

SAMPLE INDUSTRIAL MAINTENANCE MACHINIST/MECHANIC CURRICULUM **(With potential Student Learning Outcomes)**

This document was created for use as a guide for dialogue between community colleges that have Industrial Maintenance Machinist/Mechanic (IMMM) related programs and their industrial partners, to help insure that what colleges are teaching aligns with industry's hiring needs. In the development of this document it became clear that arriving at a "core" curriculum that would meet all of industry's needs was not possible due to differing needs by industry, and differences of college opinion on how best to meet those needs. Hence consensus on this document was not sought – rather it should be used as a guide for dialogue with local industry partners to refine curriculum.

Content found herein was informed by the following:

- Laney College (Louis Quindlen's) Industrial Maintenance Technology Certificate curriculum
- A survey created by Mark Martin, responded to by 19 industry partners representing 15 companies/agencies as follows:
 - Anheuser-Busch
 - Calbee America, Inc.
 - City of Fairfield
 - City of San Jose
 - East Bay Municipal Utility District (EBMUD)
 - North Coast County Water District
 - San Francisco Sewage Department
 - Shell Oil
 - Tesoro Corporation
 - Unico Mechanical
 - Union Sanitary District
 - USS-POSCO
 - Wood Group
 - Wood Group Field Services
 - Zone 7 Water Agency
- Work done by David Kail to collect and synthesize internal training curriculum, intern and staff job descriptions and hiring announcements from the following industry partners:

○ California Tooling and Machine Apprenticeship Association	○ Metropolitan Water District of Southern California
○ City of Vallejo	○ Shell Oil
○ County of Alameda	○ USS-POSCO
○ East Bay Municipal Utility District (EBMUD)	○ Union Sanitary District
	○ Zone 7 Water Agency
- Work done in small groups to provide feedback and comments at the September 22, 2011 IMMM Meeting attended by 35 individuals representing 9 colleges and 14 industry partners

Suggestions follow for potential courses. An estimate of the instructional hours has also been made (1 college unit is approximately 18 hours of lecture plus homework; 1 college unit of laboratory hands-on time is approximately 54 hours). IMMM course makeup, content and instruction time are all part of the community college and industrial partner discussion.

SAMPLE INDUSTRIAL MAINTENANCE MACHINIST/MECHANIC CURRICULUM

- Safety should be incorporated into every course, rather than a stand-alone safety course
- Students are encouraged to take Shop and Field Maintenance I as an introductory career exploration course

	Lecture Units	Lab Units	Total Units
MACHINING I	3	2	5
MACHINING II	3	2	5
INDUSTRIAL HYDRAULICS AND PNEUMATICS	2	1	3
SHOP AND FIELD MAINTENANCE I	1	2	3
SHOP AND FIELD MAINTENANCE II	1	2	3
INTRODUCTION TO WELDING	2	1	3
BASIC ELECTRICITY	2	1	3
BLUEPRINTS, MECHANICAL DRAWING, AND DRAWINGS	3	0	3
BASIC DRAFTING	2	1	3
MATHEMATICS FOR TECHNICIANS	3	0	3
INTRODUCTION TO COMPUTER SOFTWARE	1	0	1
TECHNICAL READING AND WRITING	2	0	2
			37

Example Student Schedule:

PREREQUISITES: Arithmetic, Eligibility for Technical Reading and Writing

Semester I:

BLUEPRINTS, MECHANICAL DRAWING, AND DRAWINGS	3 units
SHOP AND FIELD MAINTENANCE I	3 units
MATHEMATICS FOR TECHNICIANS	3 units
BASIC ELECTRICITY	3 units
	12 units

Semester II:

MACHINING I	5 units
SHOP AND FIELD MAINTENANCE II	3 units
INDUSTRIAL HYDRAULICS AND PNEUMATICS	3 units
TECHNICAL READING AND WRITING	2 units
	13 units

Semester III:

MACHINING II	5 units
INTRODUCTION TO WELDING	3 units
INTRODUCTION TO COMPUTER SOFTWARE	1 unit
BASIC DRAFTING	3 units
	12 units

Below is the DRAFT IMMM Curriculum that was reviewed at the 9/22/11 meeting including a synthesis of industry and other feedback (in red), all of which was used to inform the Sample Curriculum above. We thought it would be useful to colleges to have the actual feedback provided by industry that ultimately led to the Sample Curriculum above.

DRAFT IMMM Curriculum – 56 units
College General Requirements – 7 units

Total Curriculum for a California Certificate of Achievement – 63 units
(Full time students may take 12 to 18 units per academic semester, so this equates to 4 semesters (2 years) of full-time attendance).

