ONTARIO COLLEGE OF TRADES

ORDRE DES MÉTIERS DE L'ONTARIO

Apprenticeship Curriculum Standard

Pattern Maker

Level 3

443A

2004

Hours Disclaimer**:**

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.

Please Note:

Apprenticeship Training and Curriculum Standards were developed by the Ministry of Training, Colleges and Universities (MTCU). As of April 8th, 2013, the Ontario College of Trades (College) has become responsible for the development and maintenance of these standards. The College is carrying over existing standards without any changes.

However, because the Apprenticeship Training and Curriculum Standards documents were developed under either the *Trades Qualification and Apprenticeship Act* (TQAA) or the *Apprenticeship and Certification Act, 1998* (ACA), the definitions contained in these documents may no longer be accurate and may not be reflective of the *Ontario College of Trades and Apprenticeship Act, 2009* (OCTAA) as the new trades legislation in the province. The College will update these definitions in the future.

Meanwhile, please refer to the College's website (www.collegeoftrades.ca) for the most accurate and up-to-date information about the College. For information on OCTAA and its regulations, please visit: www.collegeoftrades.ca/about/legislation-and-regulations.

Table of Contents

INTRODUCTION

The Level 3 – Pattern Maker has been developed in keeping with the prescribed Ministry of Training, Colleges and Universities (MTCU) 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 Training, Colleges and Universities 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.

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 Training, Colleges and Universities 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 MTCU in consultation with industry advisory groups. The development was completed using a process and format approved by MTCU.

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

Summary of Total Program In-School Training Hours

Reportable Subjects	Total	Theory	Practical
Engineering Drawings, Charts & Tables	30	30	0
Patternmaking Machining Technology	15	15	0
NC/CNC Technology for Patternmaking	24	24	0
Casting Technology	66	50	16
Patternmaking Technology	105	68	37
Total	**240**	**187**	**53**

Number: 83.0

Title: Engineering Drawings, Charts & Tables Technology

Duration: 15 Total Hours

Theory: 15 hours Practical: 0 hours

Prerequisites: L1 - CC - Units 2.0, 3.0, 4.0, 5.0, 8.0, 9.0, 10.0
PM L2 - Units 76.0, 77.0, 78.0, 79

Co-requisites: PM L3 - Units 84.0, 85.0, 86.0, 87.0

Cross-Reference to Learning Outcomes/Performance Objectives:
PM - U5510 to U5518

General Learning Outcome:

The apprentice is able to read casting part and assembly drawings, describe dimensional terminology and use pattern building reference material, charts and table.

Hrs.	No.	Outcomes
6	83.1	Read and interpret casting, part and assembly.
6	83.2	Describe dimensional terminology and practices.
3	83.3	Describe the use of pattern building reference materials, charts, and tables.
7.5	83.4	Create isometric drawings from orthographic views.
7.5	83.5	Construct volutes for a pump casting.

Learning Content:

83.1.0 Read and interpret casting, part, and assembly drawings.

83.1.1 Describe the types and applications of casting, pattern tooling components including:
- mould plates
- clamping plates
- ejector plates
- parallels
- sprue bushings
- core/cavity inserts
- slides
- standard accessories
- springs
- seals

83.1.2 Describe the drawing scale.

83.1.3 Describe the language of components prints, symbols, abbreviations, and specifications including:
- bill of material
- graphic shape
- symbols
- scales
- title block
- surface finish
- engineering change notice (ECN)
- detail drawings

83.1.4 Describe fractional, decimal, and metric dimensional values including:
- shape
- fits
- allowances
- angles
- nominal sizes
- tolerances
- references
- concentricity
- squareness
- parallelism

Learning Content:

83.1.5 Describe the process of machining allowances including:
- spot face
- drilled holes
- machined face

83.1.6 Read and interpret engineering drawings including:
- casting
- assembly
- part
- machining

83.1.7 Describe the symbols and abbreviations of pattern tooling part/product drawings to determine:
- part/product material
- surface finish
- secondary operations
- workpiece material
- dimensions

83.1.8 Describe fractional, decimal, and metric dimensional values as applied in engineering drawings.

Learning Content:

83.2.0 Describe dimensional terminology and practices.

83.2.1 Describe geometric dimensional terms and characteristics including:

- regardless of feature size
- least material condition
- basic dimensions
- datums
- feature control frame
- symbols
- individual and related features
- datum targets
- terms
- maximum material condition
- pictorial
- schematic
- simplified

83.2.2 Describe geometric form control symbols including:

- flatness
- straightness
- circularity
- cylindricity
- profile of a line
- profile of a surface
- perpendicularity
- angularity
- parallelism
- circular runout
- position
- concentricity
- co planarity
- symmetry
- datum targets
- correlative tolerance

Learning Content:

83.3.0 Describe the use of pattern building reference materials, charts, and tables.

83.3.1 Describe geometric dimensional terms and characteristics including:
- shrinkage/contraction
- draft
- ejector/core pin
- cored threads/studs
- wear ratio
- hardness
- applications
- types
- format
- standards
- abbreviations
- terminology
- graduations
- accuracy
- limitations

83.4.0 Create isometric drawings from orthographic views.

83.4.1 Draw three dimensional representations of pattern components to scale from two dimensional drawings.

83.5.0 Construct volutes for a pump casting.

83.5.1 Calculate the overall size of view of volute.

83.5.2 Construct volutes from given dimensions.

Evaluation Structure:

Theory Testing: 60%

Application Exercises: 0%

Final Assessment: 40%

Instructional and Delivery Strategies

Lecture
Demonstration
Practical Lab Assignments
E-Learning

Reference Material (not limited to)

Pattern Making Technology Foundry Practices

Number: 84.0

Title: **Patternmaking Machining Technology**

Duration: 15 Total Hours
Theory: 15 hours Practical: 0 hours

Prerequisites: L1 - CC - Units 2.0, 3.0, 4.0, 5.0, 8.0, 9.0, 10.0
PM L2 - Units 76.0, 77.0, 78.0, 79

Co-requisites: PM L3 - Units 83.0, 84.0

Cross-Reference to Learning Outcomes/Performance Objectives:
PM - U5510, U5511, U5512, U5514, U5516, U5517, U5518

General Learning Outcome:

The apprentice will be able to describe milling machine controls, machine attachments, cutting fluids, cutting tools and tool holders. They will be able to perform milling techniques to machine pattern tooling components.

Hrs.	No.	Outcomes
.05	84.1	Observe safe working procedures when setting up and operating milling machines.
3	84.2	Describe machine controls, coolant requirements, and milling attachments to machine pattern tooling components.
3	84.3	Identify, select, and assemble milling cutting tools and tool holders.
6	84.4	Mill duplicating aids for a duplicator or pantograph.
2.5	84.5	Perform milling techniques.

Learning Content:

84.1.0 Observe safe working procedures when setting up and operating milling machines.

84.1.1 Describe safety hazards which may occur during milling set-up and operational procedures.

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

84.2.0 Describe machine controls, coolant requirements, and milling attachments to machine pattern tooling components.

84.2.1 Describe milling attachments including:
- horizontal head
- vertical head
- high speed head
- digital read-out
- column extension

84.2.2 Describe milling work holding devices and accessories including:
- fixtures/jigs
- rotary table

Learning Content:

84.3.0 Identify, select, and assemble milling cutting tools and tool holders.

84.3.1 Describe cutting tools and tool holders including:
- sanding disc
- treppanner
- safety planer

84.3.2 Identify, select, and describe the assembly of cutting tools and tool holders by determining:
- type
- size
- cutting tool material
- shape
- application
- operating principles
- holding/mounting characteristics
- cutting tool geometry
- tolerances / surface finish

Learning Content:

84.4.0 Mill duplicating aids for a duplicator or pantograph.

84.4.1 Identify duplicator/pantograph operating principles and design parameters including:
- size
- cutting capacity
- dimensional capacity
- roughing cuts
- finishing condition
- speeds and feeds
- mounting of work piece
- master patterns
- holding requirements of tool and stylus/trace
- ratios
- type, shape, and size of stylus
- limits and clearances
- engraving symbols
- mirror imaging

84.4.2 Describe process for fabricating duplicating aids by determining:
- template set up and verification
- model location and clamping
- stylus forms and types
- cutter selection
- finish allowance
- surface finish condition
- machining procedures
- material selection

84.5.0 Perform milling techniques.

84.5.1 Describe indexing techniques using dividing head/rotary table to perform differential indexing.

84.5.2 Describe milling of forms using form cutters.

Evaluation Structure:

Theory Testing: 60%

Application Exercises: 0%

Final Assessment: 40%

Instructional and Delivery Strategies

Lecture
Demonstration
Practical Lab Assignments
E-Learning

Reference Material (not limited to)

Pattern Making Technology Foundry Practices

Number: 85.0

Title: **NC/CNC TECHNOLOGY FOR PATTERN MAKER**

Duration: 24 Total Hours
Theory: 24 hours Practical: 0 hours

Prerequisites: L1 - CC - Units 2.0, 3.0, 4.0, 5.0, 8.0, 9.0, 10.0
PM L2 - Units 76.0, 77.0, 78.0, 79.0

Co-requisites: PM L3 – Units 83.0, 84.0, 87.0

Cross-Reference to Learning Outcomes/Performance Objectives:
PM - U5511, U5512, U5516, U5517, U5518

General Learning Outcome:

The apprentice will be able to read and interpret NC/CNC process documentation, describe primary, secondary and rotary axis designations. They will be able to describe manual program interruptions and verify program operations.

