MET-2450: ROBOTICS AND AUTOMATION IN SMART MANUFACTURING

Cuyahoga Community College

Viewing: MET-2450 : Robotics and Automation in Smart Manufacturing

Board of Trustees:
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Academic Term:
Fall 2021

Subject Code
MET - Mech Eng/Manuf Ind Eng Tech

Course Number:
2450

Title:
Robotics and Automation in Smart Manufacturing

Catalog Description:
Introduces the students to the foundations of Smart Manufacturing and Industry 4.0. The practical application includes automation, process control, quality principles, and big manufacturing/service data analytic. The CSM line is an intelligent manufacturing system using the latest industry 4.0 connected advanced manufacturing equipment and training problem-solving and integration skills.

Credit Hour(s):
4

Lecture Hour(s):
2

Lab Hour(s):
6

Requisites

Prerequisite and Corequisite
MET-1120 Computer Applications and Programming.

Outcomes

Course Outcome(s):
Demonstrate competency and skill set required for Smart Manufacturing/industry 4.0.

Objective(s):

a. Explain how Industry 4.0 technology enables intelligent manufacturing systems.
b. Describe and identify automation components, such as PLC, robot, vision, safety, IIoT, pneumatics, vacuum, motors, VFD, laser, machining, CNC programming, process engineering, manufacturing.
c. Apply Industry 4.0 automation components to automate advanced manufacturing equipment and troubleshoot the production line.
d. Demonstrate the skills in modern manufacturing automation.

Course Outcome(s):
Examine the role of each part and IIOT in an integrated manufacturing system by exploring each of the system's components to discover how they interrelate.

Objective(s):

a. Analyze the role of PLCs, robot, vision, safety, IIoT, pneumatics, vacuum, motors, VFD, laser, machining, CNC programming, process engineering, manufacturing in a integrated manufacturing system.

b. Troubleshoot advanced manufacturing equipment and the production line.
c. Explain level I, II, III of mechatronics
d. Explain the integration of a line and skills for modern manufacturing.
e. Program FANUC LR Mate 200iD/7L robotic machine tender to load and unload the CNC vertical machining center.
f. Select automated manufacturing work holder for CNC machining center.
g. Explain vision inspection of machining operation.
h. Describe the operation of Laser etching of machined parts.
i. Explain vision inspection of etching.
j. Explain vision guided picking and sorting at assembly and packaging.
k. Explain packaging of complete kit in logo printed box with a choice of colors.
l. Explain advanced PLC to robot control.
m. Demonstrate the programming of Rockwell Logix 5000 series PLC's.
n. Demonstrate the programming of Rockwell HMI panel view interface touch screens.
o. Recognize fenceless robot cells with safety area scan.
p. Identify smart sensor technology over Balluff I/O Link with diagnostics.
q. Explain project-based mechatronics at each operation.
r. Identify dual-purpose end of arm tooling (EOAT) on robots with vacuum and mechanical gripping.
s. Program and operate conveyors with variable speed drives (VFD).
t. Explain the application of RFID manufacturing process tracking.
u. Describe the modular robot work cells and its applications.
v. Describe functions of mechatronics subsystems in a complex system.
w. Explain how subsystems work together.
x. Troubleshoot localized malfunctions, identify their causes/sources, correct them by repairing/replacing defective components, or document them for resolution by appropriate experts.
y. Perform routine preventive maintenance.
z. Implement safety regulations required for system operation.

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Course Outcome(s):

Demonstrate the functions of different components of Smart Manufacturing/ Industry 4.0.

Objective(s):

a. Identify and describe components Smart Manufacturing/Industry 4.0.
b. Control process through machine tending by robots.
c. Operate integrated manufacturing line.

Course Outcome(s):

Apply the concept of data-driven troubleshooting and analytics to optimize the production line.

Objective(s):

a. Apply the concept of data-driven decision making in planning and implementing Industry 4.0.
b. Analyze operational data to identify problems and proffer solutions.

