MET-3100: APPLIED SMART MANUFACTURING PROCESSES

Cuyahoga Community College

Viewing: MET-3100 : Applied Smart Manufacturing Processes

Board of Trustees:
January 2024

Academic Term:
Fall 2024

Subject Code
MET - Mech Eng/Manuf Ind Eng Tech

Course Number:
3100

Title:
Applied Smart Manufacturing Processes

Catalog Description:
Explore smart manufacturing systems and the implementation of their enabling technologies in fundamental manufacturing processes. Covers smart technology implementations in various areas, including industrial combustion control, forging operations, industrial vacuum systems, and surface finishing operations. Field Trips to relevant manufacturing enterprises are required.

Credit Hour(s):
3

Lecture Hour(s):
2

Lab Hour(s):
3

Requisites

Prerequisite and Corequisite
MET-2450 Robotics and Automation in Smart Manufacturing.

Outcomes

Course Outcome(s):
Discuss smart manufacturing systems and encompassing technologies.

Objective(s):

1. Explain smart manufacturing enabling technologies
2. Explain how data is acquired, exchanged, managed, and leveraged to aid in smart manufacturing.
3. Explain the role of digital networks in smart manufacturing systems.
4. Analyze the topography of network Integration.
5. Explain the data analytics and intelligence process.
6. Discuss smart manufacturing human-machine interaction.
7. Explain the role of advanced engineering in smart manufacturing processes.

Course Outcome(s):
Explain the vacuum systems application in manufacturing processes.

Objective(s):

1. Explain the fundamental concepts of vacuum technology.
2. Identify common vacuum system hardware and instrumentation.
3. Evaluate the applications and processes of vacuum systems and technology.

Course Outcome(s):

Distinguish between industrial combustion systems and their applications.

Objective(s):

1. Compare the applications and technologies of industrial combustion.
2. Explain industrial combustion processes and their complexities.
3. Identify the industrial process heating systems.
4. Explain the boiling systems.
5. Explain the role of burners.

Course Outcome(s):

Explain surface finishing operations and their role in producing engineering parts.

Objective(s):

1. Discuss the surface finishing process.
2. Explain the importance of surface finish.
3. Explain the units of surface finish.
4. Explain how the surface roughness is measured.
5. Compare types of surface finish operations.

Course Outcome(s):

Describe the forging operation and its role in mechanical production.

Objective(s):

1. Determine appropriate forging operations to accomplish production tasks.
2. Explain the process of die development.
3. Explain systems for cold forging.
4. Explain systems of warm forging
5. Explain systems of hot forging.

Methods of Evaluation:

1. Projects
2. Quizzes
3. Exams
4. Reports

Course Content Outline:

1. Smart manufacturing sensors for data collection and process controls:
    a. Motion sensors
        i. Resistive strain gauge
        ii. LVDT(Linear Variable Differential Transformer)
        iii. RVDT(Rotary Variable Differential Transformer)
        iv. capacitive
        v. piezo
        vi. seismic

vii. pick-ups
viii. vibrometers and accelerometers

b. Optical sensors:
i. Lasers
ii. photodetectors
iii. optical fiber as sensors

c. Sensors in Robotics:
i. Classification and characteristics
ii. Internal Sensors – position, velocity, acceleration sensors, Force sensors
iii. External sensors – proximity, touch-slip sensors. robotic vision, process of imaging, architecture of robotics, image acquisition, components of vision system, image representation, and image processing.

d. Advanced sensors
i. Semiconductor sensors
ii. Hall elements
iii. Silicon sensors for sensing radiation
iv. mechanical, magnetic
v. chemical and other signals
vi. Catalytic devices
vii. gas sensors
viii. acoustic sensors

e. Sensor-based controls
i. Controllers
ii. electrical
iii. pneumatic and hydraulic prime movers
iv. associated control hardware.
v. closed-loop control of microcomputer-based drives.
vi. Relay control systems and PLC systems and programming
vii. control, including sequence control.
viii. Sensor-based control of various actuators, mechatronic devices, and autonomous mobile robots.

2. Artificial Intelligence (AI)/Machine Learning
3. Drones and Driverless Vehicles for materials handling
4. Blockchain
5. Edge Computing
6. Predictive analytics
7. Digital twins
8. Forging Processes
   a. Reduction
   b. Extrusion
   c. Ironing
   d. Closed Die forging
   e. Upsetting/Open die forging
   f. Piercing/Trimming
9. Basic Industrial Vacuum Systems
   a. Vacuum Applications and Fundamentals
   b. Working with numbers and temperature scales
   c. Understanding matter, pressure, gas properties
   d. Vapor pressure and outgassing
   e. Gas flow and conductance
   f. Pumping speed and throughput
   g. Vacuum pumping methods
   h. Rough Vacuum Systems – Gauges – Wet and dry mechanical pumps – Traps and filters – Sorption (entrapment) pump – Pump comparison – Demo Lab: Rough vacuum system operation
   i. High & Ultra High Vacuum Systems
   j. High Vacuum – Gauges – Turbo pumps/controllers and diffusion pumps – Baffles and traps – Cryopumps – Pump comparison – System configurations and operation – Demo Lab: High vacuum system assembly and operation
   k. Ultra-High Vacuum – Outgassing issues – Gauges – Ion pumps – non-evaporative getter pumps – Titanium sublimation pumps – System configurations and operation
   l. Vacuum Materials and Hardware

m. Material selections
n. Joining techniques
o. Fittings, feed-throughs valves
p. Vacuum system performance and troubleshooting
q. Characterizing the system
r. Problems and sources
s. Methods, techniques, and tools
t. Helium Leak Detector – Principles of operation – Tuning and calibration procedures – Vacuum system leak-checking techniques

10. Surface Finishing Operations
    a. Industrial Cleaning Processes
    b. Diffusion and Ion Implantation
    c. Plating and Related Processes
    d. Conversion Coating
    e. Vapor Deposition Processes
    f. Organic Coatings
    g. Porcelain Enameling and Other Ceramic Coatings
    h. Thermal and Mechanical Coating Processes

Resources

Kandasamy, J., Kamalakanta Muduli, Kommula, V. P., & Meena, P. L. . (2022) *Smart Manufacturing Technologies for Industry 4.0*, CRC Press.

StackPath. (2023) *Vacuum Systems for the Intelligent Factory*, www.powermotiontech.com

Soroush, M., Baldea, M., & Edgar, T. F. . (2020) *Smart Manufacturing: Concepts and Methods*,

Ross, L. T., Fardo, S. W., & Walach, M. F. . (2018) *Industrial Robotics Fundamentals.*,

Serope Kalpakjian, Schmid, S. R., & K S Vijay Sekar. (2018) *Manufacturing engineering and technology*, Pearson India Education Services.

Naik, P. K. . (2018) *Vacuum*, CRC Press.

Richard James Reed. (2001) *North American Combustion Handbook: A Basic Reference on the Air and Science of Industrial Process Heating with Gaseous and Liquid Fuels*, North American Mfg.

Resources Other

1. Combustion Systems Manual
2. Smart Manufacturing Equipment Manual (CNC, Robotics)
3. Sundry Instructional Equipment Manuals

Top of page
Key: 5127