



ROBOTICS IN MANUFACTURING FUNDAMENTALS (RMF)

BODY OF KNOWLEDGE

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ROBOTICS FUNDAMENTALS

BODY OF KNOWLEDGE 2022

Topics	Competency	Importance	Weightings
1. Manufacturing Foundations/Awareness			5%
1.1 Metric System - Units of Measure	Apply Knowledge & Analyze	High	
1.2 Manufacturing & Production Methods	Apply Knowledge & Analyze	Medium	
1.2.1 Batch Production			
1.2.2 Continuous Production			
1.2.3 Just-in-time Manufacturing/Lean Manufacturing			
1.2.4 Mass Production			
1.3 Fixed Layouts	Remember & Understand	Medium	
1.4 Fixed/Hard Automation	Apply Knowledge & Analyze	Medium	
1.5 Flexible Manufacturing Systems	Apply Knowledge & Analyze	High	
1.6 Assembly Line (Product Layout)	Apply Knowledge & Analyze	Medium	
1.7 Robot Combined Layouts	Apply Knowledge & Analyze	High	
1.8 Process Layout	Apply Knowledge & Analyze	High	
1.9 Introduction to Industry 4.0 & SMART Manufacturing	Remember & Understand	Medium	
1.9.1 AI, Data Analytics, IIOT, Cybersecurity, AR/VR			
2. Robot Applications in Manufacturing			10%
2.1 Welding	Apply Knowledge & Analyze	Medium	
2.2 Assembly	Apply Knowledge & Analyze	High	
2.3 Material Handling	Apply Knowledge & Analyze	High	
2.4 Inspection	Apply Knowledge & Analyze	High	
2.5 Paint/Spray Paint	Remember & Understand	Medium	
2.6 Palletizing	Apply Knowledge & Analyze	Medium	
2.7 Sorting	Apply Knowledge & Analyze	Medium	
2.8 Food Manufacturing	Remember & Understand	Low	
3. Robot Safety			20%
3.1 General OSHA Standards/Regulations	Remember & Understand	Medium	
3.1.1 Hazardous Materials	Remember & Understand	Low	
3.1.2 Bloodborne Pathogens	Remember & Understand	High	

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Topics	Competency	Importance	Weightings
3.1.3 Fire and Safety	Apply Knowledge & Analyze	High	
3.1.4 Personal Protective Equipment (PPE)	Apply Knowledge & Analyze	High	
3.1.5 Lockout/Tagout			
3.2 Types of Safety Devices & Barriers	Apply Knowledge & Analyze	High	
3.2.1 Safety Barriers/Guards			
3.2.2 Interlocked Barrier Guard			
3.2.3 Presence-Sensing Devices			
3.2.4 Sensor Arms			
3.2.5 Pressure Mat			
3.2.6 Alarms			
3.2.7 e-stops			
3.2.8 Light Curtain			
3.3 Ergonomics	Apply Knowledge & Analyze	Medium	
3.4 Pinch Points	Apply Knowledge & Analyze	High	
3.5 Robot Safety Guidelines & Standards Awareness (OSHA, ANSI/RIA, ISO, UL, IEC, NIOSH)	Apply Knowledge & Analyze	High	
3.5.1 Process Safety (Avoidance)	Remember & Understand	Medium	
3.5.2 Types of Accidents Caused by Robots			
3.5.2.1 Impact/Collision			
3.5.2.2 Trapping			
3.5.2.3 Crushing			
3.5.2.4 Equipment			
3.6 Cobot vs. Industrial Robot Safety Considerations	Apply Knowledge & Analyze	High	
3.6.1 Fires and Safety			
3.6.2 Bloodborne Pathogens			

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4. Robot Types			15%
4.1 Collaborative Robots (Cobots)	Apply Knowledge & Analyze	High	
4.2 Mobile/Autonomous Robots (Wheeled, Legged, Drones, etc.)	Remember & Understand	Medium	
4.3 Stationary Robots	Apply Knowledge & Analyze	High	
4.3.1 Selective Compliance Assembly Robot Arm (SCARA)			
4.3.2 Cartesian			
4.3.3 Cylindrical			
4.3.4 Spherical			
4.3.5 6-Axis			
4.3.6 Articulated (or Serial) Robots			
4.3.7 Parallel Robot (Delta Robot)			
4.3.8 Pick & Place Robots			
5. Robot Hardware & Software			20%
5.1 Parts of a Robot	Apply Knowledge & Analyze	High	
5.1.1 Body			
5.1.2 Joints (Prismatic, Revolute)			
5.1.3 Arms			
5.1.4 Encoder			
5.1.5 End Effectors & End of Arm Tooling			
5.2 Motor & Drive Systems/Actuators	Apply Knowledge & Analyze	High	
5.2.1 Hydraulics			
5.2.2 Pneumatics			
5.2.3 Servo Motors	Understand & Apply	High	
5.2.4 Stepper Motors			
5.2.5 Torque, Friction, Force			20%
5.3 Limit Switches	Apply Knowledge & Analyze	Medium	
5.4 Power Supply	Remember & Understand	Medium	
5.5 Registers	Apply Knowledge & Analyze	Medium	

