Skilled Trades Ontario | Métiers spécialisés Ontario

Apprenticeship Curriculum Standard

Pattern Maker

Level 2

443A

2004

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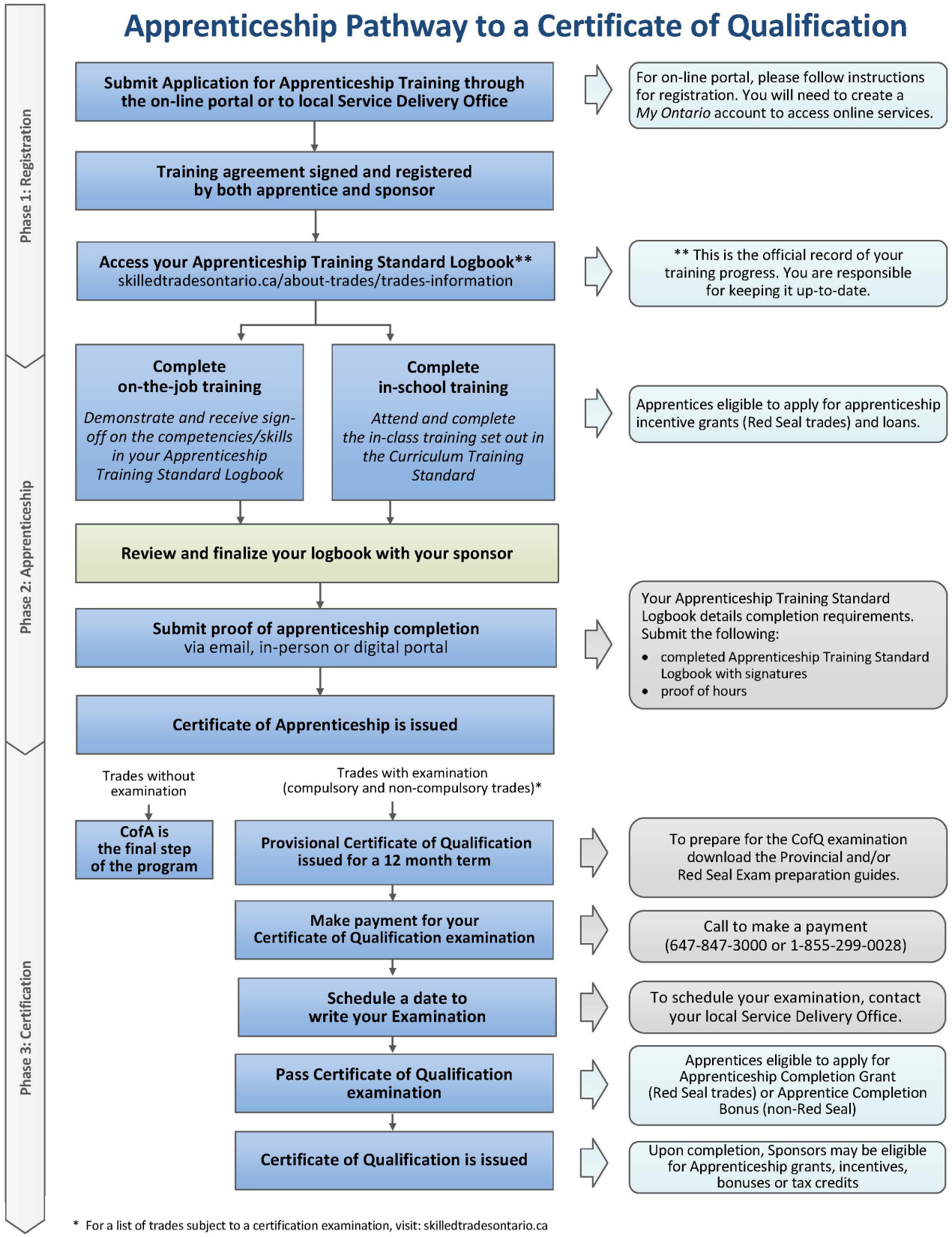
Apprenticeship Pathway to a Certificate of Qualification



* For a list of trades subject to a certification examination, visit: skilledtradesontario.ca

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Please Note: This Standard has been revised to reflect the visual identity of Skilled Trades Ontario (STO) which replaced the Ontario College of Trades on January 1, 2022. The content of this Standard may refer to the former organization; however, all trade specific information or content remains relevant and accurate based on the original date of publishing.

Please refer to STO's website: **skilledtradesontario.ca** for the most accurate and up to date information. For information about BOSTA and its regulations, please visit ***Building Opportunities in the Skilled Trades Act, 2021* (BOSTA).**

Any updates to this publication are available on-line; to download this document in PDF format, please follow the link: Skilled Trades Ontario.ca.

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Maintained with transfer to Skilled Trades Ontario 2004 (V100)

Preface

This curriculum standard for the Pattern Maker trade program is based upon the on-the-job performance objectives, located in the industry-approved training standard.

This is the second level of 3 levels of training. The Reportable Subjects Summary chart (located on page 5) summarizes the training hours for each reportable subject.

The curriculum identifies the learning that takes place in-school. The in-school program focuses primarily on the theoretical knowledge and the essential skills required to support the performance objectives of the Apprenticeship Training Standards.

Employers/Sponsors are expected to extend the apprentice's knowledge and skills through practical training on a work site. Regular evaluations of the apprentice's knowledge and skills are conducted throughout training to verify that all apprentices have achieved the learning outcomes identified in the curriculum standard.

It is not the intent of the in-school curriculum to perfect on-the-job skills. The practical portion of the in-school program is used to reinforce theoretical knowledge. Skill training is provided on the job.

Please refer to Skilled Trades Ontario website (www.skilledtradesontario.ca) for the most accurate and up-to-date information about Skilled Trades Ontario. For information on *Building Opportunities in the Skilled Trades Act, 2021 (BOSTA)*) and its regulations, please visit Building Opportunities in the Skilled Trades Act, 2021, S.O. 2021, c. 28 - Bill 288 (ontario.ca)

Pre-requisites

In order to advance to Level 2 of the apprenticeship program, an individual must have completed all of the units outlined in Level 1. Similarly, in order to advance to Level 3 of the program, an individual must have completed all of the units outlined in Level 1 and 2.

Hours Disclaimer (if applicable)

It is agreed that Training Delivery Agents (TDAs) may need to make slight adjustments (with cause) according to particular apprentice needs and may deviate from the unit sequencing and the prescribed practical and theoretical hours shown within the standard. However, all TDAs will comply with the hours at the reportable subject level.

Suggested Equipment for Training Delivery Agencies

Personal and Safety Equipment: Personal protective equipment is at the discretion of the TDA who must conform to Ontario Provincial Health and Safety Regulations.

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Introduction

The Level 2 – Pattern Maker has been developed in keeping with the prescribed Ministry of Labour, Immigration, Training and Skills Development (MLITSD) Training Standards for the Pattern Maker trade. The curriculum design provides an opportunity to cross-reference the in-school learning outcomes to the specific workplace Training Standards.

For easy reference, a time allocation has been included for each reportable subject and unit, along with the Theory/Practical breakdown for the delivery of the Learning Content. More detailed time allocations for the instructor have been provided for each topic area to assure consistency for each apprentice intake.

The continual introduction of innovative techniques and more complex equipment is resulting in increasing demands for tradespersons who are not only skilled in the practical aspects of the trade, but who also have a sound theoretical knowledge of the inspecting, diagnosing, repair, and servicing requirements. The curriculum has been developed to provide this theoretical knowledge and to offer some practical applications to complement the on-the-job work experiences of the Pattern Maker apprentices.

The objectives of the curriculum, therefore, are to provide a basis for:

- sound theoretical training to meet the challenges presented by the increasingly more complex designs and testing techniques.
- a reinforcement of fundamental skills of the trade through the exposure to practical applications.
- developing in the apprentices high standards of craftsmanship, problem-solving skills and personal pride in their trade.
- developing desirable work attitudes and a keen sense of responsibility, particularly concerning public and personal safety.

The curriculum has been designed to give the instructor every reasonable opportunity for flexibility and innovation without deviating to any significant degree from the subject requirements, as determined by the Industry Committees and as prescribed in the Regulations for the Trades. Since the scope of the prescribed curriculum is quite extensive, the apprentices must be expected to reinforce the acquired knowledge through regular independent out-of-classroom assignments. The curriculum has been presented in a chronological sequence in keeping with sound teaching methodologies. However, the actual application of the sequence may differ somewhat between colleges because of scheduling, staffing, and facilities utilization.