INTRODUCTION TO INDUSTRIAL MAINTENANCE MACHINIST / MECHANIC	7 units
MATHEMATICS AND COMPUTER SKILLS	2 units
BLUEPRINTS, MECHANICAL DRAWING, AND DRAWINGS	3 units
MACHINING I	15 units
HAND AND POWER TOOLS	1 unit
WELDING AND FABRICATION	12 units
INDUSTRIAL HYDRAULICS AND PNEUMATICS	3 units
INTRODUCTION TO PIPEFITTING	5 units
SHOP AND FIELD MAINTENANCE I (predictive, preventive, and repair)	4 units
SHOP AND FIELD MAINTENANCE II (pump, valve and equipment repair)	4 units
	56 units

INTRODUCTION TO INDUSTRIAL MAINTENANCE MACHINIST / MECHANIC – 5+2 units

PROPOSED CONTENT	YOUR THOUGHTS <small>Use this space to provide written feedback</small>
<p>Identifies and demonstrates understanding of the basic operating principles and applications of:</p> <ol style="list-style-type: none"> 1. Pumps: horizontal, vertical, end suction 2. Motors 3. Valves 4. Regulators: mechanical, hydraulic actuated 5. Pneumatic tools 6. Hydraulic systems 	<p>Basic electricity only: 1 phase and 3 phase?</p> <p>The introduction should include all of the six listed topics.</p> <p>Include guest industry speakers on interview skills, some information about hiring practices.</p> <p>To use this course to attract students it should not be more than 3 units as an introduction course. Any more units than that would discourage students for an “exploring” the career option. It should also have hands-on skills. Some of the identified skills could be approached with less units in the introductory class and then they could be included in more than one of the other classes.</p> <p>Other types of pumps to include are centrifugal, positive displacement, and gear pumps.</p> <p>The first 6 are basic and fundamental for employees. Consider adding geared drives and piping systems.</p> <p>Consider adding an introduction to pump curves.</p> <p>Types of pumps to include centrifugal, open / closed impeller, vortex, piston, progressive cavity, diaphragm, gear, lobe, and hose.</p> <p>Include mechanical drives such as chain and gear systems.</p> <p>Add gear drive systems.</p> <p>Add more detail on the list of different kinds of pumps.</p> <p>Include knowledge of gear drives and types of mechanical drive systems.</p> <p>If you have a pump program and could offer a certificate, that would be great.</p>

Maintain elementary records properly such as PM reports

1. Prepares and maintains a wide variety of basic shop and field work records, including work orders and PM requests.
2. Prepares and maintains oral and written records of supplies, materials, equipment used, and work performed.

Safety: (30 hour OSHA safety class)

1. Applies craft safety skills and safe work practices in operating shop tools, hand and power tools and equipment.
2. Obtains work area permits (operations, hot work, radiation, etc.) and rigorously follows procedures before beginning work.
3. Identifies confined space entry situations and rigorously follows procedures to ensure safe atmospheres for workers. Works comfortably in tight spaces.
4. Properly secures worksite to ensure pedestrian, traffic and worker safety.
5. Lifts up to 90 pounds safely using proper lifting techniques.

A more general machinist and welding program can cover quite a bit of this with some of these topics being what is discussed that day.

Include the functionality of basic pumps and the parts of the pump.

Include gear drives.

Maintaining records is important to an industrial machinist / mechanic's role.

Students may need a writing skills class and internet skills to be successful.

Emphasize maintaining PM records.

A technical writing course would be helpful for PM records like reports and memos. Also include CMMS / spare parts management, planning a work job (checklist / completeness), and troubleshooting.

Need to be able to write an understandable report.

Add a basic reading and writing course.

A basic quality control class might be included.

The student should be able to write reports in a narrative format.

General sense of what certificates are available rather than offer the 30 hour OSHA class.

Safety should be generic because each company must train their employees in safety as part of OSHA PSM (project safety management).

Overview of regulations is enough.

Consider offering Hazwoper certificate and OSHA certificates as electives.

I don't see spending 30 hours on this. You can let them know these types of requirements exist in 2 hours. The agencies (employers) will give them the specifics.

- 6. Climbs ladders safely and works comfortably in high job locations.
- 7. Operates a motor vehicle safely and efficiently.
- 8. Prepares the worksite for the job and cleans up after the job is done.

