



# **AMTEC**

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## **AMTEC Certification & Assessments**



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**Automotive Manufacturing Technical Education Collaborative**



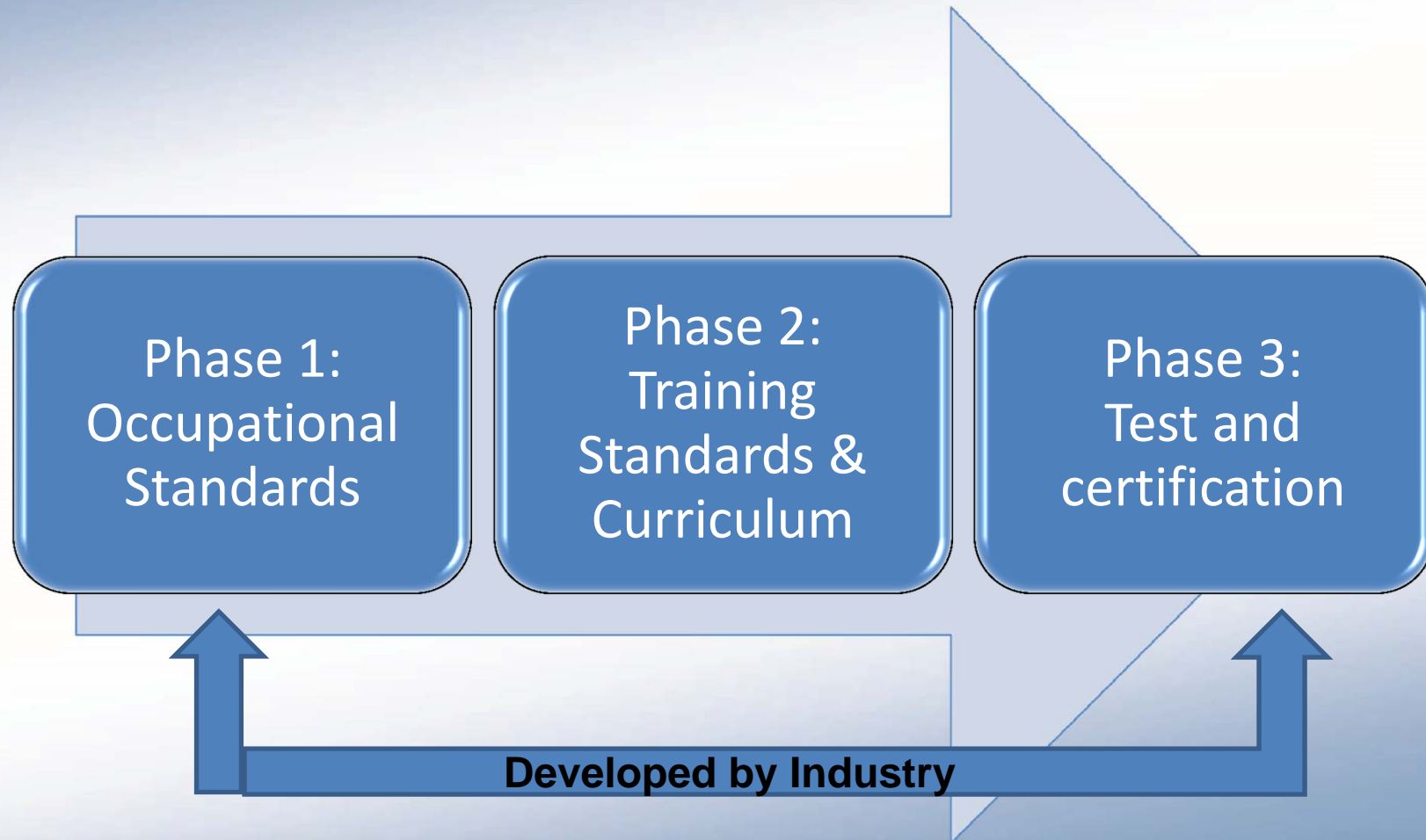
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# Multi-Skilled Maintenance Occupational Standards and Assessments

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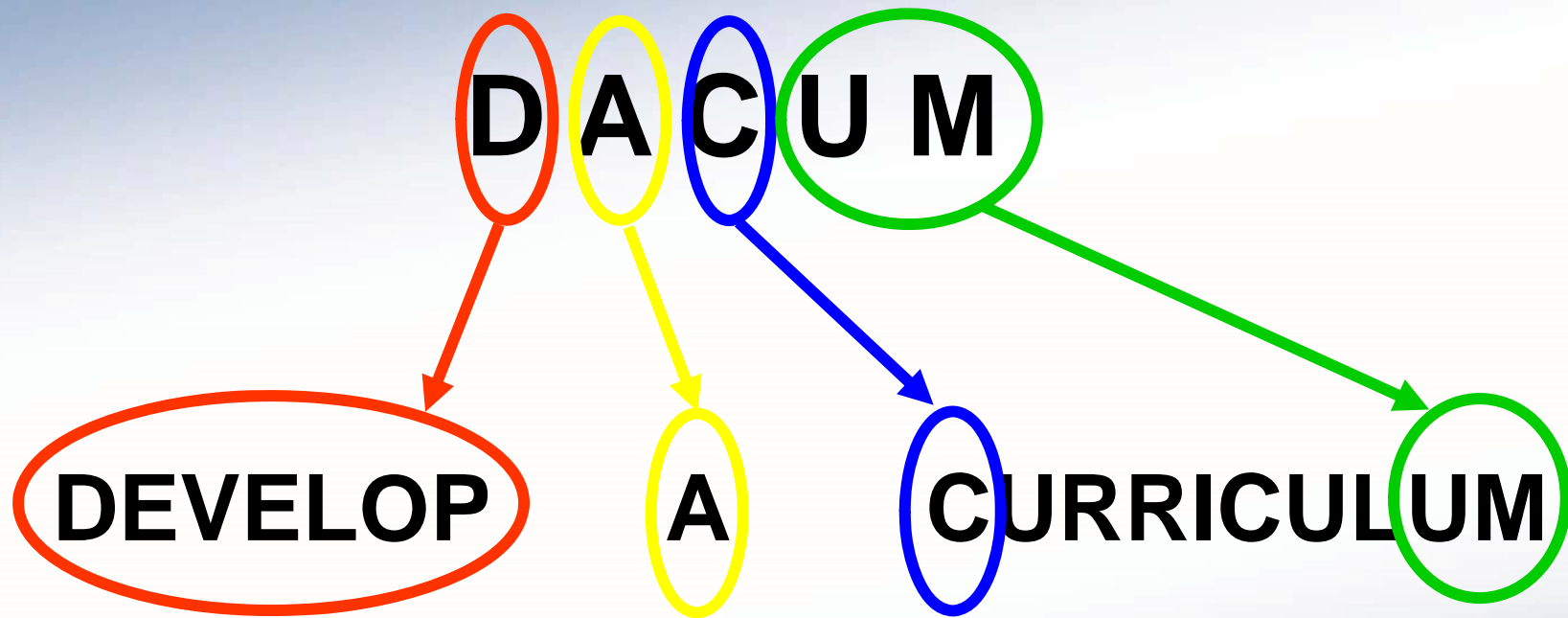
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Maintenance

Tool and Die

Two  
Turbo-  
DACUM's



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# Multi-Skilled Maintenance Original DACUM