The curriculum includes specific references to the Ministry of Labour, Immigration, Training and Skills Development Apprenticeship Training Standards. While these references to various performance objectives in the Training Standards have been linked to the respective in-school outcomes, employers should not assume complete coverage to a journeyperson level. The in- school delivery focuses primarily on the knowledge required to master the respective objectives outlined in the Training Standards. Employers, therefore, are expected to complete the training of these respective objectives by applying the prescribed in-school knowledge to the required practical learning experienced in the work setting.

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To ensure that apprentices will be able to successfully demonstrate the learning outcomes according to performance criteria, specific times have been allocated in the respective areas to allow for some applications enhancement. It is of utmost importance that all application assignments relate to prescribed experiences only. Time constraints will not permit engaging apprentices in tasks of limited learning benefit that are unrelated to the curriculum outcomes. In the Learning Content section, whenever an assigned operation for an applied test or repair procedure indicates that a demonstration should be performed, there is only enough time allocated for the instructor to perform the activity. If the statement in the assigned operations begins with “perform,” “outline,” “describe,” or “explain,” the apprentice is expected to complete the activity.

Regular evaluations of the apprentices' learning achievements must be performed in both theory and practical applications throughout the program to ensure consistency with learning outcome expectations. Testing of apprentice knowledge and skills will take place during the allotted delivery hours for each unit. In addition to providing an evaluation of apprentice competency, the review of test question answers is considered to be a valuable learning opportunity.

In all practical activities, the apprentices will observe the Occupational Health and Safety Act and the applicable regulations including use of personal protective equipment. Institutional regulations and policies may also apply.

Participation by Stakeholders
A consortium of Colleges of Applied Arts and Technology (CAAT) and one private Training Delivery Agency (TDA), working in collaboration with the Ministry of Labour, Immigration, Training and Skills Development and industry stakeholders, participated in the development of this document. The development and subsequent revisions were based on the new training standards that were previously revised by the MLITSD in consultation with industry advisory groups. The development was completed using a process and format approved by MLITSD.

The first step in the development process was to assemble a Project Steering Committee (PSC), consisting of both industry representatives and apprenticeship in-school deliverers. The PSC initiated the plan for the project development that followed. The PSC established the team which was responsible for the development of in-school apprenticeship curriculum documents for the pattern making trade.

- The trainer/instructor should explain to the apprentices that these documents are outlines only of expected curriculum outcomes.
- Safety is an integral part of the curriculum. The TDA should review safety as each unit of learning is delivered. The student should be made aware of safety concerns both within the TDA setting and those found on the job.
- It is important to note that safety is the responsibility of the employer and the employee.
- TDA safety procedures and standards should be followed during the delivery of this curriculum.

Implementation Date:
September, 2005

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Level 2

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Reportable Subject Summary – Level 2

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
76.0	Applied Trade Calculations	39	39	0
77.0	Engineering Drawings, Charts, & Tables	30	30	0
78.0	Metrology	15	15	0
79.0	Pattern Making Machining Technology	21	3	18
80.0	NC/CNC Technology for Pattern Making	24	24	0
81.0	Casting and Foundry Processes	39	14	25
82.0	Pattern Making Technology	72	58	14
	Total	**240**	**183**	**57**

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Number:	76.0		
Title:	**Applied Trade Calculations**		
Duration:	Total Hours: 30	Theory: 30	Practical: 0
Prerequisites:	CC - Units 2.0, 3.0, 4.0, 5.0, 8.0, 9.0, 10.0		
Co-requisites:	PM L2 – Units 77.0, 78.0, 79.0, 80.0, 81.0, 82.0		
Cross-Reference to Learning Outcomes/Performance Objectives: PM - U5510 to U5518			

General Learning Outcome

The apprentice will be able:

- solve mathematical problems associated with the pattern build process
- perform calculations to determine sizes, shapes, and locations for tapers, points on circles, angles, gating system and casting weights.

Curriculum Learning Outcomes

Hrs.	No.	Outcomes
6	76.1	Determine pattern-building related problems involving the Pythagorean theorem and solve for unknown values.
6	76.2	Determine pattern-building related problems involving right angle triangle trigonometry and solve for unknown values.
4	76.3	Determine pattern-building related problems involving circles and solve for unknown values.
6	76.4	Perform pattern-building calculations.
4	76.5	Determine pattern-building related problems involving oblique triangles and solve for unknown values.
4	76.6	Determine pattern-building related problems involving the law of sines and solve for unknown values.
3	76.7	Determine pattern-building related problems involving the law of cosines/cotangents and solve for unknown values.
3	76.8	Describe compound angles as applied to pattern geometry.

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Learning Content

76.1 Determine pattern-building related problems involving the Pythagorean Theorem and solve for unknown values.

76.1.1 Identify and explain the concept of the Pythagorean Theorem.

76.1.2 Calculate the values of unknown sides of right angle triangles using the Pythagorean Theorem.

76.2 Determine pattern-building related problems involving right angle triangle trigonometry and solve for unknown values.

76.2.1 Describe the sides of a right angle triangle with reference to each of the angles.

76.2.2 Describe the six trigonometric functions of a right angle triangle including:

- sine
- cosine
- tangent

76.2.3 Calculate the values of unknown sides and angles of a given right angle triangle including:

- value of a trigonometric function
- value of two sides
- value of one side and one angle
- ratio of sides

76.3.0 Determine pattern-building related problems involving circles and solve for unknown values.

76.3.1 Describe a circle and the parts including:

- circumference
- chord
- diameter
- radius
- arc
- tangent
- segment
- central angle
- inscribed angle

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76.3.2 Calculate the values of unknown parts of a circle involving:
- angles formed inside a circle
- angles formed outside a circle
- internally tangent circles
- externally tangent circles

76.4.0 Perform pattern-building calculations.

76.4.1 Perform pattern-building related calculations to determine:
- tapers
- bevels
- triangles
- distance between holes
- v blocks
- dovetails
- contraction/shrink ratios of materials
- draft angles

76.4.2 Perform calculations for patternmaking using charts and tables to determine:
- taper calculations
- trigonometric functions/laws
- mathematical formulae
- draft angles
- shrinkage allowance

76.4.3 Calculate the weight of a castings produced in various metals including:
- grey Iron
- steel
- bronze

76.4.4 Perform calculations required to produce a gating system including:
- runner
- riser
- down sprues
- in gates
- filters
- pouring basin

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76.5 Determine pattern-building related problems involving oblique triangles and solve for unknown values.

76.5.1 Describe an oblique triangle.

76.5.2 Identify and calculate the values of the unknown sides of oblique triangles.

76.6 Determine pattern-building related problems involving the law of sines and solve for unknown values.

76.6.1 Describe the law of sines.

76.6.2 Identify and calculate the values of unknown sides and angles of oblique triangles using the law of sines including:
- values of two angles and one side
- values of two sides and one angle

76.7 Determine pattern-building related problems involving the law of cosines/cotangents and solve for unknown values.

76.7.1 Describe the law of cosines and cotangents.

76.7.2 Identify and calculate the values of the unknown sides and angles of oblique triangles using the law of cosines and cotangents including:
- values of two sides and the included angle
- values of three sides

76.8 Describe compound angles as applied to pattern geometry.

76.8.1 Calculate compound angles found on patterns.

Instructional and Delivery Strategies
Lecture
Demonstration
Practical Lab Assignments
E-Learning

Reference Material (not limited to)
Pattern Making Technology Foundry Practices

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
60%	40%	100%

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Number:	77.0		
Title:	**Engineering Drawings, Charts and Tables**		
Duration:	Total Hours: 30	Theory: 30	Practical: 0
Prerequisites:	CC - Units 2.0, 3.0, 4.0, 5.0, 8.0, 9.0, 10.0		
Co-requisites:	PML2 – Units 76.0, 78.0, 79.0, 80.0, 81.0, 82.0		
Cross-Reference to Learning Outcomes/Performance Objectives: PM - U5510 to U5518			

General Learning Outcome

The apprentice will be able to read the graphic information, symbols, and pattern building reference materials as applied to foundry tooling construction and verification.

Curriculum Learning Outcome

Hrs.	No.	Outcomes
2	77.1	Describe the graphic language and symbols of engineering drawings.
2	77.2	Describe dimensional terminology and practices.
2	77.3	Describe the principle views of first and third angle projection.
6	77.4	Interpret and sketch revolved, removed, partial, and broken out sectional views.
8	77.5	Describe the elements and features of engineering drawings for foundry tooling assembly and components.
7	77.6	Describe geometric terminology and practices.
3	77.7	Describe use of pattern-building reference materials, charts, and tables.