Journey-level + facility specific knowledge

We don't need the person to come to the job with the OSHA certificate. We provide safety training. We just need them to know they will have to work safely and follow regulations.

Break this up into:

- 1. Introduction to Safety (taught at the beginning of the program)
- 2. Elective class to get OSHA certificate
- 3. BATC card preferable to OSHA certificate.

Most companies have mandatory safety training for trades employees. New hires must take this training even if they have the OSHA certificate because employers have to maintain safety training records and certify that their employees are safety trained for their specific work environment and equipment.

Very important because they need to have a safe work attitude on Day 1. Companies will reiterate this over and over throughout their career. But it needs to be fundamental to how they think and perform.

Consider adding a section on confined space entry. Consider including tapes and barricades as well as safe use of fork trucks, lifts, cranes and rigging safety.

There is too much safety for an introduction class. Safety should be spread throughout the curriculum.

Include lock out / tag out training.

This may be general safety. Employers want to know that a worker can and will work in a safe manner.

Employers will be sent to confined space training and will test for the ability of an employee to lift 90 pounds safely.

Blend EPA, OSHA, FDA, BAAQMD, OSHA, DOT, and other regulations at an apprenticeship level

<p>Work Attitude:</p> <ol style="list-style-type: none"> 1. Demonstrates character and passion for excellence in the workplace. 2. Demonstrates a willingness and enthusiasm to learn. 3. Works independently to complete work assignments. 4. Follows written and oral instructions and uses a management of change process to correct instructions as required. <p>Interpersonal Skills:</p> <ol style="list-style-type: none"> 1. Establishes and maintains effective working relationships with those encountered in the course of the work. 2. Utilizes effective conflict resolution skills. <p>Leadership:</p> <ol style="list-style-type: none"> 1. Directs plant maintenance laborers as assigned. 2. Establishes good working relationships with maintenance supply vendors. 	<p>(non-management). The course should be introductory and not detailed or specific.</p> <p>Students need an introduction to safety to understand the importance of safety, but they don't need a certificate. Employees will be trained extensively in house.</p> <p>Keep the 30-hour OSHA training.</p> <p>An overview of regulations (environmental law, OSHA) and identifying and studying state and federal agencies might be worthwhile.</p> <p>The safety portion should be first in the training so that students understand that safety is first and where to get information. Also include CalOSHA and how the webpage is set up.</p> <p>Soft skills are important to industry.</p> <p>Interview and resume skills should be included. Consider having guest lecturers from industry to give students more background into what is expected in their careers.</p> <p>A good work attitude is very important.</p> <p>Soft skills are important.</p> <p>The work attitude training is good, but it should not be too in depth. The rights and wrongs of work attitude should be included.</p> <p>Interpersonal skills are fundamental to working in industry.</p> <p>Be a follower. We have a large age gap in industry for over 60 years old to 25 year old.</p> <p>Include organizational behaviors.</p> <p>We do not expect our machinists to be leaders.</p> <p>Our mechanics do not direct plant maintenance laborers. Our machinists also don't need good working relationships with maintenance supply vendors. We provide their supplies.</p>
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	<p>Eliminate the leadership section.</p> <p>An introductory course is excellent. Students need a basic introductory course to be prepared for the career that they are entering.</p> <p>Also, attitude and interpersonal skills are the <u>most</u> important factors in hiring. The rest is easy.</p> <p>Leadership should include teamwork as well. The topic should cover a basic understanding of teamwork principles such as roles and responsibilities of team members, meeting team objectives, progress, and adjusting to objective revisions.</p> <p>Include team-building exercises.</p> <p>Discuss managing budgets as a soft skill.</p>
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MATHEMATICS AND COMPUTER SKILLS – 2 units

PROPOSED CONTENT	YOUR THOUGHTS <small>Use this space to provide written feedback</small>
<ol style="list-style-type: none"> 1. Demonstrates and appropriately utilizes technical (shop) mathematics to solve typical machining lay out problems. 2. Adds, subtracts, multiplies, and divides fractions. 3. Converts fractions to decimals and decimals to fractions. 4. Calculates the overall distance using tolerances and equipment measurements. 5. Converts measurements from the English system to the Metric system and from the Metric system to the English system using equivalency factors. 6. Inputs information into computer programs such as Microsoft Word, Excel, and other programs as required. 	<p>Shop math is all that should be required. Be sure that the math is contextualized.</p> <p>25% of employees do not have basic math skills. The percentage may be higher for college students.</p> <p>Math courses should include at least elementary algebra and geometry.</p> <p>Employees need to be able to navigate spreadsheets but don't need to have extensive knowledge of how to create spreadsheets.</p> <p>Math skills are important. Although it may not be core, it is a good idea for employees to be able to input information into computer programs.</p> <p>A technical math course might combine algebra, trigonometry, geometry, and fractions / decimals.</p> <p>Don't want to scare people with math.</p> <p>Better to teach <u>applied</u> math. Integrate math</p>

skills development into blueprints and drawing class. (Can set prerequisite math skill level for certificate classes).