Toyota Motor Manufacturing Kentucky

# Maintenance--26 Duties, 170 Tasks

<b>A</b>	<b>MECHANICAL EQUIPMENT</b>
<b>B</b>	<b>PNEUMATIC/HYDRAULIC EQUIPMENT</b>
<b>C.</b>	<b>STEAM SYSTEM</b>
<b>D.</b>	<b>PREDICTIVE/CORRECTIVE MAINTENANCE</b>
<b>E</b>	<b>BLUEPRINT READING/SCHEMATICS</b>
<b>F</b>	<b>EQUIPMENT CONTROLS AND SENSORS</b>
<b>G</b>	<b>ELECTRICAL EQUIPMENT</b>
<b>H</b>	<b>ELECTRONIC EQUIPMENT</b>
<b>I</b>	<b>NETWORKING</b>
<b>J</b>	<b>PLC EQUIPMENT</b>
<b>K.</b>	<b>MAINTAIN NC/CNC EQUIPMENT</b>
<b>L.</b>	<b>ROBOTS</b>
<b>M</b>	<b>RESISTANCE WELDING</b>
<b>N</b>	<b>ROBOTIC GMAW WELDING</b>
<b>O</b>	<b>FABRICATE</b>
<b>P</b>	<b>COMPUTER LITERACY</b>
<b>Q</b>	<b>PREVENTATIVE MAINTENANCE</b>
<b>R</b>	<b>DUST AND MIST COLLECTORS</b>
<b>S</b>	<b>UTILITIES</b>
<b>T</b>	<b>POWER DISTRIBUTION</b>
<b>U</b>	<b>SPECIALIZED MACHINERY</b>
<b>V</b>	<b>METROLOGY</b>
<b>W</b>	<b>SAFETY AND DOCUMENTATION</b>
<b>X</b>	<b>LASER ETCHER</b>
<b>Y</b>	<b>AUTOMATIC WELDER</b>
<b>Z</b>	<b>SPECIALIZED EQUIPMENT</b>





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# Duty A Tasks

<b>A</b>		<b>MECHANICAL EQUIPMENT</b>
	<b>1</b>	<b>Troubleshoot/repair/replace brakes &amp; clutches (electromechanical and mechanical)</b>
	<b>2</b>	<b>Troubleshoot/repair/replace gears</b>
	<b>3</b>	<b>Troubleshoot/replace belts, sheaves/pulley</b>
	<b>4</b>	<b>Troubleshoot/maintain chains and sprockets</b>
	<b>5</b>	<b>Troubleshoot/repair/replace cams</b>
	<b>6</b>	<b>Troubleshoot/repair/replace seals and o-rings</b>
	<b>7</b>	<b>Troubleshoot/repair/replace bearings and bushings</b>
	<b>8</b>	<b>Troubleshoot/repair/replace shafts</b>
	<b>9</b>	<b>Perform alignment and balancing</b>
	<b>10</b>	<b>Troubleshoot/repair/replace motors (AC and DC)</b>
	<b>11</b>	<b>Maintain couplings</b>
	<b>12</b>	<b>Maintain fans</b>
	<b>13</b>	<b>Install/maintain valves (cut-off, pressure relief...)</b>





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# Duty B Tasks

<b>B</b>		<b>PNEUMATIC/HYDRAULIC EQUIPMENT</b>
	<b>14</b>	<b>Troubleshoot/repair/replace pneumatic/hydraulic valves</b>
	<b>15</b>	<b>Troubleshoot/repair/replace cylinders and intensifiers</b>
	<b>16</b>	<b>Troubleshoot/repair/replace hoses and tubing</b>
	<b>17</b>	<b>Adjust pressures and flows mechanically and electronically</b>
	<b>18</b>	<b>Maintain fluid levels for hydraulic systems</b>
	<b>19</b>	<b>Replace filters on hydraulic/pneumatic systems</b>
	<b>20</b>	<b>Troubleshoot/repair/replace gauges</b>
	<b>21</b>	<b>Troubleshoot/repair/replace pneumatic/hydraulic pumps</b>
	<b>22</b>	<b>Troubleshoot/replace accumulators</b>
	<b>23</b>	<b>Troubleshoot/repair/replace air motors</b>
	<b>24</b>	<b>Maintain vacuum system on pneumatic equipment</b>
	<b>25</b>	<b>Maintain filtration systems</b>
	<b>26</b>	<b>Adjust switches and controls on hydraulic/pneumatic system</b>
	<b>27</b>	<b>Install/design hydraulic/pneumatic components to upgrade/enhance systems</b>



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# Task A1-Detail

A.		MECHANICAL EQUIPMENT	Tools and Equipment
	1	<b>Troubleshoot/repair/replace brakes &amp; clutches (electromechanical and mechanical)</b>	
	a	Inspect brake for wear, leaks, damage, excessive wear on pads, etc.	Common hand tools
	b	Disassemble discs and pads	Vernier caliper
	c	Clean rotors	Micrometer
	d	Reassemble	Surface grinder
	e	Adjust or set air pressures or mechanical springs	Lathe
	f	Set gap on electrical brakes (air gap on electromechanical or gap on mechanical brake	Milling machine
	g	Troubleshoot/repair/replace electromagnet on electromechanical brake	Feeler gauge
	h	Set brake and clutch timing using transducers and monitors	Hydraulic press
			Instruction book



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# Task A1—Details continued

Calculations	Communications	Technology	Safety
Measure in decimals (thousandths)	Interpret written work order	Principles of brakes	Common safety practices
Basic math	Verbal with co workers	Basic mechanical skills	PPE
Metric measurement; conversion	Verbal with operator	Electrical and mechanical brakes	Pinch points
	Read technical manual	Basic machine operation; sequence of operation	Turning hazard
	Interpret schematic		Stored energy
	Search database (computerized)		Lock out/tag out procedures
	Input data into a computer		Respiratory protection



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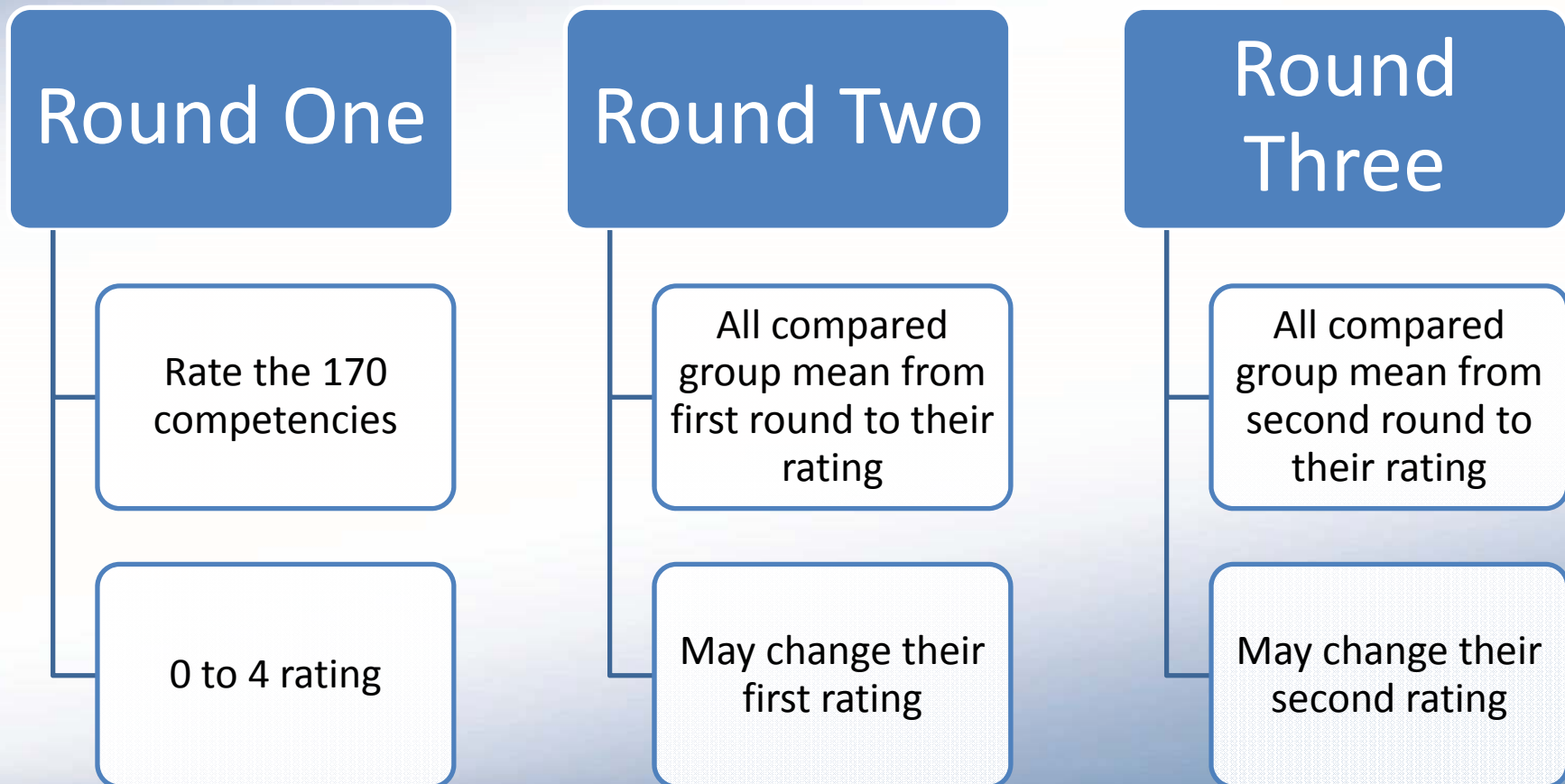
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# Delphi—3 Rounds