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Learning Content

77.1.0 Describe the graphic language and symbols of pattern- building engineering drawings.

77.1.1 Describe the application of graphic representations used in engineering drawings including:

- manufacturing
- assembly
- sub-assembly
- casting
- machining

77.1.2 Describe the language used in engineering drawings including:

- graphic shape
- terminology
- symbols
- sizes
- scales
- title block
- zoning system
- engineering change notice (ECN)
- lettering on drawings
- sub/assembly
- detail drawings
- bill of material

77.1.3 Describe drawing lines used to illustrate and dimension components and assemblies including:

- object
- hidden
- leader
- short break
- long break
- section
- cutting plane
- phantom
- centre
- extension
- dimension

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77.1.4 Describe engineering drawing symbols including:
- roughness value
- grade numbers
- location/datum/target
- surface texture
- positional tolerancing
- machined surfaces
- geometric symbols
- not to scale

77.2.0 Describe dimensional terminology and practices.

77.2.1 Describe dimensioning methods including:
- point to point
- datum
- tabular
- arrowless

77.3.0 Describe the principle views of first and third angle projection.

77.3.1 Describe third angle projection.

77.3.2 Describe first angle projection.

77.3.3 Read and interpret engineering drawings to identify features of a finished component.

77.4.0 Interpret and sketch revolved, removed, partial, and broken out sectional views.

77.4.1 Describe orthographic projections including:
- removed
- partial
- broken out
- isometric

77.4.2 Describe auxiliary views of orthographic projection.

77.4.3 Describe the basic function of an auxiliary view including:
- angular position/inclined surface
- true shape or profile

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77.4.4 Describe the types of auxiliary view including:
- primary
- secondary
- sectional

77.4.5 Describe types of sectional views including:
- partial
- revolved
- removed
- offset
- broken out

77.4.6 Describe the basic function of an auxiliary view including:
- offset
- partial
- revolved
- removed

77.5.0 Describe the elements and features of engineering drawings for foundry tooling assembly and components.

77.5.1 Describe engineering drawing features including:
- detail drawings
- notes and specifications
- cross reference
- revision
- scale
- multiple detail drawings

77.5.2 Describe drawing elements related to workpiece processing techniques including:
- welding symbols
- forging and casting (draft angles)
- fillets and rounds
- non-machined dimensional features
- nominal dimensions
- machined-dimensional features
- casting drawings

77.5.3 Read and interpret pattern-building engineering drawings to identify features of a finished component.

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77.6.0 Describe geometric terminology and practices.

77.6.1 Describe geometric terminology as applied to pattern- building engineering drawings regardless of feature size, including:

- straightness
- flatness
- roundness
- cylindricity
- profile of a line or a surface
- angularity
- perpendicular
- parallelism
- position
- concentricity
- symmetry
- feature control frame
- general rules
- virtual condition
- symbols
- total run-out
- maximum material condition
- least material condition
- projected tolerance zone
- basic dimension
- datum feature and targets
- circularity
- circular run-out
- correlative tolerance
- datums

77.6.2 Describe pattern-building geometric dimensional terms and characteristics regardless of feature size, including:

- least material condition
- basic dimensions
- datums
- feature control frame
- virtual condition
- symbols

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- individual and related features
- datum targets
- terms
- maximum material condition
- pictorial
- schematic
- simplified

77.7.0 Describe use of pattern-building reference materials, charts, and tables.

77.7.1 Read and interpret pattern-building reference material and value table/charts to determine:

- magnitudes and dimensions
- standards
- terminology
- graduations
- accuracy
- limitations
- draft
- shrink factor
- spline control points

Instructional and Delivery Strategies
Lecture
Demonstration
Practical Lab Assignments
E-Learning

Reference Material (not limited to)
Pattern Making Technology Foundry Practices

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
60%	40%	100%

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Number:	78.0		
Title:	**Metrology**		
Duration:	Total Hours: 15	Theory: 15	Practical: 0
Prerequisites:	CC - Units 2.0, 3.0, 4.0, 5.0, 8.0, 9.0, 10.0		
Co-requisites:	PM L2 – Units 76.0, 77.0, 79.0, 80.0, 81.0, 82.0		
Cross-Reference to Learning Outcomes/Performance Objectives: PM - U5510 to U5518			

General Learning Outcome

Upon successful completion, the apprentice will be able to select and use measuring devices used in the pattern build process.

Curriculum Learning Outcomes

Hrs.	No.	Outcomes
3	78.1	Describe the fundamentals of dimensional metrology in the pattern making process.
3	78.2	Describe the fundamentals of measuring, checking, and gauging equipment.
3	78.3	Describe measuring techniques using direct/indirect reading linear measuring equipment.
3	78.4	Demonstrate measuring techniques using direct/indirect reading angular measuring equipment.
3	78.5	Describe measuring and checking procedures using indicating gauges and comparators.

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Learning Content

78.1.0 Describe the fundamentals of dimensional metrology in the pattern making process.

78.1.1 Describe geometric features that are measured during machining operations.

78.1.2 Describe terms used in measurement techniques including:
- accuracy
- precisions
- tolerances
- reliability
- limits
- fits
- datums

78.1.3 Describe error sources in measurement techniques including:
- inherent instrument
- observational
- manipulative
- bias
- parallax

78.2.0 Describe the fundamentals of measuring, checking, and gauging equipment.

78.2.1 Describe measuring, checking, and gauging equipment including:
- direct/indirect linear measuring equipment
- direct/indirect angular measuring equipment
- indicating gauges and comparators

78.2.2 Describe direct/indirect reading linear measuring instruments including:
- bench micrometer
- gauge blocks
- vernier protractor

78.2.3 Describe direct/indirect reading angular instruments including:
- sine bar
- sine plate
- precision square
- angular gauge blocks

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- precision level

78.2.4 Describe inspecting and checking gauges including:
- tooling balls
- radius gauges
- feeler gauges
- gauge blocks

78.2.5 Describe indicating gauges including:
- dial indicator
- dial test indicators

78.3.0 Describe measuring techniques using direct/indirect reading linear measuring equipment.

78.3.1 Describe cleaning techniques of calibrated test specimen surfaces.

78.3.2 Describe features to be measured and the specified accuracies.

78.3.3 Identify and select direct/indirect reading linear measuring equipment by determining:
- types
- components
- adjusting mechanisms
- lengths and widths
- values of graduations
- accessibility to locations
- Applications
- measuring accuracy
- temperature variations
- manipulative error and bias
- parallax
- handling, storing, and maintenance procedures

78.3.4 Demonstrate measurement of linear features.

78.3.5 Demonstrate recording techniques.

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78.4.0 Demonstrate measuring techniques using direct/indirect reading angular measuring equipment.

78.4.1 Describe cleaning techniques of calibrated test specimen surfaces.

78.4.2 Select direct/indirect reading angular measuring equipment by determining:

- applications
- type
- components
- measuring /checking ranges
- workpiece size and geometry
- dimensional values
- selection for gauge block build-up
- wringing of gauge blocks
- handling, storing, and maintenance procedures

78.4.3 Demonstrate measurement of angular features.

78.4.4 Demonstrate recording techniques.

78.5.0 Describe measuring and checking procedures using indicating gauges and comparators.

78.5.1 Describe cleaning techniques of calibrated test specimen surfaces.

78.5.2 Describe features to be checked.

78.5.3 Select indicating gauges and comparators by determining:

- applications
- type
- components
- adjusting mechanisms
- accessibility to location
- predetermined values
- temperature variations
- graduation values
- checking and measuring ranges
- holding, positioning, and mounting characteristics
- handling, storing, and maintenance procedures

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78.5.4 Demonstrate measuring techniques using indicating gauges and comparators.

78.5.5 Demonstrate recording techniques.

Instructional and Delivery Strategies
Lecture
Demonstration
Practical Lab Assignments
E-Learning

Reference Material (not limited to)
Pattern Making Technology Foundry Practices

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
70%	0%	30%

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Number:	79.0		
Title:	**Pattern Making Machining Technology**		
Duration:	Total Hours: 21	Theory: 3	Practical: 18
Prerequisites:	CC - Units 2.0, 3.0, 4.0, 5.0, 8.0, 9.0, 10.0		
Co-requisites:	PM L2 - Units 76.0, 77.0, 78.0, 80.0, 81.0, 82.0		
Cross-Reference to Learning Outcomes/Performance Objectives: PM - U5510, U5511, U5512, U5514, U5516, U5517, U5518			

General Learning Outcome

Upon successful completion, the apprentice will be able to describe the functions and operations and care of patternmaking machine tools and cutting tools.

Curriculum Learning Outcomes

Hrs.	No.	Outcomes
1.5	79.1	Observe safe working procedures when setting up and operating machine tools used in patternmaking.
6.0	79.2	List and describe machine tools used in patternmaking.
12.0	79.3	Describe the types of machining operations performed on patternmaker machine tools, cutting tools and individual parts.
1.5	79.4	Perform routine maintenance on machine tools.