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5.6 Robot Sensors	Apply Knowledge & Analyze	High	
5.6.1 Vision Sensors			
5.6.2 Proximity Sensors			
5.6.3 Collision Sensors			
5.6.4 Collision Detection Sensors			
5.6.5 Monitoring Workspaces and Protected Spaces through Software	Remember & Understand		
5.7 Payload	Apply Knowledge & Analyze	High	
5.8 Potentiometers	Remember & Understand	Medium	
5.9 Conveyors			
5.10 Input Device	Apply Knowledge & Analyze	High	
5.10.1 Hardware/User Interface			
5.10.2 Software/User Program			
6. Robot Programming & Operations			30%
6.1 Reading & Interpreting Prints & Drawings	Apply Knowledge & Analyze	High	
6.2 Coordinate Systems			
6.2.1 Cartesian Coordinate System & Robot Positioning	Apply Knowledge & Analyze	High	
6.2.1.1 Linear Axes (X, Y, Z Orgin)			
6.2.1.2 Positive & Negative Direction			
6.2.1.3 Rotational Axes (A, B, C)s			
6.2.1.4 Joint Frame			
6.2.1.5 Tool Frame			
6.2.1.6 Tool Center Point (TCP)			
6.2.1.7 User Frame			
6.2.1.8 Tool Control Point (TCP)			
6.2.1.9 Control Group & Jogging Coordinate			
6.2.1.10 Relative Position			
6.2.1.11 Degrees of Freedom			
6.2.2 Cylindrical Coordinate	Apply Knowledge & Analyze	Medium	

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6.2.3 Base Coordinate System	Apply Knowledge & Analyze	High	
6.2.4 Tool Coordinate System	Apply Knowledge & Analyze	High	
6.2.5 Robot Origin/World View	Apply Knowledge & Analyze	High	
6.3 Control Systems			
6.3.1 Control Loops	Apply Knowledge & Analyze	High	
6.3.2 Open Loop (Non-Servo)	Apply Knowledge & Analyze	Medium	
6.3.3 Closed Loop (Servo) System	Apply Knowledge & Analyze	High	
6.3.4 Process Control (Proportional-Integral-Derivative/PID Control)	Apply Knowledge & Analyze	Medium	
6.3.5 X, Y, Z Movements	Apply Knowledge & Analyze	High	
6.4 Foundational Concepts in Robot Programming & Operation			
6.4.1 Inputs/Outputs (I/O)	Apply Knowledge & Analyze	High	
6.4.1.1 Commands			
6.4.1.2 Controller			
6.4.1.3 Controlling I/O			
6.4.2 Input/Output Monitor and Instructions	Apply Knowledge & Analyze	High	
6.4.2.1 Variable Monitor			
6.4.2.2 Arithmetic Instructions			
6.4.2.3 Inform/Control Instructions			
6.4.2.4 Job Creation			
6.4.2.5 Iteration			
6.4.2.6 Motion Programming			
6.4.2.7 Modifying Existing Instructions			
6.4.2.8 Subroutine			
6.4.2.9 Conditional Branching			
6.4.2.10 Programming Macros			
6.4.2.11 Calibration			

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Topics	Competency	Importance	Weightings
6.4.2.12 Threshold			
6.4.2.13 Path Confirmation & Playback			
6.4.2.14 Pick and Place Cycle			
6.4.3 Device Configuration	Apply Knowledge & Analyze	High	
6.4.4 Array	Remember & Understand	Medium	
6.4.5 Robot Motion	Apply Knowledge & Analyze	High	
6.4.5.1 Manual Movement			
6.4.5.2 Joint Motion			
6.4.5.3 Circular Motion			
6.4.5.4 Linear Motion			
6.4.6 Singularity	Apply Knowledge & Analyze	High	
6.5 Basic Robot Programming			
6.5.1 Online Programming	Apply Knowledge & Analyze	High	
6.5.1.1 Teach Pendant and Walk-Through/Lead-Through Programming			
6.5.1.2 Programming			
6.5.1.3 Right Hand Rule			
6.5.2 Offline Programming	Apply Knowledge & Analyze	High	
6.5.2.1 Simulations			
6.5.2.2 Control Programs			