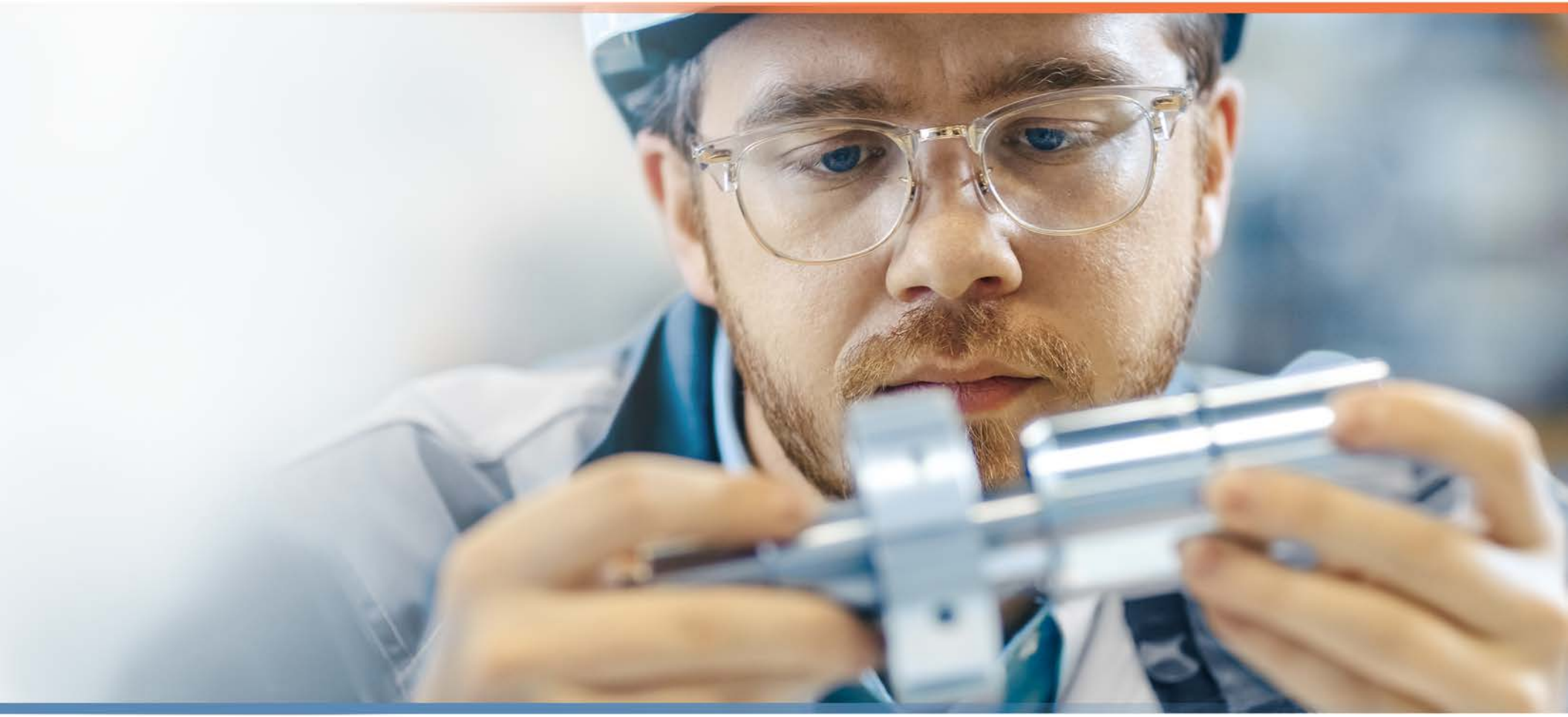
TECHNICAL CERTIFICATION
BODY OF KNOWLEDGE