ORA, Inc.



# Delphi—3 rounds required







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		Importance Ratings
4	Essential	not having skill/knowledge in this area will keep you from gaining employment in this occupation
3	Very Important	skill/knowledge in this area <b>WILL enhance</b> employability in this area
2	Important	skill/knowledge in this area <b>MAY enhance</b> employability in this area
1	General Importance	skill/knowledge in this area will be learned on-the-job and <b>would NOT effect</b> employment in this occupation
0	Not Important	skill/knowledge in this area <b>are NOT important</b> for employment in this occupation at all



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# Delphi Data Analysis

Compared Individual Business Ratings

Compared Individual School Ratings

Compared Business Ratings to Educator  
Ratings



# R3-Compare Business Ratings

			BUSINESS					
Delphi Results by Organization			Grand Total	Overall Business	BMW	Ford	GM	Toyota
Maintenance			Mean N=52	Mean N=34	Mean N=5	Mean N=2	Mean N=11	Mean N=8
<b>A</b>		<b>MECHANICAL EQUIPMENT</b>	<b>3.34</b>	<b>3.44</b>	<b>3.33</b>	<b>3.50</b>	<b>3.38</b>	<b>3.50</b>
	1	Troubleshoot/repair/replace brakes & clutches (electromechanical and mechanical)	2.98	2.97	3.20	3.50	2.82	3.00
	2	Troubleshoot/repair/replace gears	2.94	2.91	2.80	3.50	2.36	3.25
	3	Troubleshoot/replace belts, sheaves/pulley	3.08	2.91	3.00	3.50	2.36	3.00
	4	Troubleshoot/maintain chains and sprockets	2.88	2.65	2.80	3.50	2.18	3.25
	5	Troubleshoot/repair/replace cams	2.75	2.70	2.80	3.50	2.36	3.13
	6	Troubleshoot/repair/replace seals and o-rings	3.38	3.32	3.40	2.50	2.73	3.75
	7	Troubleshoot/repair/replace bearings and bushings	3.27	3.24	3.40	3.50	2.91	3.25
	8	Troubleshoot/repair/replace shafts	3.13	3.09	3.00	3.50	2.73	3.38
	9	Perform alignment and balancing	3.00	2.79	2.40	3.50	2.55	3.25
	10	Troubleshoot/repair/replace motors (AC and DC)	3.54	3.56	3.60	3.50	3.18	3.88
	11	Maintain couplings	3.06	2.97	3.20	3.50	2.45	3.38
	12	Maintain fans	3.00	2.91	2.60	3.50	2.73	3.25
	13	Install/maintain valves (cut-off, pressure relief...)	3.00	2.91	3.00	3.50	2.64	3.38

# R3-Compare Educator Ratings

			EDUCATORS								
			Grand Total	Overall Educators	KCTCS	Alamo	Palo Alto	Vincennes	Pellissippi	Arkansas	Other
		Maintenance	Mean N=52	Mean N=18	Mean N=12	Mean N=1	Mean N=1	Mean N=1	Mean N=1	Mean N=1	Mean N=8
A		<b>MECHANICAL EQUIPMENT</b>	<b>3.34</b>	<b>3.15</b>	<b>3.13</b>	<b>3.00</b>		<b>3.00</b>	<b>4.00</b>	<b>3.00</b>	<b>3.50</b>
	1	Troubleshoot/repair/replace brakes & clutches (electromechanical and mechanical)	2.98	3.00	3.08	3.00	2.00	2.00	4.00	3.00	2.88
	2	Troubleshoot/repair/replace gears	2.94	3.00	3.00	3.00	3.00	3.00	4.00	2.00	3.25
	3	Troubleshoot/replace belts, sheaves/pulley	3.08	3.39	3.58	3.00	2.00	4.00	4.00	2.00	3.38
	4	Troubleshoot/maintain chains and sprockets	2.88	3.33	3.50	3.00	1.00	4.00	4.00	3.00	2.38
	5	Troubleshoot/repair/replace cams	2.75	2.83	2.75	3.00	2.00	4.00	4.00	2.00	2.43
	6	Troubleshoot/repair/replace seals and o-rings	3.38	3.50	3.67	3.00	3.00	2.00	4.00	4.00	3.88
	7	Troubleshoot/repair/replace bearings and bushings	3.27	3.33	3.42	3.00	2.00	3.00	4.00	4.00	3.50
	8	Troubleshoot/repair/replace shafts	3.13	3.22	3.17	3.00	4.00	3.00	4.00	3.00	3.25
	9	Perform alignment and balancing	3.00	3.39	3.33	3.00	4.00	3.00	4.00	4.00	2.75
	10	Troubleshoot/repair/replace motors (AC and DC)	3.54	3.50	3.42	3.00	4.00	4.00	4.00	4.00	3.75
	11	Maintain couplings	3.06	3.22	3.33	3.00	2.00	3.00	4.00	3.00	3.00
	12	Maintain fans	3.00	3.17	3.08	3.00	4.00	3.00	4.00	3.00	2.88
	13	Install/maintain valves (cut-off, pressure relief...)	3.00	3.17	3.25	3.00	2.00	3.00	4.00	3.00	2.63