Employees use programs like SAP or Maximo or other work maintenance program.

This area would have a stronger “learning” if it was taught “contextually” with measuring and blue prints.

Math skills # 1 – 6 are very useful. Shop math should be enough for “entry level” employees to be prepared to pass the test.

Math skills are necessary and fundamental.

Consider adding e-mail / internet research skills.

Students need basic computer skills so that they can enter data into a database like Excel. They will not be required to build a spreadsheet but they will need the ability to navigate in the spreadsheet.

All of the math should be dealing with a machinist.

Shop math (technical math) with algebra and geometry.

Combine all math skill in a focused (contextualized) way.

Add PowerPoint, Microsoft Outlook, and CAD.

Consider adding database, computer based maintenance management systems, PowerPoint, and Outlook.

This is another area that is a component of machining especially.

The math should be contextualized to the specific program.

Add Outlook to the list of computer programs that a student needs to be able to use.

	<p>Add PowerPoint and Outlook.</p> <p>Basic computer literacy also an understanding of the capability of programs like CMMS work orders.</p>
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BLUEPRINTS AND DRAWINGS – 3 units

PROPOSED CONTENT	YOUR THOUGHTS Use this space to provide written feedback
<ol style="list-style-type: none"> 1. Reads and interprets basic orthographic drawings for component parts and systems (dimension lines, datum lines, measurements, and size tolerances). 2. Reads and interprets blueprints, mechanical drawings, designs, sketches, layout drawings, plans, specifications, shop drawings, service and repair manuals, and schematics. 3. Reads and interprets isometric drawings. 4. Sketches, dimensions and applies appropriate tolerances for equipment repair and/or component replacement. 5. Uses caliper dividers, steel rule, and scribe for precision layout and set ups. 6. Demonstrates an understanding of the properties of materials, including the effects of heat-treating . 7. Applies geometric dimensioning and tolerancing, 8. Sketches lay out drawings for maintenance work. 	<p>Blueprint and technical drawing reading is a very important, basic skill for employees.</p> <p>Consider including piping and instrument drawings (P&IDs).</p> <p>Technical drawing is an advanced skill that most mechanics will not need.</p> <p>Blueprint and technical drawing reading is a core skill. We want people who are good technicians. Our machinists are specialists.</p> <p>Blueprint reading and mechanical drawing are critical skill areas. This is the foundation for the development of fabrication and layout skills.</p> <p>An employee needs to understand engineering design.</p> <p>The chronology might follow the NiMs credential Machining Level I. Solid Works / AutoCad / CNC programming are all secondary skills and are dependent upon the industry that the individual is hired into. Job planning, benchwork, and layout are the fundamental skills.</p> <p>Water / Wastewater –</p> <ul style="list-style-type: none"> • Most blueprint drawings are 2 plane – not isometric. • Digitalizing our drawings now, so use of hand held devices will be implemented in the future. <p>Water / Wastewater and Refinery – #1 and #2 are the most important. #8 is a fundamental skill that is needed. #3 is not essential.</p>

In a laboratory part of the class teach sketches as complete working drawings to complete maintenance work.

#2 is the most important skill on the list.

An employee needs to know how to determine and confirm that they are using the latest version of a drawing or blue print.

#1 is focused on machining and will be learned as a person becomes a journey level machinist.

Blueprint and drawing is a fundamental skill that employees will need.

Basic drafting is all that is required.

1, 2, and 5 should be part of the machining training. Eliminate #3.

Blueprint reading is important to making a part.

Employees should be able to make a sketch. This needs to be part of a core.

Include both 2-dimensional and 3-dimensional isometric drawings.

Again a part of both machining and welding.

A basic traditional drafting class can get you there.

Basic drafting is enough. Can you visualize, draft, and understand what a given part does?