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Topics	CMfgT		CMfgE	
	Importance	**Competency**	**Importance**	**Competency**
1. Manufacturing Foundations	**20%**		**15%**	
1.1. Mathematics	High	Apply & Analyze	High	Apply & Analyze
1.1.1.Algebra				
1.1.2.Trigonometry				
1.1.3.Analytical Geometry				
1.1.4.Calculus	Low	Remember & Understand	Low	Remember & Understand
1.1.5.Statistics	Medium	Apply & Analyze	Medium	Apply & Analyze
1.1.6.Measurement				
1.2. Print Reading	High	Evaluate & Create	High	Evaluate & Create
1.3. Geometric Dimensioning and Tolerancing	High	Apply & Analyze	High	Apply & Analyze
1.3.1 GD&T				
1.3.2 Tolerance Analysis				
1.4. Engineering Science	Medium	Apply & Analyze	High	Apply & Analyze
1.4.1.Chemistry				
1.4.2.Physics				
1.4.3.Fluid Mechanics				
1.4.4.Thermodynamics/Heat Transfer				
1.4.5.Mechanical Technologies in Statics & Dynamics				
1.4.6.Analytical Simulation, Methods and Techniques				
1.4.7.Electrical Circuits and Electronics				
1.5. Environmental Health & Safety	Medium	Apply & Analyze	High	Apply & Analyze
1.5.1.Human Factors				
1.5.2.New Technologies Safety				
1.5.3.Hazardous Materials				
1.5.4.Personal Protective Equipment				
1.5.5.Situational Awareness				
1.5.6.Ergonomics				
1.5.7.Hand Tool Use				

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	Importance	**Competency**	**Importance**	**Competency**
1.6. Ethics				
2. Manufacturing Process Application	**10%**		**15%**	
2.1. Materials Properties & Applications of:	High	Apply & Analyze	High	Apply & Analyze
2.1.1.Metals				
2.1.2.Plastics/Polymers				
2.1.3.Composites				
2.1.4.Ceramics				
2.2. Manufacturing Processes				
2.2.1.Additive Manufacturing/3D Printing	Medium	Apply & Analyze	Medium	Apply & Analyze
2.2.1.1. Discrete part manufacturing				
2.2.1.2. Biomedical Applications (e.g. medical devices, surgical implements, tissue printing)				
2.2.2.Subtractive Manufacturing/Material Removal	Medium	Apply & Analyze	Medium	Apply & Analyze
2.2.3.Fabrication	Medium	Apply & Analyze	High	Apply & Analyze
2.2.3.1. Hot and Cold Forming	Medium	Apply & Analyze	Medium	Apply & Analyze
2.2.3.2. Casting and Molding	Medium	Remember & Understand	Medium	Apply & Analyze
2.2.4.Electrical/Electronics Manufacturing	Medium	Apply & Analyze	Medium	Apply & Analyze
2.2.5.Treatments (e.g. heat treatment) and Coatings	Medium	Remember & Understand	Medium	Apply & Analyze
2.2.6.Finishing			Medium	Apply & Analyze
2.2.7.Joining, Welding and Assembly	Medium	Apply & Analyze	Medium	Apply & Analyze
2.2.8.Material Handling and Packaging	High	Remember & Understand	Medium	Apply & Analyze
3. Design & Development	**20%**		**15%**	
3.1. Intellectual Property Protection	Low	Remember & Understand	Medium	Remember & Understand
3.1.1.Patents				
3.1.2.Trademarks				
3.1.3.Copyrights				

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	Importance	**Competency**	**Importance**	**Competency**
3.1.4.Trade Secrets				
3.2. Computer-Aided Design/Drafting/Engineering Graphics/Modeling/Bill of Materials	High	Apply & Analyze	High	Apply & Analyze
3.2.1.Software				
3.2.2.Slice Files				
3.2.3.3D vs 2D Modeling				
3.2.4.Drafting Standards Mechanism				
3.2.5.Computer-Aided Drafting				
3.2.6.Bill of Materials				
3.3. Concurrent Engineering/Design for X:	Medium	Apply & Analyze	High	Apply & Analyze
3.3.1.Manufacture				
3.3.2.Assembly				
3.3.3.Maintenance				
3.3.4.Sustainability				
3.3.5.Serviceability				
3.3.6.Reliability				
3.3.7.Environment				
3.3.8.Affordability				
3.3.9.Lightweighting				
3.3.10. Additive Manufacturing				
3.4. Computer-Aided Engineering (CAE) Design and Manufacturing Tools	Medium	Apply & Analyze	High	Apply & Analyze
3.4.1.Engineering Analysis Tasks				
3.4.1.1. Process Simulation				
3.4.1.2. Structural Analysis				
3.4.1.3. Fluid Dynamics				
3.4.1.4. Design for Process Variables				
3.4.1.5. Engineering Design Analysis				
3.5. Equipment/Tool Design and Development	Medium	Apply & Analyze	Medium	Apply & Analyze
3.5.1.Cutting Tool Design				
3.5.2.Workholding Tool Design				