# R3-Compare Business to Educator Ratings

			Round 3 Business/Industry			Round 3 Educator			Business Vs Educators		
Maintenance			Mean	N	Std. Deviation	Mean	N	Std. Deviation	Difference Round 3		
Delphi Results for Business and Industry vs. Educators											
<b>M</b>			<b>RESISTANCE WELDING</b>	<b>1.50</b>	<b>28</b>	<b>1.453</b>	<b>2.29</b>	<b>17</b>	<b>0.772</b>	<b>-0.79</b>	<b>***</b>
	85	*	Perform visual inspection of resistance welding equipment operation	1.82	34	1.527	2.33	18	0.767	-0.51	
	86	*	Align components in resistance welding equipment	1.71	34	1.528	2.33	18	0.767	-0.63	**
	87	*	Repair/replace failed components in resistance welding equipment	1.71	34	1.567	2.33	18	0.767	-0.63	**
	88	*	Maintain and troubleshoot gun servos	1.62	34	1.518	2.33	18	0.767	-0.72	**
	89	*	Perform parameter adjustments (weld conditions) on resistance and stud welding	1.71	34	1.567	2.28	18	0.826	-0.57	
	90	*	Troubleshoot/repair/replace location pins and datum surfaces	1.76	34	1.539	2.28	18	0.826	-0.51	
	91	*	Maintain cooling system in resistance welding equipment	1.59	34	1.480	2.33	18	0.767	-0.75	***
	92	*	Perform resistance checks (resistance of cable and condition of insulators)	1.71	34	1.567	2.33	18	0.767	-0.63	**
<b>N</b>			<b>ROBOTIC GMAW WELDING</b>	<b>1.25</b>	<b>28</b>	<b>1.404</b>	<b>2.12</b>	<b>17</b>	<b>0.600</b>	<b>-0.87</b>	<b>***</b>
	93		Perform visual inspection of Robotic-GMAW welding equipment operation	1.41	34	1.540	2.17	18	0.618	-0.75	***
	94		Replace weld controller in Auto-mig welding equipment	1.50	34	1.562	2.22	18	0.647	-0.72	**
	95		Maintain torch/brazing equipment	1.50	34	1.562	2.11	18	0.676	-0.61	**
	96		Maintain welding gas regulating systems	1.44	34	1.418	2.11	18	0.676	-0.67	**



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## AMTEC Standards, Curriculum, & Assessments

AMTEC Skills  
Standards

Module/Courses  
Content

AMTEC  
Assessments



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## Core Curriculum—

# Result--20 Duties, 110 Tasks

Meeting  
with all  
partners

- Business
- Educators

Used

- DACUM
- Delphi Data

# Identified Core Curriculum

<b>H</b>		<b>ELECTRONIC EQUIPMENT</b>	<b>Fundamental</b>	<b>Advanced</b>	<b>Certificate</b>	<b>Shop Specific</b>
	<b>60</b>	<b>Maintain/install fiber optics</b>	<b>Introduction</b>	<b>x</b>		
	<b>61</b>	<b>Troubleshoot/repair/replace vision systems</b>	<b>Introduction</b>	<b>x</b>		
	<b>62</b>	<b>Install/maintain/troubleshoot bar code readers</b>	<b>Introduction</b>	<b>x</b>		
	<b>63</b>	<b>Troubleshoot/maintain (single rail transport) SRT monorail</b>				<b>x</b>
	<b>64</b>	<b>Maintain and calibrate quality touch center system (MARPOS)</b>				<b>x</b>
<b>I</b>		<b>NETWORKING</b>	<b>Fundamental</b>	<b>Advanced</b>	<b>Certificate</b>	<b>Shop Specific</b>
	<b>65</b>	<b>Use DeviceNet protocol</b>	<b>Introduction</b>	<b>x</b>		
	<b>66</b>	<b>Use Data Highway protocol</b>	<b>Introduction</b>	<b>x</b>		
	<b>67</b>	<b>Use TCP/IP protocol</b>	<b>Introduction</b>	<b>x</b>		
	<b>68</b>	<b>Use ControlNet protocol (Allen Bradley)</b>				<b>x</b>
	<b>69</b>	<b>Use FL net protocol</b>				<b>x</b>

# Assign Core Competencies to Courses

			Fluid Power and Electrohydraulics / pneumatic	General PM and Predictive Maintenance	PLC	Blueprint Reading / Schematics	Robotics	Controls and Instrumentation	Basic Electricity and Electronics	Mechanical Systems / Mechanical Drives / Power Transmissions	Safety	Computer Literacy	Welding and Fabrication	Machine Tool
<b>A</b>		<b>MECHANICAL EQUIPMENT</b>												
	1	Troubleshoot/repair/replace brakes & clutches (electromechanical and mechanical)								x				
	2	Troubleshoot/repair/replace gears								x				
	3	Troubleshoot/replace belts, sheaves/pulley								x				
	4	Troubleshoot/maintain chains and sprockets								x				
	5	Troubleshoot/repair/replace cams								x				
	6	Troubleshoot/repair/replace seals and o-rings								x				
	7	Troubleshoot/repair/replace bearings and bushings								x				
	8	Troubleshoot/repair/replace shafts								x				
	9	Perform alignment and balancing								x				
	10	Troubleshoot/repair/replace motors (AC and DC)						x						
	10	Troubleshoot/repair/replace motors (AC and DC)								x				
	11	Maintain couplings								x				
	12	Maintain fans								x				
	13	Install/maintain valves (cut-off, pressure relief...)	x											
	13	Install/maintain valves (cut-off, pressure relief...)						x						
<b>B</b>		<b>PNEUMATIC/HYDRAULIC EQUIPMENT</b>	Power and Electrohydraulics / pneumatic	General PM and Predictive Maintenance	PLC	Blueprint Reading / Schematics	Robotics	Controls and Instrumentation	Basic Electricity and Electronics	Mechanical Systems / Mechanical Drives / Power Transmissions	Safety	Computer Literacy	Welding and Fabrication	Machine Tool
	14	Troubleshoot/repair/replace pneumatic/hydraulic valves	x											
	15	Troubleshoot/repair/replace cylinders and intensifiers	x											
	16	Troubleshoot/repair/replace hoses and tubing	x											
	17	Adjust pressures and flows mechanically and electronically	x											
	18	Maintain fluid levels for hydraulic systems	x											



# Allocated Courses into Modules

		Module 1	Module 2	Module 3	Module 4	Module 5	Module 6	Module 7
A	MECHANICAL EQUIPMENT	Fundamentals	Flow, Directional, Pressure Control Valves	Actuators	Pumps and reservoirs	Fluids and Filters	Hose, pipes and Tubing fabrication	Electrohydraulic and pneumatics
13	Install/maintain valves (cut-off, pressure relief...)		x					
B	PNEUMATIC/HYDRAULIC EQUIPMENT							
14	Troubleshoot/repair/replace pneumatic/hydraulic valves		x					
15	Troubleshoot/repair/replace cylinders and intensifiers			x				
16	Troubleshoot/repair/replace hoses and tubing						x	
17	Adjust pressures and flows mechanically and electronically		x					x
18	Maintain fluid levels for hydraulic systems					x		
19	Replace filters on hydraulic/pneumatic systems					x		
20	Troubleshoot/repair/replace gauges	x						
21	Troubleshoot/repair/replace pneumatic/hydraulic pumps				x			
22	Troubleshoot/replace accumulators				x			
23	Troubleshoot/repair/replace air motors			x				
24	Maintain vacuum system on pneumatic equipment						x	
25	Maintain filtration systems					x		
26	Adjust switches and controls on hydraulic/pneumatic system							x
27	Install/design hydraulic/pneumatic components to upgrade/enhance systems							x
E	BLUEPRINT READING/SCHEMATICS							
42	Interpret pneumatic and hydraulic drawings	x						
G	ELECTRICAL EQUIPMENT							
55	Install/maintain solenoid valve		x					

# 12 Courses by Clock Time

	Courses	Clock Time	Lecture	Lab	%
1	Fluid Power and Electrohydraulics/pneumatics	120	60	60	13%
2	General PM and Predictive Maintenance	30	20	10	3%
3	PLC	100	40	60	10%
4	Blueprint Reading/Schematics	30	20	10	3%
5	Robotics	80	40	40	8%
6	Controls and Instrumentation	100	40	60	10%
7	Basic Electricity and Electronics	100	40	60	10%
8	Mechanical Systems/Mechanical Drives/Power Transmissions	100	40	60	10%
9	Safety	40	30	10	4%
10	Computer Literacy	40	10	30	4%
11	Welding and Fabrication	120	24	96	13%
12	Machine Tool	100	20	80	10%
	<b>Total Clock Hours</b>	960	384	576	100%
	<b>Credit (Lecture at 15:1 and Lab at 30:1)</b>		26	19	
				45	24