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Learning Content

79.1.0 Observe safe working procedures when setting up and operating machine tools used in patternmaking.

79.1.1 Describe hazards which may occur during lathe set up and operational procedures.

79.1.2 Demonstrate safe working habits including:
- wearing all required protective clothing gear
- good housekeeping
- start up and shut off procedures
- securing and stabilizing of workpiece
- lock out procedures

79.2.0 List and describe machine tools used in patternmaking.

79.2.1 List and describe machine tools used in patternmaking including:
- milling machine
- overhead router
- disc sander
- table saw
- drill presses
- wood lathe
- metal lathe
- jointer
- planer
- bobbin sander
- wood pattern mill
- CNC mills
- deep hole drilling machine
- vertical bandsaw
- abrasive cut-off saw
- panel saw
- tool grinder
- radial arm saw

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79.3.0 Describe the types of machining operations performed on patternmaker machine tools, cutting tools and individual parts.

79.3.1 Describe the functions and operational features of the patternmaking radial arm saw, cutting tools, and parts including:

- blade
- cross cut blade
- combination blade
- dado head
- control panel
- table
- fence
- sawdust exhaust
- saw blade
- motor and spindle
- arm clamp handle
- arm elevation handle
- mitre clamp
- bevel clamp

79.3.2 Describe machining operations performed on the patternmaking radial arm saw including:

- cutting off
- beveling
- compound angling
- rabbetting

79.3.3 Describe the functions and operational features of the patternmaking jointer, cutting tools, and parts including:

- control panel
- infeed table
- outfeed table
- danger zone
- cutter block
- cutters

79.3.4 Describe machining operations performed on the patternmaking jointer including:

- facing a side
- facing an edge
- chamfering
- beveling

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79.3.5 Describe the functions and operational features of the patternmaking thickness planer, cutting tools, and parts including:
- in-feed table
- corrugated roller
- smooth roller
- control panel
- table rise and fall hand wheel
- table locking lever
- feed change gear lever

79.3.6 Describe machining operations performed on the patternmaking thickness planer including:
- machining parallel
- jigging and fixturing

79.3.7 Describe the functions and operational features of the patternmaking band saw, cutting tools, and parts including:
- blade
- control panel
- table
- rip fence
- cross-cut fence
- wheel guards
- saw guides

79.3.8 Describe machining operations performed on the patternmaking band saw including:
- rip sawing
- cross cutting
- bevelling
- chamfering
- contouring
- re-sawing

79.3.9 Describe various types of patternmaking sanders including:
- disc
- bobbin
- profile

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79.3.10 Describe the functions and operational features of the patternmaking sanders, and parts including:
- control panel
- table
- mitre gauge
- spindle rise and fall
- table inserts
- interchangeable mandrels

79.3.11 Describe machining operations performed on the patternmaking grinders including:
- facing a side
- facing an edge
- machining ends
- machining thickness
- beveling
- chamfering
- producing compound angles
- producing outside curves or radii
- profiling bobbin or spindle (inside curve or radii)

79.3.12 Describe the abrasive grades used on patternmaking sanders including:
- disk-abrasive paper / cloth
- spindle-abrasive paper
- sleeves
- belts

79.3.13 Describe the functions and operational features of hand tool grinders, cutting tools, and parts including:
- control
- grinding wheel
- tool rest
- guard

79.3.14 Describe machining operations performed on the hand tool grinders including:
- hollow grinding
- grinding angles
- grinding gouges

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79.3.15 Describe types of patternmaking wood lathes including:
- pedestal
- conventional

79.3.16 Describe the functions and operational features of the pattern making wood lathes, cutting tools, and parts including:
- control panel
- head stock
- bed
- tail stock
- tool rest holder
- tool rest
- dead centre
- live centre
- face plate
- speed pulleys and gears
- feed gears
- skew chisels
- scrapers
- parting tools
- gouges

79.3.17 Describe machining operations performed on the patternmaking wood lathes including:
- spindle turning
- face plate turning

79.3.18 Describe the functions and operational features of the patternmaking drill presses, cutting tools, and parts including:
- drill bits
- bobbin sander
- buffing wheel
- control panel
- table
- speed pulley and gears
- column
- base
- chuck
- depth stop
- down feed wheel

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79.3.19 Describe machining operations performed on the patternmaking drill presses including:
- drilling
- sanding
- buffing

79.3.20 Describe the functions and operational features of the patternmaking overhead router, cutting tools, and parts including:
- router bits
- control panel
- table
- head
- centre pin / guide pin

79.3.21 Describe machining operations performed on the patternmaking overhead router including:
- routing
- shaping
- surfacing
- radius cutting
- contouring with centre pin

79.3.22 Describe the functions and operational features of the patternmaking wood mills, cutting tools, and parts including:
- router bits
- shaper bits
- corebox cutters
- hole boring cutters
- dovetail cutters
- profile cutters
- planer block
- saddle
- track
- control panel
- table
- head

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79.3.23 Describe machining operations performed on the patternmaking wood mills including:
- routing
- indexing
- boring
- facing
- shaping internal and external features
- sanding

79.4.0 Perform routine maintenance on machine tools.

79.4.1 Select and demonstrate routine maintenance procedures.

79.4.2 Demonstrate lubrication procedures.

79.4.3 Demonstrate dismantling, handling and storage of tools, tooling, workholding devices, and measuring instruments.

Instructional and Delivery Strategies
Lecture
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Practical Lab Assignments
E-Learning

Reference Material (not limited to)
Pattern Making Technology Foundry Practices

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
15%	60%	25%

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Number:	80.0		
Title:	**NC/CNC Technology for Patternmaker**		
Duration:	Total Hours: 24	Theory: 24	Practical: 0
Prerequisites:	CC - Units 2.0, 3.0, 4.0, 5.0, 8.0, 9.0, 10.0		
Co-requisites:	PM L2 - Units 76.0, 77.0, 78.0, 79.0, 81.0, 82.0		
Cross-Reference to Learning Outcomes/Performance Objectives: PM - U5510, U5511, U5512, U5514			

General Learning Outcome

Upon successful completion, the apprentice will be able to describe the operating principles, applications, program structure documentation and manual operation of NC/CNC machines.

Curriculum Learning Outcomes

Hrs.	No.	Outcomes
1	80.1	Observe safe working procedures when setting up and operating NC/CNC machines.
3	80.2	Describe operating principles and applications of NC/CNC machine tools.
2	80.3	Describe the basics of NC/CNC dimensioning.
2	80.4	Identify the types and classification of NC/CNC machining equipment.
5	80.5	Describe part programming methods, set-up sheets, tooling lists, part program manuscripts, and input media.
3	80.6	Describe manual operation systems for NC/CNC machines.
4	80.7	Determine and prepare a plan for NC/CNC programming.
4	80.8	Input and verify programs for NC/CNC machine systems to perform linear and circular machining exercises.

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Learning Content

80.1.0 Observe safe working procedures when setting up and operating NC/CNC machines.

80.1.1 Describe safety hazards which may occur during NC/CNC machine set-up and operational procedures.

80.1.2 Demonstrate safe working habits including:
- wearing all required protective clothing and gear
- good housekeeping
- start-up and shut-off procedures
- securing and stabilizing of workpiece

80.2.0 Describe operating principles and applications of NC/CNC machine tools.

80.2.1 Describe types of NC/CNC machine tools including:
- vertical machining centres
- vertical turning centres
- routers

80.2.2 Describe the capabilities of NC/CNC machining systems including:
- types of equipment
- editing capability
- program path ability
- processing power

80.2.3 Describe the operating principles of NC/CNC machine controls including:
- NC controls
- CNC controls
- adaptive controls
- tapeless control
- PC/DNC systems

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80.2.4 Describe the major features and functions of NC/CNC systems including:
- ball screws
- CPU
- input devices
- tool changers
- work envelope
- workholding devices
- power drive systems
- safety interlocks

80.2.5 Describe the steps in the process of a NC/CNC manufacturing plan including:
- engineering drawing
- NC part program
- input media
- CNC machine tool
- finished part
- conformance of part to drawing specifications
- tool set up
- workpiece set up

80.3.0 Describe the basics of NC/CNC dimensioning.

80.3.1 Describe the Cartesian Coordinate System including:
- quadrant notation
- point location in XY plane
- point location in XYZ space

80.3.2 Describe machine tool axis designations including:
- primary linear axis
- secondary linear axis
- primary rotary axis
- secondary rotary axis
- right hand rule
- axis orientation

80.3.3 Identify types of machine zero point locations including:
- fixed zero points
- full zero shift
- floating zero

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80.3.4 Identify and establish set-up point locations by determining:
- machine home position
- absolute zero position
- Z axis touch off points

80.3.5 Describe the capabilities of positioning and contouring using NC/CNC machines including:
- linear interpolation
- circular interpolation
- rapid positioning

80.3.6 Describe use of dimensioning practices including:
- baseline dimensioning (datum)
- relative (chain) dimensioning

80.4.0 Identify the types and classification of NC/CNC machining equipment.

80.4.1 Describe NC/CNC equipment used for machining operations including:
- machining centres
- turning centres
- grinding centres
- electrical discharge machines
- flame cutting machines
- coordinate measuring machines
- CNC router

80.4.2 Determine and select coordinate systems for NC/CNC machining including:
- type of machine
- axes designation
- vertical machining centre
- horizontal machining centre
- horizontal boring mill
- typical specifications

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80.5.0 Describe part programming methods, set-up sheets, tooling lists, part program manuscripts, and input media.

