Course Outline – Introduction to Robotics Technology

Course Topic: Introduction to Robotics Technology
Contact Hours: 75 hrs.

Course Description:

This course is an overview of robotic and automated systems technology. The student will be introduced to basic manufacturing techniques, robot terminology, different types of automation, safety, basic robotic programming, interfacing robotic communications, automated work cells, and robotic applications. Robot operations and programming fundamentals will be applied by the students.

Course Outcomes and Objectives

ROB-1 Summarize the essential characteristics of industrial robotics

1. Define the types of manufacturing systems and their relationship to Robotics and Automated Manufacturing
2. Explain the major components of robotic systems
   - Define the function of the robot arm, controller, and power source.
   - Define end of arm tooling
   - Define teaching/programming devices and data storage
3. Explain the definition of the characteristics term of robotic systems
   - Define Degree of Freedom, Position Axes, Orientation Axes.
   - Define Work Envelope
   - Define Tool Center Point
4. Explain the critical specifications of payload, degrees of freedom, repeatability, accuracy, work envelope dimensions, speed, programming support, and environmental requirements
5. Locate & identify all components of the robotic cell including all equipment, operator interfaces, tooling, perimeter guarding, safety devices, etc. (Walk through with the Instructor-- AMTEC Trainer)(Could be written with Pictures)
6. Identify & practice all safety considerations related to operating the robotic cell. (Instructor demonstration with Student's full participation – AMTEC trainer)

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ROB-2 Classify the devices and role for robotics safety

1. List the types of guarding methods and control devices
2. Identify safety considerations during installation, maintenance, programming, automatic operations
3. Explain the role of training in robotics safety
4. Locate & identify the main components of the robot including the controller, manipulator arm, teach pendant, standard operator panel, dress-out, cables, connections, and end-of-arm-tooling or vacuum components. (Walk through with the Instructor—Amtec trainer) (could be written with Pictures)
5. Locate & identify the main components of the robot including the controller, manipulator arm, teach pendant, standard operator panel, dress-out, cables, connections, and end-of-arm-tooling or vacuum components. (Walk through with the Instructor—Amtec trainer) (could be written with Pictures)

ROB-3 Explain the classification of robotic systems

1. Define classification by control system, arm geometry, and path control
2. Define the classification by Open-Loop and Closed-Loop control system
3. Identify non-servo type of devices and their advantages and disadvantages
4. Identify theory of a basic servo system
5. Define the closed system for robotics control
6. Define the advantages and disadvantages of a servo system and their applications
7. Identify the proper names for the axis for both Joint and Cartesian coordinate systems as applicable to the robot. (Written)

ROB-4 Explain the classification by arm geometry of robotic systems

1. Define Cartesian (rectangular) arm geometry
2. Define cylindrical arm geometry
3. Define spherical (polar) arm geometry
4. Define articulated arm geometry
5. Demonstrate the proper power-up and shut-down sequence of the robotic cell.
6. Perform the Cold Start procedure and describe the benefit. (Book procedure exercise)
7. Use the teach pendant to identify & clear alarms that would inhibit robotic cell operation. View alarm history. (Book procedure exercise)
8. Reset and clear teach pendant errors. (Book procedure exercise)
9. Match the robot's degrees of freedom. (Walk through with the Instructor)(or written exercise)
10. Match each teach pendant button to their proper name & function. (Hands-on with written exercise and book reference)

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11. Navigate & match teach pendant screens to their proper name & function. (Hands-on with written exercise and book reference)
12. Jog the robot in each coordinate system and document the arm motion. (Hands-on with written exercise and book reference)
13. Adjust the robot jog speed. (Hands-on exercise with book reference)
14. Set-up and test software axis limits. (Hands-on exercise with book reference)
15. Master the robot using zero degree mastering and single axis mastering procedures. (Hands-on exercise with book reference)
16. Set-up & test a specific tool center point (TCP). (Hands-on exercise with book reference)
17. Demonstrate Tool frame set-up procedure. (Hands-on exercise with book reference)
18. Perform the User frame (RTCP) set-up procedure. (Hands-on exercise with book reference)

ROB-5 Explain the classification by arm geometry of robotic systems.