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# Final

<b>AMT 101</b>	<b>Fluid Power and Electrohydraulics/Pneumatics</b>
<b>AMT 102</b>	<b>General PM and Predictive Maintenance</b>
<b>AMT 103s</b>	<b>PLC (Siemens)</b>
<b>AMT 103ab</b>	<b>PLC (Allen-Bradley/Rockwell)</b>
<b>AMT 104</b>	<b>Blueprint Reading/Schematics</b>
<b>AMT 105</b>	<b>Robotics</b>
<b>AMT 106</b>	<b>Controls &amp; Instrumentation</b>
<b>AMT 107</b>	<b>Basic Electricity &amp; Electronics</b>
<b>AMT 108</b>	<b>Mechanical Systems/Mechanical Drives/Power Transmissions</b>
<b>AMT 109</b>	<b>Safety</b>
<b>AMT 100</b>	<b>Computer Literacy</b>
<b>AMT 110</b>	<b>Welding &amp; Fabrication</b>
<b>AMT 120</b>	<b>Machine Tool Operations</b>



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# Each Course into 59 Modules— Keeping Link to Standards

Mod.	<b>Fluid Power and Electrohydraulics/pneumatics</b>	Lecture	Lab	Standard Link
1	<b>Fundamentals</b>	16		20, 42
2	<b>Flow, Directional, Pressure Control Valves</b>	10	18	13, 14, 17
3	<b>Actuators</b>	6	8	15, 23
4	<b>Pumps and reservoirs</b>	8	8	21,22
5	<b>Fluids and Filters</b>	5	3	18, 19, 25
6	<b>Hose, pipes and tubing fabrication</b>	3	9	16, 24
7	<b>Electrohydraulics/pneumatics</b>	12	14	17,26,27
		60	60	



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Course	Module	Title
<b>1</b>		<b>AMT 101: Fluid Power and Electrohydraulics/Pneumatics</b>
	1	AMT 1011: Fundamentals
	2	AMT 1012: Reservoirs, Fluids, & Filters
	3	AMT 1013: Hoses, Pipes, & Tubing
	4	AMT 1014: Actuators, Pumps, & Accumulators
	5	AMT 1015: Flow, Directional, Pressure, Flow Control Valves
	6	AMT 1016: Electrohydraulics/Pneumatics
	7	AMT 1017: Systems and System Troubleshooting



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# Curriculum

## DACUM

2		Troubleshoot/repair/replace gears
	a	Perform visual inspection: alignment, worn/missing teeth, cracked teeth, etc.
	b	Inspect gear to shafts for fitting (looseness, etc.)
	c	Replace gear
	d	Set clearances
	e	Set backlash
	f	Check oil level
	g	Check grease lines for function
	h	Apply predictive technology (vibration analysis, ultrasonic, oil analysis)
	i	Select and use correct lubrication

## 61 Student Learning Outcomes

	AMT 1086—Gears and Cams
A	Gear and cam maintenance safety.
B	Describe the purpose and function of gears and gear drives.
C	Open gears.
D	Enclosed gears.
E	Seals, breathers, and lubrication.
F	Gear ratings and application and selection.
G	Industrial cam follower functions, uses, and terms.
H	Industrial cam follower bushing types and operating clearances.
I	Gear identification.
J	Assemble a parallel shaft gear drive.
K	Assemble an angle shaft gear drive.
L	Assemble a worm and wheel gearbox drive unit.
M	Identify the common types of cam followers and rod ends.
N	Replace, install, and adjust cam followers and rod ends.





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# Curriculum

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59 Modules  
Curriculum  
Development

- Teams of industry and faculty
- Created student learning outcomes for modules
- Created one pre and one post-test aligned to student learning outcomes





**AMT**

Ignite. Edu

▼ **Open** ▲ **Close all toggles.**

▼ *Getting Started - Toggle*

▼ *Allen-Bradley Hardware & Software (I/O) Pre-Assessment - Toggle*

▼ *Preview Learning Modules & Tasks - Toggle*

▼ *Lesson 1: Rockwell's Integrated Architecture - Toggle*

▼ *Lesson 2: Memory & Project Organization - Toggle*

▼ *Lesson 3: Starting a New Project in ControlLogix - Toggle*

▼ *Lesson 4: Connecting a Personal Computer (PC) to the PLC - Toggle*

▼ *LABS 1 - 4 - Toggle* ←

▼ *Lesson 5: Input/Output (I/O) Modules & Wiring - Toggle*

▼ *LABS 5 - 7 - Toggle* ←

▼ *Lesson 6: Troubleshooting Automated Systems - Toggle*

▼ *LABS 8 - 10 - Toggle* ←

▼ *Lesson 7: Configuring I/O Modules in a Remote Chassis - Toggle*

▼ *Lesson 8: HMI/Factory Talk View Studio - Toggle*

▼ *Lesson 9: Overview of Integrated Manufacturing System Simulator A-B Hardware & Software - Toggle*

▼ *Allen-Bradley Hardware & Software (I/O) Post-Assessment - Toggle*

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[autoworkforce.org](http://autoworkforce.org)

## AMT 1071

### Introduction to Basic Electricity

- Lab 1: Electrical Safety
- Lab 2: Sources of Electricity
- Lab 3: Ohmmeter Lab Project
- Lab 4: Open & Closed Circuits
- Lab 5: Components & Schematic Symbols
- Lab 6: Voltage & Current Meter Measurements
- Lab 7: Ohm's Law
- Lab 8: Watt's Law
- Lab 9: Resistance in Series Circuits
- Lab 10: Current in Series Circuits
- Lab 11: Voltage in Series Circuits
- Lab 12: Effects of an Open in Series Circuits
- Lab 13: Effects of a Short in Series Circuits
- Lab 14: Variable Resistors
- Lab 15: Equivalent Resistance of a Parallel Circuit
- Lab 16: Voltage in Parallel Circuits
- Lab 17: Current in Parallel Circuits
- Lab 18: Effects of an Open in Parallel Circuits
- Lab 19: AC Sine Wave Generation
- Lab 20: Magnetism
- Lab 21: Magnetism -- Electromagnetism (Relay)



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# Rubric

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	<b>Tool Selection and Use</b>		<i>Highly Proficient A</i>	<i>Competent B</i>	<i>Partially Competent/ Developing C</i>	<i>Limited D</i>	<i>Major Improvement Required E</i>
3	Selection of equipment	25	Correctly and efficiently selected equipment				Incorrect selection of equipment
4	Correct set up	25	Correctly set up the equipment for readings		Somewhat correct		Incorrect set up
5	Use of Meter	25	Correctly and efficiently connected meter to device		Somewhat efficiently		Had to have assistance in connecting the meter to device
6	Care and use of tools	15	Handled tools carefully and respectfully		Mishandled one or more of the tools		Showed disrespect for the tools



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	<b>Troubleshooting Skills</b>		<i>Highly Proficient A</i>	<i>Competent B</i>	<i>Partially Competent/ Developing C</i>	<i>Limited D</i>	<i>Major Improvement Required E</i>
7	Sequence of diagnosing problem	20	Used a logical sequence to locate the problem		Used a trial and error approach but was able to locate the problem		Was unable to locate the problem
8	Efficient use of time	15	Finished tasks on or ahead of time		Barely finished task in allocated time		Did not complete task
9	Accurately diagnosed condition of component	25	Correctly diagnosed condition of all 8 components		With assistance was able to diagnose condition of at least 6 components		Could not diagnose condition of 4 or more of the components