MACHINING I – 15 units

PROPOSED CONTENT	YOUR THOUGHTS <small>Use this space to provide written feedback</small>
<ol style="list-style-type: none"> 1. Sets up and machines tapers, 60 degree V-threads, boring (internal), facing, and grooving. 2. Sets up and fabricates pump parts such as a pump shaft. 3. Sets up and reduces the diameter of a pump impeller to a given diameter. 4. Sets up, indexes and machines general components for fabrication projects (brackets, etc.) and coupling replacements (drill and bore). 5. Sets up, drills, reams and bores bolt circle patterns, precision holes and machine tapping. 6. Performs radial and standard drill press work including precision drilling, reaming, and boring for various components (flanges, sheet metal fabrication, equipment housings, etc.). 7. Sets up and precision grinds drills, milling cutters/end mills, bearing journals, etc., using universal grinder and/or portable tool post grinder. 8. Demonstrates proficiency operating the following machining tools: <ol style="list-style-type: none"> a) Lathe b) Milling machine c) Band saw d) Drill press e) Grinder (both stationary and portable) 	<p>The National Institute of Metalworking Skills (NiMs) certificates are a very good idea. Industry would emphasize the basics and fundamentals over advanced skill certificates.</p> <p>Two semesters of machining are probably enough for this career.</p> <p>Introductory and intermediate machining skills are very important.</p> <p>Refinery and Water / Wastewater – Plant mechanics do not need extensive machining skills.</p> <p>Exposure to use of equipment like the lathe, etc.</p> <p>Need discussion / overview of industrial materials and corrosion prevention control. Add to shop and field maintenance class.</p> <p>This area probably needs more units; perhaps as many as 20 units total.</p> <p>Need to emphasize “materials” skills.</p> <p>In the first year of training students should be able to demonstrate enough proficiency in the five machine tools listed.</p> <p>Add tool cutting geometry to the five machine tool skills listed.</p> <p>Union Sanitation District contracts out the machining work. Mechanics do not need to know if parts are out of tolerance in order to give directions to a contract machine shop.</p> <p>Employees in this area need a fundamental knowledge of equipment and set-up but not a detailed machinist training.</p> <p>This type of work needs to be the focus of the first year. Might be part of the core.</p>

	<p>All of the tools listed under #8 are important.</p> <p>A list of student projects should be added and included as an attachment to the course documentation.</p> <p>#1 may be just a little too specific.</p> <p>#8 is a critical, basic skill. At the end we should know what they are and what they can do.</p>
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HAND AND POWER TOOLS – 1 unit

PROPOSED CONTENT	YOUR THOUGHTS <small>Use this space to provide written feedback</small>
<p>1. Identifies and demonstrates understanding of the basic operating principles and applications of hand and power tools used in the trade.</p> <p>a) Demonstrate the safe and proper use of typical hand tools such as hammer, file, torque wrench, and hand wrenches.</p> <p>b) Makes repairs using various hand and power tools, including drill motor, roto-hammer, pipe threading machines, taps and dies, impact wrench, hack saw, punch, files, etc.</p> <p>c) Identifies and applies precision measuring tools to check and measure machine work and equipment dimensions. Demonstrates basic skill in the use of tape measure, outside micrometer, dial indicator and Vernier caliper.</p> <p>d) Demonstrate the safe and proper use of typical stationary and portable power tools such as drills, saws, hydraulic presses, and grinders.</p> <p>e) Demonstrates proper operation of machine tools and equipment, including cutting tool speed selection, feed formula and work clamp technique.</p> <p>f) Demonstrate the safe and proper use of other work tools such as steel rules and scribes.</p>	<p>Include in the hand tools curriculum gas powered, hydraulic powered, and electric powered tools.</p> <p>This should not be a separate class but rather included in the introduction to machining and/or other classes in the curriculum.</p> <p>Proper use of hand tools is a very important skill to know.</p> <p>It would be good to cover this in the introduction class. This would make it more interesting and would give students an idea whether they actually like this kind of work, and would be useful for daily life.</p> <p>Combine the use of hand tools into the “introduction” class to give students more “hands-on” experience at the beginning of the curriculum.</p> <p># 1c is very important for entry-level employees. We have a tool identification test.</p> <p>Hand and power tool use will be a fundamental skill of mechanics.</p> <p>Power and hand tool identification tests will be given.</p> <p>Consider adding inventory management skills.</p> <p>Include gas, electric, and hydraulic power tools.</p>

	<p>This is the start of the whole program. If you can't use hand tools, then you can't work.</p> <p>Band saws, drill presses, and concrete core drilling tools should be included. In addition, training on different types of drill bits (wood, steel, concrete, hole saw, and hole boring) as well as sharpening drill bits could be included.</p>
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WELDING AND FABRICATION – 12 units