1. Define limited-sequence control
2. Define point-to-point control
3. Define controlled-path control
4. Define continuous-path control

ROB-6 Classify the type of sensors used in robotic applications.

1. Define simple sensors and their interface
2. Describe contact sensors
3. Describe simple non-contact photoelectric and proximity sensors
4. Describe simple process control pressure, level, and flow sensors
5. Define complex process control sensors simple sensors and their interface
6. Describe complex sensors for strain, viscosity, and pressure
7. Describe the use of Vision System for identification, part inspection, and part location/orientation

ROB-7 Outline the types of End-of-Arm Tooling used in robotic applications.

1. Define the General Requirements for End-of-Arm Tooling
2. List the tooling power sources
3. List the type of standard grippers
4. Describe servo and non-servo grippers
5. Describe the operation and list the types of vacuum devices
6. List the types of magnetic devices
7. List the types of pneumatic flexible devices.
8. List the types of special-purpose application tooling
9. List the types of devices for protecting End-of-Arm Tooling
10. Define passive and active compliance systems

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ROB-8 Summarize the methods for programming robotic systems.

1. Define the role of Work-Cell programming.
2. Describe the controller functions in a robotic system.
3. Describe the use and differences of On-Line and Off-Line Programming.
4. Contrast the purpose of programmed points and program logic statements
5. Describe the use of a PLC to control a simple robot

ROB-9 Illustrate the use of numbering systems for robotic applications.

1. Describe the use of numbering systems for error codes in robot programming and maintenance.
2. Convert numbers from Decimal to Binary and Binary to Decimal.
3. Convert numbers from Hexadecimal to Binary

ROB-10 Demonstrate the Power ON procedures for robots.

1. Procedures for placing the robot into teach mode
2. Procedures to select a program on the robot
3. Procedures for placing the robot into auto mode and execute a program
4. Procedures to hold and abort a program
5. Procedures for restart of a held program

ROB-11 Demonstrate the Coordinate Systems and Jogging of a robot.

1. Jog the robot in Joint mode
2. Define the “Right Hand Rule” for Cartesian coordinates
3. Jog the robot in World mode

ROB-12 Demonstrate the use of teach pendent to creating, edit, and select programs on Teach Pendant.

1. Create a simple program on the teach pendant
2. Demonstrate the changing of number values in program instructions
3. Demonstrate inserting and deleting lines in a program
4. Demonstrate adding and changing program instructions

ROB-13 Demonstrate the use of teach pendent to display screens for robot operations and maintenance.

1. Access the screen for Tool Center Point and use Direct Entry of TCP
2. Access the screen to monitor and change data register values
3. Access Digital and Robot Input/Output type and identify the status

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4. Access the Alarm screen for active and alarm history
5. Access the Position Register screen and demonstrate recording and move to functions
6. Access and perform file backup
7. Access and perform robot mastering

ROB-14 Demonstrate the creating programs with offline software teach and execute programs on the robot.

1. Demonstrate the opening of offline software to create a program in the text editor
2. Demonstrate the compiling of a text format program file for robot execution
3. Demonstrate the exporting of a program to the robot
4. Demonstrate the jogging to and teaching program points
5. Demonstrate the importing of a program from the robot
6. Demonstrate the use of file handing to remotely store and retrieve programs

ROB-15 Demonstrate the proper use of programs structures with offline software.