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			<i>Highly Proficient A</i>	<i>Competent B</i>	<i>Partially Competent/ Developing C</i>	<i>Limited D</i>	<i>Major Improvement Required E</i>
	<b>Work Habits</b>						
10	Work Attitude	15	Alert to finding and correcting problem		Honestly attempted to find and correct problems		Showed frustration in finding and correctly problem
11	Work Procedure	25	Always followed standard procedures; demonstrated planning and organization skills in correcting the problem		Complied with standard procedures; Showed some plan and organization in working		Did not follow standard procedures; Disorganized and slipshod methods;
12	Professionalism	20	Work showed pride in accomplishment		Tried hard and shows promise		Work lacks praiseworthy factors
13	Self-confidence	15	Appeared comfortable and posed when performing tasks		Fairly self-confident; occasionally disconnected		Hesitant, timid, uncertainty
14	Knowledge of job	25	Has an exceptionally thorough knowledge of the job		Has good knowledge but needed coaching		Has inadequate knowledge of job

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## AMTEC Standards, Curriculum, & Assessments

AMTEC Skills  
Standards

Module/Courses  
Content

AMTEC  
Assessments





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# Curriculum

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## AMTEC Standards, Curriculum, & Assessments

AMTEC Skills  
Standards

Module/Courses  
Content

AMTEC  
Assessments



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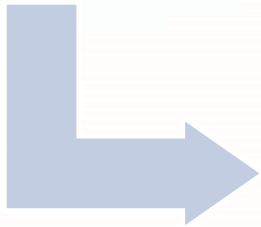
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# Assessment Goals

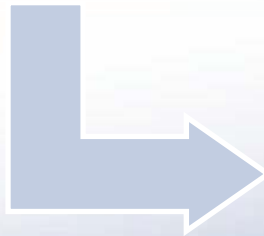
110  
Standards

- 2 versions of Comprehensive Test –
- 19 topic areas and 110 standards



13  
courses

- 13 End-of- Course (topic level) Assessments



59  
modules

- 59 pre- and 59 post- tests

# Assessment Plan Details

## 110 Standards

- Aligned to Standards
- 2 versions
- Developed by Industry
- NOCTI Business Solutions

## 13 courses (topics)

- Aligned to Subset of Standards
- 13 tests
- Developed by Industry
- NOCTI Business Solutions

## 59 modules

- Aligned to Student Learning Outcomes
- 59 pre- and 59 post-tests
- Developed by Faculty
- Offered in LMS



**AMTEC**

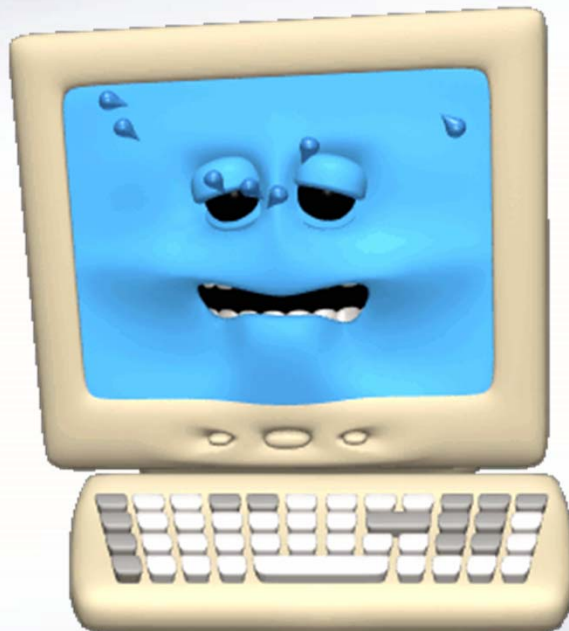
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# Comprehensive Assessment



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# Duty Specification for Core

		Fundamental	Percent	200 Items	Grand Mean N=52
A	MECHANICAL EQUIPMENT	x	6%	11	3.08
B	PNEUMATIC/HYDRAULIC EQUIPMENT	x	5%	11	3.04
D.	PREDICTIVE/CORRECTIVE MAINTENANCE	Knowledge	5%	10	2.77
E	BLUEPRINT READING/SCHEMATICS	x	6%	12	3.28
F	EQUIPMENT CONTROLS AND SENSORS	x	6%	12	3.38
G	ELECTRICAL EQUIPMENT	x	6%	13	3.57
H	ELECTRONIC EQUIPMENT	Intro	4%	8	2.35
I	NETWORKING	Intro	4%	8	2.34
J	PLC EQUIPMENT	x	6%	13	3.56
L.	ROBOTS	x	5%	11	3.03
M	RESISTANCE WELDING	x	3%	7	1.92
O	FABRICATE	x	4%	9	2.47
P	COMPUTER LITERACY	x	6%	12	3.43
Q	PREVENTATIVE MAINTENANCE	x	6%	12	3.40
U	SPECIALIZED MACHINERY	x	5%	10	2.82
V	METROLOGY	x	5%	9	2.56
W	SAFETY AND DOCUMENTATION	x	7%	13	3.67
X	LASER ETCHER	Intro	3%	5	1.43
Y	AUTOMATIC WELDER	x	3%	7	1.84
Z	SPECIALIZED EQUIPMENT	x	3%	5	1.44
			100%	200	

# Test Specification by Task

			Fundamental	Items Needed	Items Have	Grand Mean N=52
<b>E</b>		<b>BLUEPRINT READING/SCHEMATICS</b>				
	<b>41</b>	<b>Interpret mechanical drawings</b>	x	3	0	3.60
	<b>42</b>	<b>Interpret pneumatic and hydraulic drawings</b>	x	3	32	3.48
	<b>43</b>	<b>Interpret electrical schematics</b>	x	3	49	3.73
	<b>44</b>	<b>Interpret piping and instrumentation diagram (P&amp;ID)</b>	x	2	0	2.96
	<b>45</b>	<b>Operate basic drafting software (AutoCAD or Visio)</b>	Introduction	2	0	2.62





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## Cut Score

- *“Is it essential that a candidate answer this item correctly in order to be certified as a Multi-Skilled Automotive Maintenance Technician by AMTEC”?*





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## A MECHANICAL EQUIPMENT

1. A1-2. The purpose of having a clutch connecting two shafts together is to \_\_\_\_\_.
  - a. allow two shafts to be connected while running \* (65.4)
  - b. multiply the torque of the drive shaft (16.2)
  - c. allow for easier assembly and disassembly of the drive system (11.0)
  - d. change the direction of rotation (6.6)
  
2. A2-2. Gear teeth require clearance at the contacting point for proper operation. This is also called what?
  - a. Working depth (38.2)
  - b. Backlash \* (44.7)
  - c. Addendum (7.9)
  - d. Chordal thickness (6.6)



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# Passing Score

Test Category	Number of Test Questions	Percent Required for Passing
A: Mechanical Equipment	13	76.9%
B: Pneumatic/Hydraulic Equipment	14	78.6%
D: Predictive/Corrective Maintenance	8	87.5%
E: Blueprint Reading/Schematics	13	76.9%
F: Equipment Controls and Sensors	12	83.3%
G: Electrical Equipment	11	81.8%
H: Electronic Equipment	8	75.0%
I: Networking	8	75.0%
J: PLC	13	92.3%
L: Robots	10	90.0%
M: Resistance Welding	7	85.7%
O: Fabricate	8	87.5%
P: Computer Literacy	11	100.0%
Q: Preventative Maintenance	12	75.0%
U: Specialty Equipment	10	80.0%
V: Metrology	7	85.7%
W: Safety and Documentation	13	76.9%
X: Laser Etcher	5	80.0%
Y: Automatic Welder	4	75.0%
Total Number of Items Deemed Essential	187	154
Total Number of Items		187
Percent Required for Passing		<b>82.4%</b>