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	Importance	**Competency**	**Importance**	**Competency**
3.5.3.Die/Mold Design				
3.5.4.Gage Design				
3.5.5.Machine Design				
3.5.6.Power Systems Design (Mech/Elec/Fluid)				
3.5.7.Control Systems Design (Mech/Elec/Fluid)				
3.5.8.Nanotechnology				
3.5.9.Packaging				
3.6. Additive Manufacture/3D Printing Applications	Medium	Remember & Understand	Medium	Apply & Analyze
3.6.1.Rapid Prototyping				
3.6.2.Production Parts				
3.6.3.Tooling				
3.6.4.3D Scan and Print				
4. Digital Enterprise	**5%**		**6%**	
4.1. Digital Organization	Low	Remember & Understand	Medium	Remember & Understand
4.1.1.Governance				
4.1.2.Security				
4.1.3.Cybersecurity				
4.1.4.Risk Management				
4.1.5.Risk Strategy				
4.2. Industrial Internet of Things	Medium	Remember & Understand	Medium	Apply & Analyze
4.2.1.Device Sensors				
4.2.2.Data Collection				
4.2.3.Network Infrastructure				
4.2.4.Organizational Technology				
4.2.5.Considerations for 3D Printing				
4.3. Data Science	Low	Remember & Understand	Medium	Remember & Understand

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	Importance	**Competency**	**Importance**	**Competency**
4.3.1.Cloud Computing				
4.3.2.Data Analytics				
4.3.3.Data Pathways				
4.3.4.Data Cost Modeling				
4.4. Digital Performance Management (DPM)	Medium	Remember & Understand	Medium	Apply & Analyze
4.4.1.Visualization				
4.4.2.Equipment Effectiveness				
4.4.3.Dashboards				
4.4.4.Decision Making from Dashboards				
4.4.5.Increased Energy Efficiency				
4.5. Artificial and Augmented Intelligence	Low	Remember & Understand	Medium	Remember & Understand
4.5.1.Machine Learning				
4.5.2.Automated Responses				
4.6. Machine Health, Asset Optimization and Industrial Maintenance	Medium	Apply & Analyze	Medium	Apply & Analyze
4.6.1.Condition Monitoring				
4.6.2.Preventative Maintenance				
4.6.3.Predictive Maintenance				
4.6.4.Total Productive Maintenance				
4.7. Digital Twin	Low	Remember & Understand	Low	Remember & Understand
4.8. Digital Thread	Low	Remember & Understand	Low	Remember & Understand
5. Automated Systems & Controls	**10%**		**6%**	
5.1. Controls	High	Apply & Analyze	Medium	Apply & Analyze
5.1.1.Computer Numerical Controls (CNC)				
5.1.2.Programmable Logic Controls (PLC)				
5.2. Computer Systems and Networks	Medium	Remember & Understand	Medium	Apply & Analyze

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	Importance	**Competency**	**Importance**	**Competency**
5.2.1.Information Technology Infrastructure				
5.2.2.Operational Technology				
5.2.3.Enterprise-wide Systems Integration				
5.2.4.Database Systems				
5.2.5.Communication Protocols				
5.3. Supply Chain	Medium	Remember & Understand	Medium	Apply & Analyze
5.3.1.Machine-to-Machine (M2M) Part Movement				
5.3.2.Capacity Planning				
5.3.3.One Piece Flow				
5.3.4.Demand Forecast for Products				
5.3.5.Distribution Center Management				
5.3.6.Supplier Performance Data (informed contract negotiations)				
5.3.7.Supply Planning				
5.4. Robotics	Medium	Apply & Analyze	Medium	Apply & Analyze
5.4.1.Collaborative Robots				
5.4.2.Automated Mobile Robots				
5.4.3.Robot Safety				
5.4.4.Fixed Route and Intelligent Navigation of Automated Robots				
5.5. Supervisory Control & Data Acquisition (SCADA)/Human-Machine Interface (HMI)	Medium	Remember & Understand	Medium	Apply & Analyze
5.5.1.Machine-to-Machine (M2M)				
5.5.2.Closed Loop Machine Interface				
5.5.3.Open Loop Machine Interface				
6. Quality	**10%**		**15%**	
6.1. Total Quality Management (TQM)	Medium	Apply & Analyze	High	Apply & Analyze
6.1.1.Quality Management Systems (QMS)				
6.1.2.Audits				