PROPOSED CONTENT	YOUR THOUGHTS <small>Use this space to provide written feedback</small>
<ol style="list-style-type: none"> 1. Fabricates and repairs components and equipment using a variety of welding equipment and techniques including gas (welding and brazing), electric arc, Mig and Tig. 2. Fabricates and repairs components and equipment using an oxyacetylene welder. 3. Demonstrates the safe and effective use of a cutting torch. 4. Welds a knee brace for structural support. 5. Fabricates and repairs equipment using a variety of metal alloys and materials (angle and channel iron, flat bar, round stock, pipe and sheet metal). 	<p>Include proficiency with a cutting torch in the welding curriculum.</p> <p>Mig and Tig welding are advanced skills that are not required for industrial mechanic careers.</p> <p>Probably, a single 3 unit course is enough for industrial jobs.</p> <p>This is not needed for my craft, but is a good background training and probably necessary for an all around program.</p> <p>This course is too long. Mechanics need to know oxy-acetylene but don't need to know full welding fabrication.</p> <p>A list of student projects should be added and included as an attachment to the course documentation.</p>

DUSTRIAL HYDRAULICS AND PNUEMATICS – 3 units

PROPOSED CONTENT	YOUR THOUGHTS <small>Use this space to provide written feedback</small>
<ol style="list-style-type: none"> 1. Industrial hydraulics (basic theory, maintenance & troubleshooting) 2. Overhauls operating cylinders for hydraulic cylinder valves, stackable valves, servo valves, including versa valves. 3. Industrial pneumatics (basic theory, maintenance & troubleshooting) 	<p>A single course for hydraulics and pneumatics is a good idea. The course should be at an introductory level.</p> <p>Consider including an introduction to gas compressors in the course.</p> <p>This course should be part of the curriculum.</p> <p>Applied physics in an industrial environment.</p> <p>This is not needed for my craft, but is a good background training and probably necessary for an all around program.</p> <p>Just an overview of hydraulics and pneumatics is all that is needed.</p> <p>Consider having the students construct an actual hydraulic system.</p>

INTRODUCTION TO PIPEFITTING – 5 units

PROPOSED CONTENT	YOUR THOUGHTS <small>Use this space to provide written feedback</small>
<ol style="list-style-type: none"> 1. Demonstrates proficiency in basic pipefitting and blinding techniques. 2. Completes a layout of the job before starting to fit the pipe. 3. Demonstrates the proper connection of flanged pipe including bring the fastener to the required torque. 4. Bends a section of pipe to the tolerances on a working drawing. 5. Bends a section of tubing to the tolerances on a working drawing. 6. Installs pipe saddles at appropriate distances to support the pipe. 7. Threads pipe using a pipe threading machine. 8. Connects pipe using a flash butt welder. 9. Connect pipe using a lap seam welder. 10. Replaces pipe insulation as required. 11. Selects appropriate fasteners for the 	<p>This course may not be required for industrial jobs because what will be needed will be taught on the job.</p> <p>Mechanics will blind lines, work with stainless steel, and may or may not cut threads in steel pipe.</p> <p>Consider including working with tubing if this course is offered.</p> <p>Mechanics may run electrical conduits as part of their job responsibilities.</p> <p>Consider including factors associated with buried piping and cathodic protection of piping systems.</p> <p>Need: pipe materials application</p>

<p>equipment and torques to the specification.</p> <p>12. Levels equipment using appropriate shimming practices.</p>	<p>#4 is not relevant. We don't want bent pipe.</p> <p>This is not needed for my craft, but is a good background training and probably necessary for an all around program.</p> <p>Include most common pipe materials and classes.</p> <p>This course is too long and could be reduced in size.</p> <p>Tube bending and fitting is very important.</p> <p>Include in the course copper, black iron, copper cleaning, soldering as well as black iron for steam and PVC for landscaping.</p>
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SHOP AND FIELD MAINTENANCE I (predictive, preventive, and repair) – 4 units