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# Comprehensive Test

MAGNET (Ohio)

- Cuyahoga Community College
- Lorain Community College
- Lakeland Community College

Toyota

- TMMI—Ivy Tech
- TMMK—Bluegrass Community & Technical College

General Motors

- Pune, India
- Flint—Mott Community College
- Orion Plant—Oakland Community college
- UzDaewooAuto

BMW

- Spartanburg Community College

Severstal

- Henry Ford Community College

Nissan

- Smyrna-Tennessee Technology Center—Murfreesboro

Somerset Community  
College

- Industrial Maintenance Completers

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## 2012 Comprehensive Test

1,627 tests

7 passed with 82.4%

- 3 incumbent workers from TMMK
- 4 Nissan North America--Smyrna





# Comments on Test

## Positive

- Great diagnostic tool on 19 topic areas

## Negative (validity and relevancy concerns)

- Too easy (yet few pass)
- Some items not relevant for specific plants
- Too short for 19 topic areas (187 items total)
- Many items are too “book”-related content—not application-related



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# Data

[autoworkforce.org](http://autoworkforce.org)

Test Category	Number of Test Questions	Recalculated Average Score	Passing Score Established by Panel	Percent of Pilot Group that would have passed Basic level by section N=228
A: Mechanical Equipment	13	69.7%	76.9%	49%
B: Pneumatic/Hydraulic Equipment	14	65.7%	78.6%	35%
D: Predictive/Corrective Maintenance	8	44.8%	87.5%	2%
E: Blueprint Reading/Schematics	13	48.4%	76.9%	5%
F: Equipment Controls and Sensors	12	61.8%	83.3%	14%
G: Electrical Equipment	11	57.9%	81.8%	17%
H: Electronic Equipment	8	57.9%	75.0%	33%
I: Networking	8	40.7%	75.0%	11%
J: PLC	13	60.8%	92.3%	7%
L: Robots	10	75.8%	90.0%	38%
M: Resistance Welding	7	60.8%	85.7%	21%
O: Fabricate	8	63.5%	87.5%	20%
P: Computer Literacy	11	70.2%	100.0%	9%
Q: Preventative Maintenance	12	67.8%	75.0%	50%
U: Specialty Equipment	10	70.8%	80.0%	49%
V: Metrology	7	52.6%	85.7%	5%
W: Safety and Documentation	13	64.6%	76.9%	31%
X: Laser Etcher	5	33.4%	80.0%	7%
Y: Automatic Welder	4	52.5%	75.0%	40%
Total Number of Items Deemed Essential	187	60.7%	82.4%	1%



# Participant Feedback

## Duty Level

		Number of Items	Your % Correct	Comment
A	MECHANICAL EQUIPMENT	13	69.2%	N.I.
B	PNEUMATIC/HYDRAULIC EQUIPMENT	14	78.6%	N.I.
D	PREDICTIVE/CORRECTIVE MAINTENANCE	8	37.5%	N.I.
E	BLUEPRINT READING/SCHEMATICS	13	69.2%	N.I.
F	EQUIPMENT CONTROLS AND SENSORS	12	83.3%	pass
G	ELECTRICAL EQUIPMENT	11	63.6%	N.I.
H	ELECTRONIC EQUIPMENT	8	75.0%	pass
I	NETWORKING	8	37.5%	N.I.
J	PLC EQUIPMENT	13	76.9%	N.I.
L	ROBOTS	10	90.0%	pass
M	RESISTANCE WELDING	7	100.0%	pass
O	FABRICATE	8	75.0%	N.I.
P	COMPUTER LITERACY	11	90.9%	N.I.
Q	PREVENTATIVE MAINTENANCE	12	75.0%	pass
U	SPECIALIZED MACHINERY	10	80.0%	pass
V	METROLOGY	7	71.4%	N.I.
W	SAFETY AND DOCUMENTATION	13	76.9%	pass
X	LASER ETCHER	5	40.0%	N.I.
Y	AUTOMATIC WELDER	4	100.0%	pass
		187	73.8%	N.I.

# Participant Feedback

## Task Level

J		PLC EQUIPMENT	# Items	Your % Correct
	70	Create/modify/monitor PLC programs	2	100.0%
	71	Program/maintain operator interface software	2	100.0%
	72	Troubleshoot communication systems in PLC	2	50.0%
	73	Replace PLC processor	2	100.0%
	74	Perform backups of PLC software programs	2	50.0%
	75	Install/maintain PCL hardware	2	100.0%
	76	Edit/Program PLC	1	100.0%
L.		ROBOTS	# Items	
	83	Install/Maintain robot systems	6	50.0%
	84	Program/edit robot software	4	75.0%
M		RESISTANCE WELDING	# Items	
	85	Perform visual inspection of resistance welding equipment operation	1	100.0%
	86	Align components in resistance welding equipment	1	100.0%
	87	Repair/replace failed components in resistance welding equipment	1	100.0%
	89	Perform parameter adjustments (weld conditions) on resistance and stud welding	1	0.0%
	90	Troubleshoot/repair/replace location pins and datum surfaces	1	100.0%
	91	Maintain cooling system in resistance welding equipment	1	0.0%
	92	Perform resistance checks (resistance of cable and condition of insulators)	1	100.0%
O		FABRICATE	# Items	
	97	Perform pipefitting tasks	2	100.0%
	98	Operate machining equipment	3	66.7%
	99	Operate welding equipment for fabrication	3	66.7%

# Program Feedback

## By Task

<b>E</b>		<b>BLUEPRINT READING/SCHEMATICS</b>	<b># Items</b>	<b>% of Group Correct</b>
	<b>41</b>	<b>Interpret mechanical drawings</b>	<b>3</b>	<b>68.7%</b>
	<b>42</b>	<b>Interpret pneumatic and hydraulic drawings</b>	<b>3</b>	<b>24.9%</b>
	<b>43</b>	<b>Interpret electrical schematics</b>	<b>3</b>	<b>53.1%</b>
	<b>44</b>	<b>Interpret piping and instrumentation diagram (P&amp;ID)</b>	<b>2</b>	<b>72.7%</b>
	<b>45</b>	<b>Operate basic drafting software (AutoCAD or Visio)</b>	<b>2</b>	<b>30.8%</b>
<b>F</b>		<b>EQUIPMENT CONTROLS AND SENSORS</b>	<b># Items</b>	<b>% of Group Correct</b>
	<b>46</b>	<b>Troubleshoot/replace/install circuit boards</b>	<b>1</b>	<b>74.3%</b>
	<b>47</b>	<b>Install/maintain/troubleshoot photo eyes</b>	<b>1</b>	<b>9.3%</b>
	<b>48</b>	<b>Install/maintain/troubleshoot servo motors</b>	<b>2</b>	<b>59.3%</b>
	<b>49</b>	<b>Install/maintain/troubleshoot VFD drives (Variable Frequency Drive)</b>	<b>2</b>	<b>45.6%</b>
	<b>50</b>	<b>Install/maintain/troubleshoot limit and proximity switches</b>	<b>2</b>	<b>96.0%</b>
	<b>51</b>	<b>Troubleshoot/calibrate/adjust and replace sensors and input devices</b>	<b>2</b>	<b>84.1%</b>
	<b>52</b>	<b>Calibrate process control loop (PID)</b>	<b>1</b>	<b>63.6%</b>
	<b>53</b>	<b>Troubleshoot/replace transducers</b>	<b>1</b>	<b>48.6%</b>