80.5.1 Describe required documentation for NC/CNC machining process including:
- set-up sheet
- tooling list
- part program manuscript
- input media

80.5.2 Describe the individual components of a part program manuscript including:
- sequence numbers
- preparatory functions
- axis motions
- feed rates
- spindle speeds
- tool numbers
- miscellaneous functions

80.5.3 Describe additional word and block structures that exist within the part program code including:
- decimal point programming
- block delete
- comments
- optional stops

80.5.4 Describe the individual components of a set-up sheet including:
- part zero position
- part location
- clamp locations
- fixture locations

80.5.5 Describe the components of a tooling list including:
- tool type
- tool number
- diameter offset number
- tool length offset number

80.5.6 Describe the common means of producing part program files including:
- CAM systems
- manual programming

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80.6.0 Describe manual operation systems for NC/CNC machines.

80.6.1 Describe manual program interruption including:
- single block operation
- feedhold
- emergency stop

80.6.2 Describe manual data input including:
- line command execution
- set-up applications

80.6.3 Describe practical applications of the program data override including:
- rapid motion override
- spindle speed override
- feedrate override
- dry run operation
- Z axis neglect
- manual absolute setting
- auxiliary lock functions
- machine lock

80.6.4 Describe interfacing to peripherals including:
- RS-232C Interface
- PC/DNC

80.7 Determine and prepare a plan for NC/CNC programming.

80.7.1 Determine and select NC/CNC machine to produce pattern tooling including:
- machining centre
- turning centre
- router

80.7.2 Read and interpret documentation to determine:
- workpiece material specifications
- order of operations

80.7.3 Plan sequence of machining by identifying:
- order of machining
- tooling selection
- workpiece set-up

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80.8.0 Input and enter programs for NC/CNC machine systems to perform linear and circular machining exercises.

80.8.1 Use preparatory commands (G-codes) for applications in machining and turning centres.

80.8.2 Use G-codes in a block including:
- modality of G-codes and M-codes
- recognize conflicting commands
- order in a block

80.8.3 Use M-codes including:
- tool change
- spindle rotations
- optional stop
- coolant

80.8.4 Use codes to specify dimensions including:
- metric/inch selection
- absolute data input - G90
- incremental data input – G91
- combination in the same block
- diameter programming
- radius programming
- leading and trailing zeros input

80.8.5 Use codes to specify speeds and feeds including:
- spindle function
  - S-code
  - spindle rotation direction
  - spindle stop
  - spindle orientation
  - spindle speed (RPM)
- feedrate control
  - feedrate function
  - feedrate per minute
  - feedrate per revolution
  - feedrate override and feedhold
  - feedrate override and functions

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80.8.6 Use codes to specify tool function including:
- tool offset registration
- milling application
  - tool number
  - offset number
- lathe application
  - tool number
  - offset number

80.8.7 Use codes to specify reference points including:
- machine reference point
- workpiece reference point
- tool reference point
- position register command
  - G92 command
  - G54 command

80.8.8 Use codes to establish tool length compensation including:
- general concepts
  - actual tool length
  - difference in tool length and size
  - G43 command
  - G44 command
  - G49 command
- programming format
  - separate block - Z motion only
  - X and Y motion

80.8.9 Use codes for rapid positioning including:
- rapid traverse motion
- tool path
  - workpiece approach

80.8.10 Use codes to invoke zero return commands including:
- return to machine zero
- return position check

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80.8.11 Use codes in contouring programs including:

- linear interpolation
  - G01 command
  - single axis motion
  - interpolation in two axes
  - three axis linear interpolation
- circular interpolation
  - G02 and G03 commands
  - programming format
  - direction of motion
  - start and end point of an arc
  - arc centre
  - blend radius
  - quadrants
  - full circle programming
  - feedrate for circular motion
- rough and finished shape
  - methods of calculations
  - work sketch and calculations
  - sheet of coordinates

Instructional and Delivery Strategies
Lecture
Demonstration
Practical Lab Assignments
E-Learning

Reference Material (not limited to)
Pattern Making Technology Foundry Practices

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
60%	0%	40%

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Number:	81.0		
Title:	**Casting Technology**		
Duration:	Total Hours: 39	Theory: 14	Practical: 25
Prerequisites:	CC - Units 2.0, 3.0, 4.0, 5.0, 8.0, 9.0, 10.0		
Co-requisites:	PML2 - Units 76.0, 77.0, 78.0, 79.0, 80.0, 82.0		
Cross-Reference to Learning Outcomes/Performance Objectives: PM - U5514, U5515, U5516, U5517			

General Learning Outcome

Upon successful completion, the apprentice will be able to identify ferrous and non-ferrous metals, describe moulding sand and binders, and describe requirements of the moulding process.

Curriculum Learning Outcomes

Hrs.	No.	Outcomes
13	81.1	Describe ferrous and non ferrous metals and the characteristics as applied to patternmaking.
8	81.2	Describe moulding sand and sand binders that patterns and core boxes are exposed to during the moulding process.
18	81.3	Describe the moulding process used to produce moulds and castings.

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Learning Content

81.1.0 Describe ferrous and non ferrous metals and the characteristics as applied to patternmaking.

81.1.1 List and define ferrous and non ferrous metals and determine the shrinkage and machine finish for each metal including:
- grey iron
- ductile iron
- steel
- brass
- bronze
- aluminum

81.2.0 Describe moulding sand and sand binders that patterns and core boxes are exposed to during the moulding process.

81.2.1 List moulding processes and describe their application including:
- green sand
- pit moulding
- open sand
- air set
- “V process”

81.2.2 Describe moulding sand and the properties including:
- refractory
- gradation (particle size)
- venting
- particle shape

81.2.3 List types of moulding sand binders including:
- petroleum based
- water
- clay
- resin

81.2.4 Describe the effects of the moulding process and methods of preventing damage to the pattern and core box(es) including:
- expansion due to moisture
- abrasion
- handling
- storage

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81.2.5 Describe foundry and moulding terminology including:

- casting
- cope
- drag
- core types
- core box
- core oven
- core sand
- back draft
- flask
- flask pins
- follow board
- gating
- green sand
- mould
- draft

81.3.0 Describe the moulding process used to produce moulds and castings.

81.3.1 Describe the function, methods of alignment, and sizes of flasks.

81.3.2 Describe styles of flasks and the component parts including:

- pin located cope & drag
- pin located cope & drag with cheek
- snap flask and slip jacket
- flaskless cope and drag

81.3.3 Describe gating systems and the effects on the casting including:

- runner bar
- in gates
- sprue
- riser
- pouring basin

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81.3.4 List the possible results of incorrect gating systems on the casting including:

- freezing off
- porosity
- sand erosion
- shrink holes
- blow hole
- distortion
- scaling
- expansion
- contraction
- filters
- exothermic sleeve

81.3.5 Describe elements of pattern design which improve the quality and strength of a casting including:

- taper/draft
- finished surfaces
- fillets
- ribs
- chill and riser pads
- joint line
- core locations

Instructional and Delivery Strategies
Lecture
Demonstration
Practical Lab Assignments
E-Learning

Reference Material (not limited to)
Pattern Making Technology Foundry Practices

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
25%	50%	25%

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Number:	82.0		
Title:	**Pattern Making Technology**		
Duration:	Total Hours: 72	Theory: 58	Practical: 14
Prerequisites:	CC - Units 2.0, 3.0, 4.0, 5.0, 8.0, 9.0, 10.0		
Co-requisites:	PM L2 - Units 76.0, 77.0, 78.0, 70.0, 80.0, 81.0		
Cross-Reference to Learning Outcomes/Performance Objectives: PM - U5510 to U5518			

General Learning Outcome

Upon successful completion, the apprentice will be able to plan for the pattern build process, create pattern layouts, verify profiles and shapes, pattern assembly, hand finishes and inspect finished foundry tooling.