PROPOSED CONTENT	YOUR THOUGHTS Use this space to provide written feedback
<ol style="list-style-type: none"> 1. Troubleshoots and repairs chemical feed systems and components, including control valves, eductors, rotometers, etc. 2. Performs preventive maintenance and repairs on pumping and equipment. 3. Disassembles, cleans repairs, adjusts, calibrates, reassembles, and tests mechanical equipment, valves, and pumps. 4. Balances rotors for rotating equipment such as compressors and large pumps. 5. Inspects equipment using preventive maintenance techniques. 6. Completes oil checks on pumps, motors, coupling, bearings, and gear boxes. 7. Lubricates and exercises valves. 8. Completes vibration analysis on critical rotating equipment. 9. Performs mean time between failure analyses on selected equipment. 10. Monitors and inspects mechanical equipment on a prescribed schedule. 11. Performs predictive and diagnostic testing on equipment. 12. Performs routine oil checks on pump/ motor/ compressor bearing/gear housings, valve 	<p>This may be a lecture only class.</p> <p>I am not sure that our machinists do all this maintenance work (like oil checks). Maybe they need to understand that it all needs to be done.</p> <p>Need more units for this skills area. For plant mechanics this is the majority of their job (less machining).</p> <p>Mechanics need to perform intake inspections of parts, document the condition of the parts as found, and label / mark the components.</p> <p>An introduction to work management programs like SAP and Maximo would tie together computer skills with field maintenance.</p> <p>This is getting into the meat of the curriculum and is excellent.</p> <p>Add skills in material compatibility to select proper composition. Include pressure, temperature, and flow criteria to select the proper components for pumps.</p>

<p>lubrication and exercise, pressure settings for pilot control and test procedures, etc.</p> <p>13. Troubleshoots problems with oil systems, grease systems, and air-oil/oil mist systems.</p>	<p>Include the principles and purpose of corrosion control methods such as coatings, insulation, sacrificial components, and inspection, testing, and repair.</p> <p>This is great for the 2nd year of training.</p> <p>In item #2 add “creates a PM checklist”. Have students create a PM checklist in class.</p> <p>In item #6, include maintenance on valve packing.</p> <p>Add use of uni-struts (framework for plumbing, electrical, ladders and platforms, etc.)</p>
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SHOP AND FIELD MAINTENANCE II (pump, valve and equipment repair) – 4 units

PROPOSED CONTENT	YOUR THOUGHTS Use this space to provide written feedback
<ol style="list-style-type: none"> 1. Identifies and demonstrates understanding of the basic operating principles and applications of pump/ motor couplings. 2. Sets up and performs inspections (straightness, concentricity of diameters, shoulder fits, etc) and precision machine work (+/- .0005) on pump and motor shafts (thread types 29 degree Acme, 60 degree V American Standard, 60 degree metric), pump case rings and bearing housings. 3. Sets up and performs inspections and precision machine work (+/- .0005) to fabricate and repair pump and motor shafts and bearing housings (bolt hole circles, keyways (variety of geometric shapes), precision hole boring, etc. Troubleshoots motor and pump casings, bearing housings, case ring and seal body fit to determine required repairs (milling pockets, material build-up, re-machining, etc.). 4. Identifies, performs routine maintenance and replaces wear components on manual, mechanical, pneumatic, and electromechanical valves. 5. Mounts, installs, aligns, troubleshoots and makes skilled repairs to a wide variety of valves (altitude, pressure control, relief). 	<p>This is an important area to include in the training.</p> <p>This area is very important for the water industry.</p> <p>This is excellent.</p> <p>Mechanics need a basic understanding of AC / DC electricity, single phase and 3 phase, electrical energy lock out / tag out, and how to disconnect and reconnect motors. They will need to know how to use a volt ohm meter.</p> <p>This is great for a second year course.</p> <p>On item #4 add “creates”.</p> <p>On item #5 add “tests using laser thermometer”.</p> <p>On item #11, add “creates PMs.”</p>

<ol style="list-style-type: none">6. Maintains steam traps.7. Replaces mechanic seals on a variety of pumps.8. Replaces pump couplings on a variety of pump systems.9. Laser aligns pump shafts and motors to given tolerances.10. Mechanically aligns pump shafts and motors.11. Identifies, performs routine maintenance and replaces wear components on pumps.12. Sets up and balances pump and motor rotating assemblies. Learns and applies field balancing techniques (vibration analysis).13. Mounts, installs, aligns, troubleshoots and makes skilled repairs to a wide variety of pumps.14. Identifies, performs routine maintenance and replaces wear components on pumps.15. Demonstrates basic understanding of the application and operation of gear types, pulleys, couplings, chain drives, v-belt drives, flat belt drives, and mechanical ratios for power and winch systems.16. Repairs and replaces gear box components including gears and seals.17. Applies bearing theory to identify the correct application, installation, and maintenance of bearing systems	
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Employer Preference Skills

Below are additional topics that individual employers thought might be included in a college program, but were not considered part of the Sample Curriculum, intended to serve a number of industry sectors.