1. Enter in a program structure Joint and Linear Motions.
2. Enter in a program structure Local and Global Positions
3. Enter in a program structure the Motion Speed
4. Enter in a program structure Fine and Continues termination of motion
5. Enter in a program structure Robot Inputs/Outputs to control End of Arm Tooling
6. Enter in a program structure Digital Inputs/Outputs in Process Sequence
7. Enter in a program structure a count based looping condition
8. Enter in a program structure Conditional Branching for Process Selection
9. Enter in a program structure Digital Inputs with conditional delays
10. Enter in a program structure Program Calls

ROB-16 Demonstrate the use of robot simulation.

1. Demonstrate software start-up explain screen layout areas
2. Demonstrate the use of Views - Zoom, Pan, and Rotate
3. Demonstrate robot Joint Jog in simulation
4. Demonstrate robot Cartesian jog in simulation
5. Create an application path in simulation and edit in logic statements.
6. Demonstrate the testing of an application in simulation
7. Demonstrate the manipulating object locations and generating a motion path
8. Demonstrate the use of animation for part movement in simulation

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Course Outline:

SESSION 1: April 28, Tuesday
LECTURE: Robotic Applications
Lab Orientation
Power On and Jog

READING ASSIGNMENT:
Chapter 1

SESSION 2: April 30, Thursday
LECTURE: Chapter 1
History of Robotics
Definition of a robot
Mass Production
Batch Manufacturing
Flexible Manufacturing Systems
Robotic Safety

READING ASSIGNMENT:
Chapter 2

SESSION 3: May 05, Tuesday
LECTURE: Chapter 2
Robot introduction
Basic components of robot systems
Manipulator geometry
Wrists
End effectors
Classifying robots by drive control systems
Classifying robots by teaching methods
Specifying robot by repeatability, precision, accuracy

READING ASSIGNMENT:
Chapter 3

SESSION 4: May 07, Thursday
LECTURE: Chapter 3

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Robot Classification
Control Systems
Open-loop
Operations
Advantages/Disadvantages
Applications
Closed-loop
Operations
Advantages/Disadvantages
Applications

READING ASSIGNMENT:
Chapter 4

SESSION 5: May 12, Tuesday
LECTURE: Chapter 4
Robot Classification
Rectangular Geometry
Cylindrical Geometry
Spherical Geometry
Jointed-spherical Geometry
Power Sources
Path Control
Continuous-path
Point-to-point
Controlled
Non-controlled

READING ASSIGNMENT:
Chapter 5

SESSION 6: May 14, Thursday
LECTURE: Chapter 5
Sensor Overview
Contact Sensors
Noncontact Sensors
Photoelectric
Proximity

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Simple Process Sensors
Complex Process Sensors
Review for MID-TERM EXAM

- review chapters 1-5
- review lecture material for sessions 1-6
- review operating procedures for robot and TPP programming

READING ASSIGNMENT:
No text reading assignment.

SESSION 7: May 19, Tuesday
MID-TERM EXAM
LECTURE: Lab Assignment

READING ASSIGNMENT:
Chapter 6

SESSION 8: May 21, Thursday
Mid-Term exam results
LECTURE: Chapter 6
End-of-Arm Tooling
Terms
Power Sources
Standard Grippers
Angular
Parallel
Internal-external Gripping
Vacuum
Magnetic
Flexible
Special Purpose

READING ASSIGNMENT:
Chapter 7

SESSION 9: May 26, Tuesday
LECTURE: Chapter 7
Controller Functions

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Elements of a Robot Program
Program Commands
Arm Motion
Task Point Diagram
Online-offline Programming

SESSION 10: May 28, Thursday
LECTURE: Numbering Systems
Binary

SESSION 11: June 02, Tuesday
LECTURE: Numbering Systems
Binary Review
Hexadecimal
Robot Safety
Robots Require Respect = 3Rs
People dealing with robots

SESSION 12: June 04, Thursday
LECTURE: Lab Assignment
Review for FINAL EXAM
Chapters 6 and 7
All labs
All procedures on robots

SESSION 13: June 09, Tuesday
LECTURE: Lab Assignment

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