Curriculum Learning Outcomes

Hrs.	No.	Outcomes
.05	82.1	Observe safe working habits when performing pattern tooling fabrication procedures.
6	82.2	Devise and detail a plan for the pattern build process.
6	82.3	Organize the pattern build process.
4	82.4	Sectionalize an engineering drawing.
4	82.5	Describe building aids used in pattern construction.
4	82.6	Create pattern equipment layout.
1	82.7	Describe the use of templates to produce and verify sectional profiles and shapes.
1	82.8	Describe the process of rough cutting pattern components for assembly.
5	82.9	Describe the assembly of basic pattern sections.
3	82.10	Describe assembly techniques and processes.
3	82.11	Describe the resin pattern tooling fabrication process.

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Hrs.	No.	Outcomes
1	82.12	Describe methods of inspecting the surface finish of resin pattern tooling.
1	82.13	Describe the application, types, selection and characteristics of gel coat.
1	82.14	Describe the process of fabricating a resin pattern support frame.
1	82.15	Describe the methods required to produce a aluminum support casting for resin pattern tooling.
.05	82.16	Describe the production and the application of lightener/filler blocks used in the resin pattern.
.05	82.17	Describe the application of release agents.
1	82.18	Describe the types and application of resins, catalysts and fillers.
.05	82.19	Describe the process of pouring resin to produce resin pattern tooling.
1	82.20	Describe the lay-up process to gel coated surface.
1	82.21	Describe the process of stabilizing reinforcing material.
.05	82.22	Describe the types of tools, equipment and extraction methods used for the extraction of the moulded part/tooling.
.05	82.23	Describe the final inspection process of the moulded part/tooling.
3	82.24	Describe the steps required to produce and inspect a pressure cast match plate.
.05	82.25	Describe the process of machining the back face of a pressure cast cope and drag pattern.
1	82.26	Describe the methods of finishing the surface of a pressure cast match plate.
.05	82.27	Describe the process of drilling mounting holes in a pressure cast match plate.
1	82.28	Describe methods of fabricating and installing gating systems.

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Hrs.	No.	Outcomes
.05	82.29	Describe the process of fastening wear plates/flask slides-guides on cast match plates.
1	82.30	Describe the methods of determining the position of a pattern on a moulding plate.
.05	82.31	Describe the process of transferring dowel holes on a pattern plate.
.05	82.32	Describe the process of fastening a pattern to a pattern plate.
3	82.33	Describe the process of producing pattern tooling from metal stock, castings or resin tooling board.
3	82.34	Describe the automated core box manufacturing process.
1	82.35	Describe the process of fabricating a core jig setting to locate and place the core in the mould.
1	82.36	Describe the process of fabricating a core assembly fixture to facilitate the assembly of several cores.
1	82.37	Describe the process of fabricating a go-no-go gauge to check the profile and dimensional accuracy of the casting.
1	82.38	Describe the process of fabricating a core support fixture to maintain the shape, size, profile structure of the core during the curing process.
3	82.39	Describe the production of custom fabricated specialized lost foam pattern tooling.
1	82.40	Describe the correct application and care of layout tools.
1	82.41	Describe the make up and applications of woodworking joints.
1	82.42	Describe the assembly of mould components.
.05	82.43	Describe pattern component hand finishing/polishing processes and techniques.

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Learning Content

82.1.0 Observe safe working habits when performing pattern tooling fabrication procedures.

82.1.1 Describe safety hazards which may occur during the building pattern tooling.

82.1.2 Demonstrate safe working habits including:
- wearing all required protective clothing and gear
- good housekeeping
- start-up and shut-off procedures
- securing and stabilizing of workpiece
- lock out procedures

82.2.0 Devise and detail a plan for the pattern build process.

82.2.1 Visualize 3D model of the workpiece from orthographic views.

82.2.2 Describe the mouldability of the part including:
- establish the location of joint/parting lines
- determine the location of cores, cavities and/or core prints
- determine the shape and location of loose pieces as required

82.2.3 Evaluate the drawing for errors.

82.2.4 Identify machined surfaces.

82.2.5 Identify datum locations and centre lines.

82.2.6 Identify shrinkage allowances.

82.2.7 Evaluate tolerances and allowances.

82.2.8 Describe job specifications including:
- draft
- moulding process
- pattern/casting identification
- shrinkage allowance

82.2.9 List sources and types of reference material including:
- charts and tables
- revision drawings
- engineering drawings

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82.2.10 Describe material requirements based on moulding process and production volume including:
- wood
- resin
- metals
- polystyrene

82.2.11 List and describe the features of pattern components including:
- ribs
- flanges
- bosses
- fillets
- lifting plates
- core boxes
- core prints
- loose pieces
- draft

82.2.12 Identify and select the required pattern components from a specific drawing.

82.3.0 Organize the pattern-build process.

82.3.1 List and describe hand tools including:
- chisel
- gouge
- plane
- spoke shave
- files
- rasps
- screw drivers
- hammers
- mallet
- brace and bit
- saws
- hand router

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82.3.2 List and describe power hand tools including:

- drill
- router
- die grinder
- circular saw
- disc sander
- electric planer
- hole saw
- belt sander
- jig saw

82.3.3 List and describe machine tools including:

- milling machine
- overhead router
- disc sander
- table saw
- drill
- wood lathe
- metal lathe
- jointer
- planer
- bobbin sander
- wood pattern mill
- CNC mills
- vertical bandsaw
- abrasive cut-off saw
- panel saw
- grinder

82.3.4 Develop a pattern build-plan including:

- sequencing process
- fabrication process
- pattern assembly process
- verification and checking process

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82.4.0 Sectionalize an engineering drawing.

82.4.1 Produce a layout including:
- full size
- contraction
- joint lines
- core prints
- draft angles
- loose pieces
- lifting points
- machining allowance

82.4.2 Describe types of joining methods including:
- glue
- screws
- saddle joints
- lap joints

82.4.3 Identify and determine core shapes and sizes.

82.4.4 Identify and determine core print sizes.

82.4.5 Identify and determine core print clearances.

82.4.6 Identify and determine parting lines.

82.5.0 Describe building aids used in pattern construction.

82.5.1 List and describe the application of building aids including:
- templates
- radius gauges
- profile gauges
- sweeps
- jigs and fixtures
- datum points
- follow board

82.5.2 Describe methods of establishing and checking building aid contours using:
- mylar drawings
- plotter printouts
- layout

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82.6.0 Create pattern equipment layout

82.6.1 Describe the reasons for producing a pattern layout including:
- pattern construction engineering
- full size building aid
- verification of moulding process
- verification of dimensional accuracy

82.6.2 List and describe the tools used to produce a pattern equipment layout including:
- protractor
- scribers
- combination square
- marking knife
- dividers
- verniers
- parallel gauge
- height gauge
- radius gauges
- shrink rules
- draft angle charts

82.6.3 List and describe the types of material used to produce layouts.
- pine
- hardboard
- plywood

82.7.0 Describe the use of templates to produce and verify sectional profiles and shapes.

82.7.1 Describe the application of templates including:
- checking contours for accuracy
- transferring information from shapes
- controlling the shape
- provide consistency of shapes on similar features

82.7.2 List and describe the hand tools used to produce templates including:
- chisel
- spoke shave
- files
- rasps
- measuring equipment

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82.7.3 Describe the machine tools used to produce templates including:
- profile sander
- sander
- vertical band saw
- bobbin sander
- CNC machining centre

82.8.0 Describe the process of rough cutting pattern components for assembly.

82.8.1 Describe use of measuring and checking devices used in rough cutting pattern components including:
- tape rule
- dividers
- verniers
- squares
- trammels
- template
- steel rule

82.8.2 Describe methods of removing excess material from the rough assembly using hand tools including:
- hand carving
- hand planing
- spoke shaving
- hand sawing

82.8.3 Describe methods of removing excess material from the rough assembly using machine tools including:
- lathes
- sanders
- CNC
- band saw
- table saw

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82.8.4 Describe roughing techniques using a vertical band saw including:
- type of material
- width of blade
- set of blade
- type of tooth
- feed and speed
- teeth per inch

82.8.5 Describe roughing techniques using a disc sander including:
- types of abrasives & grade
- speeds of sander
- direction of cut

82.8.6 Describe roughing techniques using a bobbin sander including:
- types of abrasive and grade
- speeds of sander
- direction of cut

82.8.7 Describe roughing techniques using a milling machine including:
- work holding methods
- types of cutters
- speeds and feeds

82.8.8 Describe roughing techniques using a wood lathe including:
- work holding methods
- types of cutters
- speeds and feeds

82.8.9 Describe roughing techniques using a metal lathe including:
- work holding methods
- types of cutters
- speeds and feeds

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82.9.0 Describe the assembly of basic pattern sections.