INDUSTRIAL RIGGING – 1 unit

PROPOSED CONTENT	YOUR THOUGHTS <small>Use this space to provide written feedback</small>
<ol style="list-style-type: none"> 1. Properly distributes, balances and secures loads for safe transport. 2. Safely rigs materials and equipment. 3. Rigs and operates truck mounted-crane and winch to move loads safely. 4. Properly rigs loads for safe and efficient movement. 	<p>I doubt that this is needed although apparently others do feel it should be included.</p> <p>Applied physics in an industrial environment.</p> <p>Keep this topic in the curriculum.</p> <p>This topic could include basic levers, mechanical advantage, and friction.</p> <p>Just touch on this topic.</p> <p>Consider adding knowledge of hand signals and how to give signals.</p> <p>This can also be an industrial bone-head physics class.</p>

INTRODUCTION TO ELECTRICITY AND INSTRUMENTATION – 3 + 3 + 3 + 3 units

PROPOSED CONTENT	YOUR THOUGHTS <small>Use this space to provide written feedback</small>
<ol style="list-style-type: none"> 1. Electronics (ohm's law, use of test equipment, etc.) 2. Electrical (wiring, power systems, etc.) 3. Motor Controls (including PLC's & VFD) 4. Instrumentation and Calibration 	<p>This should not be part of a core curriculum for a machinist or mechanic for us. They only need enough knowledge to do some basic troubleshooting. We have electricians, EMT's, and instrument technicians to do the detailed work.</p> <p>Eliminate this topic and instead offer it as a separate certificate.</p> <p>The only skill that should be taught given the time available is troubleshooting with a multimeter. Students could build an electrical control system with a simple motor, controller, relays, and a power source.</p>

ADVANCED MATHEMATICS FOR INDUSTRIAL MAINTENANCE MACHINIST / MECHANICS – 5 units

PROPOSED CONTENT	YOUR THOUGHTS Use this space to provide written feedback
<ol style="list-style-type: none"> 1. Geometry 2. Trigonometry 3. Algebra I 4. Algebra II 5. Statistics 	<p>This level of math would be good to include in the curriculum.</p> <ol style="list-style-type: none"> 1. Geometry – layout 2. Trigonometry – just Pythagorean theory, everything is found (pipes...) 3. Incorporate statistics (#5) with tolerances. Industrial applied math. <p>Contextualize the entire math curriculum.</p> <p>Consider building these skills into the math course which is specific to the machine shop.</p>

INTRODUCTION TO GENERAL MAINTENANCE SKILLS – 3 units

PROPOSED CONTENT	YOUR THOUGHTS Use this space to provide written feedback
<ol style="list-style-type: none"> 1. Demonstrates basic understanding of use and application of materials, fittings, joint types and assembly methods for plumbing system installation and repair. 2. HVAC technology. 3. Basic carpentry. 4. Painting. 5. Concrete installation. 6. Sets up and performs tapered bored keyways (internal) and external shaft keyways (straight and tapered). 7. Tubing and Hose System Maintenance. 	<p>Machinist / mechanics do not do numbers 1 -5 so we should get rid of these topics. They should already be able to do numbers 6 and 7 as part of their machinist courses.</p> <p>#6 is not essential.</p> <p>Do not offer #1 - #5 for mechanics. #6 is included in the work that machinists do. #7 should be part of the hydraulics and fluid power class.</p> <p>Consider discussing “smart” buildings, fire alarms, and security at an introductory level.</p> <p>To #3 add crating, forms, basic framing and sheet rock.</p> <p>To #4 add epoxy, metal, and general construction.</p>

STUDENT ELECTIVES

PROPOSED CONTENT	YOUR THOUGHTS <small>Use this space to provide written feedback</small>
<ol style="list-style-type: none"> 1. 8 Hour OSHA Safety Training Certificate 2. Computer Aided Design software 3. TWIC (Transportation Worker Identification Credential) card 4. BATC (Bay Area Safety Training) card 5. Forklift drivers license 6. Boom truck operation training 	<p>These topics would be OK as electives, but are certainly not required.</p> <p>Asbestos lead training is needed. TWIC – required for refineries. BATC – preferable to OSHA certificate. #5 and #6 are also useful for water and wastewater and refinery plants – we provide this to our employees.</p> <p>The employer will cover these topics so they can be left out.</p> <p>I like the 8 hour OSHA training as an elective.</p> <p>The TWIC card will be covered in hiring.</p> <p>I like the forklift and boom truck training.</p> <p>Include asbestos and lead regulation familiarization.</p>