED.912.9410120.7.4

Explain the types, use, and advantages of linear actuators used in robotics.

CTE-TECED.912.9410120.8 - Solve problems using critical thinking skills, creativity and innovation.

Solve problems using critical thinking skills, creativity and innovation.

CTE-TECED.912.9410120.8.1

Employ critical thinking skills independently and in teams to solve problems and make decisions.

CTE-TECED.912.9410120.8.2

Employ critical thinking and interpersonal skills to resolve conflicts.

CTE-TECED.912.9410120.8.3

Identify and document workplace performance goals and monitor progress toward those goals.

CTE-TECED.912.9410120.8.4

Conduct technical research to gather information necessary for decision-making.

CTE-TECED.912.9410120.9 - Demonstrate an understanding of basic 3D modeling concepts.
Demonstrate an understanding of basic 3D modeling concepts.

CTE-TECED.912.9410120.9.1

Compare and contrast 3D modeling software applications that offer a perspective view, an orthographic view, additive manufacturing, or a combination.

CTE-TECED.912.9410120.9.2

Explain how Cartesian coordinate systems are used to locate objects in three dimensional space.

CTE-TECED.912.9410120.9.3

Describe basic geometric shapes available in 3D modeling software (sphere, cube, cylinder, torus, cone, plane, axis point).

CTE-TECED.912.9410120.9.4

Describe basic shapes available in 2D modeling software (arcs, ellipses, circles, curve, freehand curves, polygons, splines).

CTE-TECED.912.9410120.9.5

Define the parameters used for determining the size, placement, and orientation of a modeling object.

CTE-TECED.912.9410120.9.6

Describe the Boolean modeling operations of union, subtraction, and intersection.

CTE-TECED.912.9410120.9.7

Describe how extrusion or sweeping techniques transform 2D objects into 3D objects.

CTE-TECED.912.9410120.9.8

Describe the lofting technique for creating 3D objects.

CTE-TECED.912.9410120.9.9

Describe the revolve or lathe techniques for animating a 2D object and give examples of their application.

CTE-TECED.912.9410120.9.10

Describe the scale, rotate, and move actions that comprise the transformation technique for animating a 3D object.

CTE-TECED.912.9410120.9.11

Describe the object parameters modified using the deformation technique and provide examples of its use.

CTE-TECED.912.9410120.9.12

Describe the copy or clone technique.

CTE-TECED.912.9410120.9.13

Describe the mirror technique.

CTE-TECED.912.9410120.9.14

Compare and contrast the wire frame and solid viewing tools.

CTE-TECED.912.9410120.9.15

Describe basic viewing navigation tools such as zoom, rotate, and panning.

CTE-TECED.912.9410120.9.16

Define plug-in and describe how it extends the capability of the modeling program.

CTE-TECED.912.9410120.9.17

Describe the export function and its value when producing visualizations.

CTE-TECED.912.9410120.10 - Build, program, and configure a robot to perform predefined tasks.

Build, program, and configure a robot to perform predefined tasks.

CTE-TECED.912.9410120.10.1

Design a robot.

CTE-TECED.912.9410120.10.2

Create programs as required using robotic software that will allow the robot to perform a set of tasks.

CTE-TECED.912.9410120.10.3

Configure subsystems to operate the robot.

CTE-TECED.912.9410120.10.4

Create and present a proposal, including drawings, flow charts, and specifications, describing the robot, the tasks and rationale, and the results.

Related CTE Program

0615030330:   Applied Robotics

This course provides students with content and skills essential to the design and operation of robotics, including artificial intelligence, sensors, electronic devices, engineering technologies, motion physics, electrical motors, programming, simulation and modeling, and critical thinking skills.

State Adopted Instructional Materials

[Author(s)], ([Copyright]), [Title] ([Edition] ed.), [Publisher].

CPALMS Educational Resources

Click HERE to access more than [XXXX] CPALMS-approved educational resources aligned to the standards and benchmarks in this CTE program.