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	Importance	**Competency**	**Importance**	**Competency**
6.1.3.Training				
6.1.4.Quality Standards (e.g. QS, ISO, etc.)				
6.2. Statistical Control Methods	Medium	Apply & Analyze	High	Apply & Analyze
6.2.1.Problem Analysis & Solving (e.g. Fishbone, Pareto, etc.)				
6.2.2.Factor Analysis (e.g. Design of Experiments (DOE), Correlation, etc.)				
6.2.3.Capability Analysis				
6.2.4.Reliability Analysis				
6.3. Inspection, Test and Validation	High	Apply & Analyze	Medium	Apply & Analyze
6.3.1.Metrology				
6.3.2.Inspections				
6.3.3.Test				
6.3.4.Validation & Compliance				
6.3.5.Non-Destructive Testing				
6.4. Quality for Additive Manufacturing	Medium	Remember & Understand	Medium	Apply & Analyze
6.4.1.Inspection Methods				
6.4.2.Secondary Processes				
6.4.3.Defect Inspection				
7. Continuous Improvement	**15%**		**15%**	
7.1. Systems, Processes and Tools (e.g. Lean, Six Sigma, etc.)	High	Apply & Analyze	High	Apply & Analyze
7.1.1.Benchmarking				
7.1.2.Business Process Management (BPM)				
7.1.3.Just-in-Time Manufacturing				
7.1.4.Environmental Management				
7.1.5.Visual Workplace (5S)				
7.1.6.Workflow Analysis (e.g. value stream mapping, flow charting, process mapping, SIPOC, etc.)				
7.1.7.Kanban/Pull Systems				
7.1.8.Poke Yoke/Mistake Proofing				

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7.1.9.Cellular Manufacturing				
7.1.10. Standardized Work				
7.1.11. PDCA/DMAIC				
7.1.12. Root Cause Analysis (e.g. 5 Why's, Failure Modes and Effects Analysis (FMEA), Cause and Effect diagrams, etc.)				
7.1.13. Statistical Process Control (SPC)				
7.1.14. Theory of Constraints				
7.1.15. Collaborative Innovation				
7.1.16. Single Minute Exchange of Dies (SMED)/Quick Changeover				
7.1.17. Heijunka/Leveling the Workload				
7.1.18. Jidoka/Autonomation				
7.2. Business Results and Measurement Systems	Medium	Apply & Analyze	Medium	Apply & Analyze
7.2.1.Measure Normal Versus Abnormal Conditions				
7.2.2.Measurement Guidelines/Categories				
7.2.3.Goal and Objective Setting				
7.2.4.Interdependencies Between Measures and Measurement Categories				
7.2.5.Measure Results from the Whole System				
7.2.6.Measure Flow and Waste				
7.2.7.Customer Focus				
7.2.7.1. Voice of the Customer				
7.2.7.2. Measure What Matters to the Customer				
7.2.8.Reporting				
7.3. Quality, Cost and Delivery (QCD)	High	Apply & Analyze	High	Apply & Analyze
7.3.1.Takt Time				
7.3.2.Cycle Time				
7.3.3.Lead Time				
7.3.4.Inventory Turns				
7.3.5.Queue Time				

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	Importance	**Competency**	**Importance**	**Competency**
7.3.6.Wait Time/Delays				
7.3.7.Overall Equipment Effectiveness (OEE)				
7.3.8.Changeover Time				
7.3.9.Scrap and Rework				
8. Business Acumen	**10%**		**13%**	
8.1. Soft Skills/Personal Effectiveness	High	Evaluate & Create	High	Apply & Analyze
8.1.1.Managing in a Digital Environment				
8.1.2.Interpersonal Skills				
8.1.3.Negotiating and Conflict Management				
8.1.4.Presentation Skills and Oral Communication				
8.1.5.Written Communication Skills				
8.1.6.Continual Learning & Development				
8.2. Project Management	Medium	Apply & Analyze	High	Apply & Analyze
8.2.1.Traceability				
8.2.2.Block Chain				
8.2.3.Managing Global Supply Chains				
8.3. Finance	Medium	Apply & Analyze	Medium	Apply & Analyze
8.3.1.Billing Technologies				
8.3.2.Engineering Economics				
8.3.3.Cost Justification				
8.3.4.Project Justification				
8.4. Training and Development	Medium	Remember & Understand	Medium	Apply & Analyze
8.4.1.Apprenticeships				
8.4.2.On-the-Job Training (OJT)				
8.4.3.Talent Management as a Service				
8.5. Labor Relations	Medium	Remember & Understand	Medium	Remember & Understand