82.9.1 Identify the characteristics of wood as applied the assembly process including:
- grain direction
- quarter sawn or basic timber cuts
- wood deformities
- moisture content
- characteristics and properties
- sheet materials

82.9.2 Identify adhesives and the properties as applied to the assembly process including:
- polyvinyl
- epoxy
- super glues

82.9.3 Identify procedures and equipment for clamping and securing rough- cut materials including:
- sash cramp
- “C”clamps
- bar clamps
- pinch dogs
- weights
- vises

82.9.4 Describe the application of fasteners used in assembly including:
- nails
- screws
- dowels
- corrugated fasteners
- staples

82.9.5 Describe the assembly process including:
- laminating
- segment construction
- stave construction/barrel construction

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82.9.6 Describe the type and application of measuring instruments/checking devices including:
- height gauges
- calipers
- micrometers
- depth gauges
- protractors
- precision squares
- radius gauges

82.10.0 Describe the process of fabrication a resin pattern support frame

82.10.1 Describe building a pattern on the layout from datums and centre lines including:
- backbone/spine assembly
- assemble from a main body frame assembly
- dry joints
- tool datum's

82.10.2 Describe temporary materials as applied to building aids including:
- building aids used to produce parts
- building aids used to position parts on the workpiece

82.11.0 Describe the resin pattern tooling fabrication process.

82.11.1 Describe the production processes of resin pattern tooling including:
- release agent
- mould
- master
- filler block

82.11.2 List and describe the types of resin material including:
- gel coat
- quick cast
- epoxy resin
- urethane
- fiber glass
- plaster
- back filler
- backing clay
- polyester filler

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82.11.3 Describe the application of resin materials including:
- plastic patterns/coreboxes
- splash/core plug/pattern mould for fit
- jigs and fixtures
- stamping dies
- impeller vanes

82.11.4 Describe the application of types of tools and equipment used when working with resin materials including:
- measuring scales
- paint mixer
- vacuum chamber
- paint brushes
- mixing containers
- eye protection
- gloves
- ventilation
- respirators
- protective clothing
- barrier creams

82.12.0 Describe methods of inspecting the surface finish of resin pattern tooling.

82.12.1 Describe types of surface defects found on resin pattern tooling including:
- air pockets
- sink holes
- depressions/undercuts
- coarse spots
- stress cracks
- soft spots

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82.13.0 Describe the application, types, selection and characteristics of gel coat.

82.13.1 Describe characteristics of gel coat including:
- ease of application
- non flowing
- hard surface/shore hardness
- abrasive resistance
- chemical resistance
- high detail characteristics
- time required for application

82.13.2 Describe types of gel coat including:
- polyester
- epoxy
- urethane

82.13.3 Describe the applications of gel coating including:
- reverses
- new patterns and core boxes
- duplication of patterns/coreboxes

82.13.4 Describe methods of applying gel coat including:
- brush
- durable finish
- thin coating
- high detail production

82.14.0 Describe the process of fabricating a resin pattern support frame.

82.14.1 Describe the materials and steps used to produce support frames and backing materials of a resin pattern including:
- plywood
- hard/soft wood
- aluminum
- resin
- cutting material to size
- honey comb
- expanding foam

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82.15.0 Describe the methods required to produce a aluminum support casting for resin pattern tooling.

82.15.1 Describe the methods used to produce a master one-off polystyrene or wood pattern to produce an aluminum casting in order to produce a resin lined aluminum core box including:

- determine casting wall thickness
- lay-out wall sections
  - strengthening ribs
  - bolt down bosses on sheet polystyrene
- rough cut wall sections
  - strengthening ribs
  - bolt down bosses
- assemble polystyrene pattern components
- shrinkage allowance
- determine the outside sizes of casting

82.16.0 Describe the production and the application of lightener/filler blocks used in the resin pattern.

82.16.1 Describe the application of lightener/filler blocks including:

- weight reduction
- material savings
- exothermic heat reduction
- strength

82.16.2 Describe the production of filler blocks including:

- determine the size of the filler block
- determine the filler block material
- determine the section of the resin
- rough cutting procedures

82.16.3 Describe the method of suspending and locating lightener/filler blocks/frame inside the mould including:

- describe extraction methods
- position block/frame to produce required wall sections
- locate and secure block/frame

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82.17.0 Describe the application of release agents.

82.17.1 Describe the properties of release agents for various materials including:
- urethane
- epoxy
- polyester

82.17.2 Describe methods of applying release agents including:
- brush
- spray
- cloth

82.17.3 Describe methods of mould preparation and surface finish requirements for resin pattern tooling including:
- inspecting surface for defects
  - air pockets
  - sink holes
  - depressions/undercuts
  - coarse spots
  - stress cracks
  - soft spots
- repairing defects with polyester putty
- sanding to specified finish
- sealer/release agent compatibility

82.18.0 Describe the types and application of resins, catalysts and fillers.

82.18.1 Describe the types and application of resin material including:
- gel coat
- quick cast
- epoxy resin
- urethane
- fiber glass
- plaster
- back filler
- backing clay
- polyester filler

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82.18.2 Describe the process of weighing and mixing resins including:
- calculating resin weight by volume required
- selecting resin material
- determining mix ratio with hardener/catalyst
- determining the requirement for filler
- weighing resin
- adding filler
- mix resin and catalyst
- de-gassing
- environmental effects on resins
  - temperature
  - shelf life
  - -pot life
  - -humidity

82.19.0 Describe the process of pouring resin to produce resin pattern tooling.

82.19.1 Describe the types of resin moulds including:
- open faced
- closed

82.19.2 Describe the process of pouring resin into an open faced mould including:
- applying plasticine dam
- pouring resin into open cavity above joint line

82.19.3 Describe the process of finishing a component produced in an open faced mould including:
- milling
- sanding
- filling
- chiseling
- carving

82.19.4 Describe the process of pouring resin into a closed mould including:
- drill pouring hole
- drill vent holes
- attach feeder to pouring hole
- pour resin into feeder
- inspect for leaks

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82.19.5 Describe the steps required to finish a component produced in a closed mould including:
- de-moulding the part
- removing the feeder
- removing the vents
- removing fins and flash
- inspecting for defects

82.20.0 Describe the lay-up process to gel coated surface.

82.20.1 Describe types of reinforcing materials including:
- grades of fiberglass cloth
- cloth
- interwoven mat
- chop strand mat
- chop strand

82.20.2 Describe the uses of reinforcing materials including:
- strength
- rigidity
- stability
- exothermic heat reduction
- weight reduction

82.20.3 Describe the process of applying reinforcement material in the lay up process including:
- cutting the fiberglass to the required shape and size
- mixing resin
- soaking fiberglass with resin
- applying layer on gel coat
- applying second coat overlapping the first coat
- applying further coats to develop required thickness

82.21.0 Describe the process of stabilizing reinforcing material.

82.21.1 Describe the types of back up materials including:
- backing clay
- polyester resin
- stone flour
- plywood
- chop strand
- micro balloons
- expanding foam

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82.21.2 Describe the uses of reinforcing material including:
- strength
- rigidity
- weight reduction
- exothermic heat reduction

82.21.3 Describe the process of stabilizing the reinforcing material including:
- mixing resin
- adding chop strand, back filler or flour
- applying to lay up material
- mixing two part backing clay to the same colour
- rolling to the required thickness

82.22.0 Describe the types of tools, equipment and extraction methods used for the extraction of the moulded part/tooling.

82.22.1 Describe the methods and tools used in extraction part/tooling including:
- hammer
- compressed air
- lag bolts
- wedges & levers
- draw plates with threaded rod
- jacks

82.23.0 Describe the final inspection process of the moulded part/tooling.

82.23.1 Describe methods of inspecting for defects including:
- visual
- manual testing
- resonance

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82.24.0 Describe the steps required to produce and inspect a pressure cast match plate.

82.24.1 Describe the steps required to produce a pressure cast match plate including:
- producing a parting line on a master pattern
- pouring a plaster mould
- removing master pattern from mould
- oven drying complete plaster mould
- adding spacer to produce match plate thickness and sand locks
- adding chills and reinforcing as required
- casting the aluminium match plate under pressure
- cleaning and inspecting finished match plate

82.24.2 Describe defects of pressure cast match plates and the causes including:
- gas porosity
- draws
- sinks
- miss-match
- blow holes
- stress cracks
- swell

82.24.3 Describe pressure cast match plate checking procedures using:
- straight edge
- height gauge
- callipers
- ruler

82.24.4 Describe procedures for correcting defects including:
- machining inserts
- applying resin putty
- welding
- rejecting match plate

82.25.0 Describe the process of machining the back face of a pressure cast cope and drag pattern.

82.25.1 Describe the method of machining a cope and drag pattern plate parallel to the mould joint line.

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82.26.0 Describe the methods of finishing the surface of a pressure cast match plate.