Methods of Evaluation:

a. Quizzes
b. Text assignments
c. Tests
d. Laboratory assignments
e. Participation
f. Instructor observation/evaluation of student lab exercise performance

Course Content Outline:

a. Pre-Test
b. Robot system
    i. Components
    ii. Major and minor axes
    iii. Joints
    iv. Links
    v. Servo motors
    vi. Serial pulse coders
    vii. Software and operating system
    viii. Controller types
    ix. Deadman switch positions
c. Teach pendant
    i. Functions
    ii. Standard teach pendant vs. ipendant
    iii. Quick menu
    iv. Full menu
    v. Function menu
    vi. Status indicators
    vii. Deadman switch positions
d. Power up, jogging and initial setup
    i. Powering up robot
    ii. Jogging the robot in joint and world
    iii. Viewing positional data
    iv. Robot axes limits
    v. Robot mastering
e. Robot to computer communication
f. Components
g. Robot and computer parameters for communication
h. How to test communication
i. How to access the robot web page to set up the vision
    i. Access vision set up screen
    ii. Perform setup of vision
    iii. How to check and/or change the robot IP address
    iv. How to check and/or change the computer IP address
    v. How to ping devices to ensure good communication
    vi. How to access the robot web page
    vii. Use the robot web page to access the vision setup screen
j. Perform error recovery
    i. How to check for impediments to servo power-up
    ii. How to remove impediments to servo power-up
k. Tool frames
    i. Tool frame overview
    ii. Tool frames for vision
    iii. Tool frame for robot applicator
    iv. User frames necessary for use with the vision system
    v. Use a tool frame
    vi. Offset user frame
    vii. Teaching the calibration grid frame
        1. Using the four-point method
        2. Using the five-point method
l. Fenceless robot cells with safety area scan
m. Setup an Inspection process
    i. The single view inspection process
    ii. 2-D multi-view vision process
    iii. 3-D inspection process
    iv. Setup the camera

1. Lens
2. Camera cable
3. Multiplexor
4. Communication cable
5. Calibration grid
6. Laser vision sensor
7. 3D multiplexer

n. Train the vision system to recognize the part
o. Program the robot for vision interface and part handling
p. Camera properties
   i. Focal length
   ii. CCD (Charge-coupled device) width
   iii. Standoff
   iv. Field of view
q. Setup 2D or 3DL single view process
   i. Calibration screens for 2D vision
   ii. Calibration procedure for 2D vision
   iii. Height variations
   iv. Perspective calibration
   v. Orthogonal calibration
   vi. Process screens for 2D vision
r. Digital fundamentals and PLCs factory of the future
   i. PLC hardware
   ii. Basic internal operation (flow of information) of a PLC
      1. I/O data tables
      2. Scan
      3. Memory calculations (bytes and bits)
s. Basic ladder logic programming
   i. Branches, rungs, I/O
   ii. XIO
   iii. XIC
   iv. Seal-in
t. Advanced PLC to robot control
   i. Program PLC
   ii. Program robot
   iii. Interface robot to automate manufacturing process
u. Rockwell Logix 5000 series PLC programming
   i. Program Rockwell Logix PLC
   ii. Use of PLC to integrate robot to manufacturing system
   iii. Troubleshooting techniques for PLC programs
v. Rockwell HMI panelview interface touch screens
   i. Identification of panel components
   ii. Operation of PLC panel
w. Smart sensor technology over Balluff I/O Link with diagnostics
   i. Identification of different sensors
   ii. Wire sensors for automation
   iii. Troubleshooting of sensors
   iv. Differentiation between normally closed and normally open sensors
   v. Differentiation between analog and digital sensors and their applications
x. CNC Fanuc control programming and operation
   i. Identification components of Fanuc controller panel
   ii. Write CNC code for Fanuc controller
   iii. Troubleshoot CNC code for Fanuc controller
   iv. Set up CNC for operations including tooling
   v. Perform test run of CNC code

Resources

Rick Calverley. *CNC Manufacturing Technology*. G-W, 2020.

Max Rabiee. *Programmable Logic Controllers: Hardware and Programming*. 4th. G-W, 2018.

Fanuc Robotics System. *Fanuc Robotics System R-330iB controller iRvision 2D MATVIR2DB0317CE*. Rev. B.

Fanuc Robotics. *Fanuc Robotics Handling Tool Operations and Programing MATAGHAND0318CE* . Rev. E. 2018.

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