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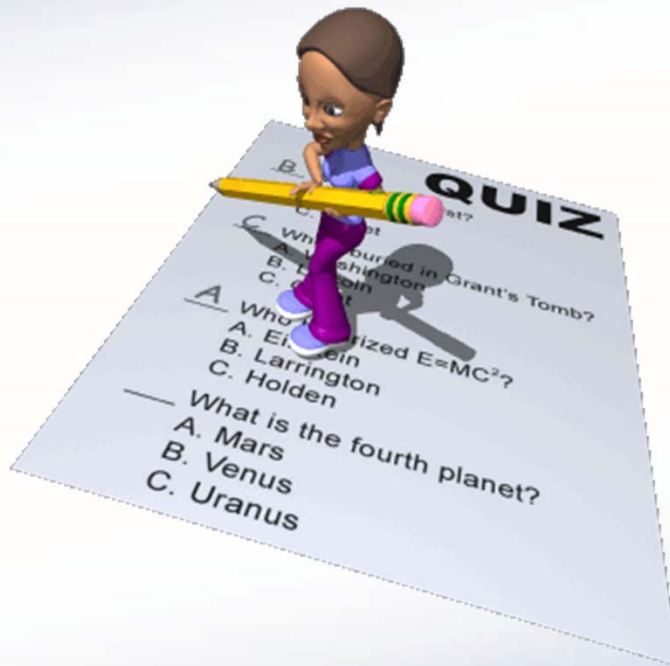
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# End-of-Course Assessments





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# 12 tests

[autoworkforce.org](http://autoworkforce.org)

		Number of Sections/Modules	Number of Test Items
1	Fluid Power and Electrohydraulics/pneumatics	7	149
2	General PM and Predictive Maintenance	5	100
3	PLC [ALLEN BRADLEY/ROCKWELL]	4	161
4	Blueprint Reading/Schematics	2	151
5	Robotics--Fanuc	5	83
6	Controls & Instrumentation	4	152
7	Basic Electricity and Electronics	4	150
8	Mechanical Systems/Mechanical Drives/Power Transmissions	6	152
9	Safety	4	137
10	Computer Literacy	4	116
11	Welding and Fabrication	4	169
12	Machine Tool Operations	7	179



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# Test Spec

<b>A</b>		<b>AMT1071: Introduction to Basic Electricity</b>	<b># items</b>
	1	Demonstrate knowledge of basic electrical principles	11
	2	Interpret electrical schematics	14
	3	Install/replace wire	13
<b>B</b>		<b>AMT 1072: Instruments</b>	<b># items</b>
	4	Demonstrate knowledge of instruments	14
	5	Operate electrical/electronic test equipment	19
<b>C</b>		<b>AMT 1073: Component &amp; Circuits</b>	<b># items</b>
	6	Demonstrate knowledge of components and circuits	13
	7	Install/maintain relays	12
	8	Install/replace fuses and circuit breakers	14
<b>D</b>		<b>AMT 1074: Solid State Drives</b>	<b># items</b>
	9	Demonstrate knowledge of solid state drives	18
	10	Maintain/install fiber optics	6
	11	Troubleshoot/repair/replace vision systems	4
	12	Install/maintain/troubleshoot bar code readers	4
	13	Perform startup and shut down of laser etcher	8
			150





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# Pilot Test

[autoworkforce.org](http://autoworkforce.org)

- The pilot test is free to industry and candidates
- Industry will receive diagnostic feedback on the results once the test is finalized
- Pilot test candidates will receive feedback on the results



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# Validate

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## Industry Pilot Test

- Establish Cut Score

## Uses

- Industry and Schools
- Diagnose to the module level



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# Pre- and Post Module Assessments

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# Curriculum

## DACUM

2		Troubleshoot/repair/replace gears
	a	Perform visual inspection: alignment, worn/missing teeth, cracked teeth, etc.
	b	Inspect gear to shafts for fitting (looseness, etc.)
	c	Replace gear
	d	Set clearances
	e	Set backlash
	f	Check oil level
	g	Check grease lines for function
	h	Apply predictive technology (vibration analysis, ultrasonic, oil analysis)
	i	Select and use correct lubrication

## 61 Student Learning Outcomes

	AMT 1086—Gears and Cams
A	Gear and cam maintenance safety.
B	Describe the purpose and function of gears and gear drives.
C	Open gears.
D	Enclosed gears.
E	Seals, breathers, and lubrication.
F	Gear ratings and application and selection.
G	Industrial cam follower functions, uses, and terms.
H	Industrial cam follower bushing types and operating clearances.
I	Gear identification.
J	Assemble a parallel shaft gear drive.
K	Assemble an angle shaft gear drive.
L	Assemble a worm and wheel gearbox drive unit.
M	Identify the common types of cam followers and rod ends.
N	Replace, install, and adjust cam followers and rod ends.



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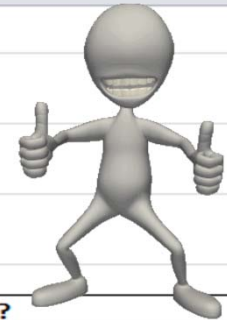


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# Industry Review

A6		R3		F	
A	B	C	D	E	F
1	<b>RELEVANCE RATING</b>	<b>DIFFICULTY RATING</b>			AMT 1071--Introduction to Basic Electricity (Pre-Test)
2	R1-Low Relevance to Training Needs	D1-Low Difficulty			
3	R2-Moderate Relevance to Training Needs	D2-Moderate Difficulty			
4	R3-High Relevance to Training Needs	D3-High Difficulty			
5					
6	R3	D2	1	A1.	<b>What is the lethal range of electrical current on the human body?</b>
7				a.	Less than 8mA
8				b.	From 8 to 20 mA
9				*c.	Greater than 20 mA
10				d.	Greater than 200 mA
11					
12	R1	D1	2	A2.	<b>NIOSH recommends which of the following for controlling electrical hazards?</b>
13				a.	Ensuring that frayed or damaged wires do not feel hot to the touch
14				*b.	Ensuring the use of GFCIs in all wet or damp areas
15				c.	Ensuring a circuit is de-energized by tapping it with a non-conductor
16				d	Ensuring a Category 1 meter is used
17					
18	R3	D2	3	A2.	<b>An electric ground wire</b>
19				a.	is typically the white wire in a basic electrical system
20				b.	is typically the black wire in a basic electrical system
21				*c.	provides a safe path for electricity should a ground or short occur
22				d	provides a return path for current
23					
24	R2	D2	4	A3.	<b>What is the greatest immediate danger after a person has received a severe electrical shock?</b>
25				a.	Unconsciousness
26				*b.	Heart fibrillation
27				c.	Hypothermia
28				d.	Severe burns





## Continuous Improvement

Data is analyzed to determine mastery



	Item	Q001	Q002	Q003	Q004	Q005	Q006	Q007	Q008	Q009	Q010	Q011
	Task Link	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2
	Key	4	4	1	2	3	3	1	1	1	3	1
Adam	87.2%			2								
Randy	77.4%			2				3	4			
David	76.6%			2					2	2		
George	74.0%			2						2		4
Joe	69.4%	3		2	1					2		
Chris	68.5%			2						3		
Mary	68.1%			2	3							
Laura	66.4%			2					4			4
Ali	64.7%	1	2	2	4	2				3		
Tom	63.4%			4					2			
Jack	62.1%			3	1				2	2		
Sid	61.3%	3		2	1					2		
James	58.3%	3	3	3	1	2		4		3		
Steve	57.9%	3		2	1				4	2		
Mike	26.8%	2		2	4	2	1	4	2	4	1	2





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