82.26.1 Describe the types and application of hand tools used in the surfacing process including:

- hand files
- scrapers
- die grinders
- abrasive mandrels
- emery cloth
- abrasives

82.27.0 Describe the process of drilling mounting holes in a pressure cast match plate.

82.27.1 Describe steps and methods of drilling mounting holes including:

- layout holes
- drill jig/fixture
- locate and secure
- select drilling machine
- select drill size
- inspect drill
- drill mounting holes
- countersink

82.28.0 Describe methods of fabricating and installing gating systems.

82.28.1 Describe the types of materials used in the construction of gating and installation components including:

- hard wood
- soft wood
- metal
- resin
- wood screws
- machine screws
- bolts

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82.29.0 Describe the process of fastening wear plates/flask slides-guides on cast match plates.

82.29.1 Describe the function of wear plates/flask slides-guides including:
- locating cope and drag mould halves
- wear prevention

82.29.2 Describe the types of wear plates/flask slides-guides.

82.30.0 Describe the methods of determining the position of a pattern on a moulding plate.

82.30.1 Describe the features and characteristics which determine the positioning of a pattern on a moulding plate including:
- gating locations
- distance from flask wall to pattern

82.31.0 Describe the process of transferring dowel holes on a pattern plate.

82.31.1 Describe techniques of transferring dowel holes on a pattern plate including face to face.

82.31.2 Describe the process of inserting shift buttons including:
- drill pilot hole
- cut cavity using form tool
- install male button
- install rivet

82.31.3 Describe the process of matching pattern halves including:
- selecting dowel hole locations
- drilling and reaming one half of the pattern
- transferring holes
- scribing centre lines

82.32.0 Describe the process of fastening a pattern to a pattern plate.

82.32.1 Describe the methods of fastening a pattern to a pattern plate including:
- matching accuracy
- selection of fastener locations
- selection of type of fastener

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82.33.0 Describe the process of production pattern tooling from metal stock castings or resin tooling board.

82.33.1 Perform calculations to determine sizes of stock material or inspect casting for machining allowance.

82.33.2 Describe the factors affecting the following material choices used for machined pattern tooling including:
- moulding process
- life expectancy of pattern equipment
- number of castings required
- tolerances
- aluminum
- cast-iron
- tooling resin board
- brass
- bronze
- steel

82.33.3 Describe techniques used to trace pattern tooling including:
- pantograph
- hydraulic tracing
- electronic tracing

82.34.0 Describe the automated core box manufacturing process.

82.34.1 Describe the type and application of items in the automated core box manufacturing process including:
- ejection systems
- backing plates
- seals
- vents
- blow tubes
- gassing plates
- blow plates
- dowels

82.35.0 Describe the process of fabricating a core setting jig to locate and place the core in the mould.

82.35.1 Describe the purpose of the core setting jig including:
- stabilizing a core in the mould
- setting multiple cores
- accuracy of location

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82.35.2 Describe the types of material used to produce a core setting jig including:
- metal
- wood
- resin

82.36.0 Describe the process of fabricating a core assembly fixture to facilitate the assembly of several cores.

82.36.1 Describe the methods of using several cores in the assembly process including assembling multiple cores as one entity prior to setting in the mould.

82.37.0 Describe the process of fabricating a go-n0-go gauge to check the profile and dimensional accuracy of the casting.

82.37.1 Describe the features and functions of a go-no-go gauge including:
- minimum
- maximum
- size
- shape
- application

82.37.2 Describe the possibilities for and causes of errors in the moulding process including:
- mould shift
- core shift
- casting distortion
- uneven shrinkage
- run outs
- sand mix

82.38.0 Describe the process of fabricating a core support fixture to maintain the shape, size, profile structure of the core during the curing process.

82.38.1 Describe the core making process including:
- oil sand
- cold box
- hot box
- air set
- zircon

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82.38.2 Describe the conditions that cause core distortion including:
- rat tail
- miss match
- core storage
- sagging

82.38.3 Describe the application of the core support fixture including:
- maintaining during the curing process
  - shape
  - size
  - structure
  - profile
- transferring between processes
- maintaining during the storage process
  - shape
  - size
  - structure
  - profile

82.39.0 Describe the production of custom fabricated specialized lost foam pattern tooling.

82.39.1 Describe the features of polystyrene pattern tooling components including no draft.

82.39.2 Describe the production methods of polystyrene pattern tooling.

82.39.3 Describe the purpose of polystyrene workpiece construction material including:
- types of foam
- types of adhesives
- types of tape

82.39.4 Sectionalize the engineering drawing for polystyrene pattern construction including:
- split lines for taping
- construction joints
- sketch shapes to check joints

82.39.5 Describe the process of rough cutting, taping and squaring up foam blocks.

82.39.6 Determine block sizes needed to reach overall dimensions of the polystyrene pattern.

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82.39.7 Discuss the types of specialized cutting tools and blades used to shape polystyrene.

82.39.8 Describe the applications of tape used in temporary joints.

82.39.9 Describe methods of rough cutting foam blocks including:
- band saw
- table saw
- sander

82.39.10 Describe the layout process for polystyrene material used in pattern tooling.

82.39.11 Describe the process of cutting and finishing polystyrene patterns.

82.39.12 Describe the types of hand cutting tools used to cut polystyrene.

82.39.13 Describe the process of assembling fabricated polystyrene parts.

82.39.14 Describe the finishing process for polystyrene patterns including:
- lathe finishing
- milling finishing
- hand finishing

82.39.15 Describe the process of filling and gluing fabricated polystyrene fillets.

82.39.16 Describe the process of finalizing the surface of a polystyrene pattern.

82.39.17 Describe the surface and structural defects or faults in polystyrene pattern tooling including:
- dents
- impressions
- broken corners

82.39.18 Select and describe the application of types of gluing compounds, sealers or tapes used for the surfacing process.

82.39.19 Describe tools and equipment used in the surfacing process.

82.39.20 Describe the inspection process of polystyrene pattern tooling.

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82.40.0 Describe the correct application and care of layout tools.

82.40.1 Describe the correct application and care of pattern making tools including:

- rules
  - standard
  - contraction or shrink
  - tape
  - straight edge
- callipers
  - inside
  - outside
  - hermaphrodite
- gauges
  - surface gauge
  - vernier height gauge

82.40.2 Describe the correct application and care of layout tools including:

- squares
  - combination
  - try square
  - set square
  - protractors
  - framing square
- bevels
  - sliding (T) bevel
- dividers
  - spring
  - rigid
- trammels
  - divider points
  - inside calliper points
  - outside calliper points
- layout Knife
- pencil

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82.40.3 Describe the correct application and care of hand tools including:

- planes
  - jointer
  - fore
  - jack
  - smooth
  - block
  - rabbet
  - round sole
  - core box
  - router
  - circular
- saws
  - hand
  - back
  - cabinet
  - keyhole
- chisels
- gouges
- drawknife
- spoke shave
- hammers
  - brad hammer
  - patternmaker`s long head
- mallet
- magnetic brad set
- brad awl
- centre punch
- ratchet bit brace
- brace bits
  - auger
  - twist drill
  - forstner
  - expansive
  - countersink
  - rose
  - screw drivers
  - robertson
  - philips
  - slotted

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- hand drill
- drills
- pilers
- screw drivers
- filleting tools
- glue scaper
- sharpening stones
- slip stone
- leather strop
- pinch dogs
- bench vice
  - woodworkers
  - pattenmaker
  - machinists
- clamps
  - hand screws
  - “C” clamps
  - bar clamp
- spirit level
- rasp
- abrasive paper

82.41 Identify and describe the make up and applications of woodworking joints.

82.41.1 Describe the types of joints used in patternmaking including:

- butt joints
- butt dowel joints
- rabbet joints
- Dado joints
  - blind or stop
  - dovetail dado
  - corner
- laptop
  - cross lap
- mitre joints
- biscuit

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82.41.2 Describe methods of strengthening joints including:
- corner blocks
- glue blocks
- corner brackets
- splines
- keys
- screws
- staples
- pin nails

82.42.0 Describe the assembly of mould components.

82.42.1 Describe mould assemblies including:
- blow moulding
- die casting
- thermo vacuum forming
- rotational moulding

82.43.0 Describe pattern component hand finishing/polishing processes and techniques.

82.43.1 Describe finishing and polishing processes and procedures used to ensure surface conformity by determining:
- internal radii
- external radii
- contours
- inside/outside corners
- surface finish

82.43.2 Select hand-finishing and polishing process and equipment including:
- electrical hand/power grinders
- rotary cutter (burrs) files
- profiling
- reciprocating units
- scrapers

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Instructional and Delivery Strategies
Lecture
Demonstration
Practical Lab Assignments
E-Learning

Reference Material (not limited to)
Pattern Making Technology Foundry Practices

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
45%	25%	30%

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