Hrs.	No.	Outcomes
.05	85.1	Observe safe working procedures when setting up and operating NC/CNC machines
1.0	85.2	Read and interpret NC/CNC process documentation
1.5	85.3	Describe the Cartesian Coordinate System including primary, secondary, and rotary axis designations for NC/CNC machines
1.0	85.4	Describe manual program interruption
3	85.5	Describe circular interpolation methods
17	85.6	Input and verify programs for NC/CNC machines to perform linear and circular machining operations

Learning Content:

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

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

85.1.2 Observe safe working habits including:
- wearing all required protective clothing and gear
- good housekeeping
- start-up and shut-off procedures
- securing and stabilizing a work piece

85.2.0 Read and interpret NC/CNC process documentation.

85.2.1 Read and interpret job documentation to determine job requirements.

85.2.2 Compile job set-up sheets by identifying:
- axis alignment
- locating points
- work holding methods
- program zero

85.2.3 Compile tooling list by identifying:
- tools
- tool holders
- type of tool material
- set-up dimensions
- tool numbers
- tool offsets

Learning Content:

85.3.0 Describe the Cartesian Co-ordinate System including primary, secondary, and rotary axis designations for NC/CNC machines.

85.3.1 Determine and select coordinate systems for turning centres including:
- two-axis lathe
- three-axis lathe
- four-axis lathe

85.3.2 Determine and select coordinate systems for machining centres including:
- vertical machining centre
- horizontal machining centre
- rotary axis
- multiple heads

Learning Content:

85.4.0 Describe manual program interruption.

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

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

85.4.3 Describe program data override including:
- rapid motion override
- spindle speed override
- feed rate override
- dry run operation
- manual absolute setting
- auxilliary lock functions
- machine lock
- practical applications

85.4.4 Describe system options including:
- graphic display
- in-process gauging
- stored stroke limits
- drawing dimensions input
- machining cycles
- cutting tool animation

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

Learning Content:

85.5.0 Describe circular interpolation methods.

85.5.1 Describe circular interpolation planes including:
- X - Y plane
- Z - X plane
- Y - Z plane
- arc centre modifiers

85.5.2 Describe circular interpolation methods.
- arc modifiers
- radius
- quadrants
- circles
- cutter radius compensation

85.6.0 Input and verify programs for NC/CNC machines to perform linear and circular machining operations.

85.6.1 Use codes to specify word and block structures including:
- M - codes
- G - codes
- program identification
- O-block
- ISO and EIA identification
- block number
- word
- starting number
- increments
- end of block
- carriage return
- block description
- status block (safe block)
- message block (program comments)
- conflicting words
- modal programming values
- execution priority

Learning Content:

85.6.2 Use codes to specify dimensions including:
- metric/inch selection
- absolute/incremental selection
- absolute data input
- incremental data input
- combination in the same block
- diameter
- radius

85.6.3 Use codes to invoke speeds and feed including:
- spindle function:
  - S-code
  - spindle rotation direction
  - spindle stop
  - spindle orientation
  - spindle speed code number
  - spindle speed (RPM)
  - peripheral speed
  -constant surface speed
- feed rate control:
  - feed rate function
  - feed rate per minute
  - feed rate per revolution
  - maximum feed rate per revolution
  - feed rate override and feed hold
  - feed rate override and functions
  - E-word

85.6.4 Use codes to specify tool number, tool length offset, and tool radius offset.

85.6.5 Use codes to establish reference points including:
- machine reference point
  - manufacturer's setting
- workpiece reference point
  - program zero application
  - program zero turning systems
- position register command
  - G92 command
  - G54 command

Learning Content:

85.6.6 Use codes to execute rapid positioning including:
- rapid traverse motion
  - positioning mode
  - G00 command
- tool path
  - work piece approach
  - single axis motion
  - multi-axis motion
  - straight angular motion
  - type of motion and time comparison
- rapid motion formulae
  - axis motion completion
  - reduction of rapid motion rate

85.6.7 Use codes to establish zero return commands including:
- zero return commands
- return to machine zero
- return position check
- return from machine zero
- second machine zero

85.6.8 Use codes to create contouring programs including:
- cutter path determination
- linear interpolation
- circular interpolation
- rough and finished shape

85.6.9 Describe cutter radius compensation including:
- cutter compensation right
- cutter compensation left
- cutter radius offset table
- cutter radius wear offset
- cutter radius setting

85.6.10 Evaluate and document a manual program to machine a workpiece that includes drilling, tapping, and profiling using cutter compensation.
- tool selection
- part zero location
- order of operations
- program structure

Learning Content:

85.6.11 Describe downloading and executing procedures.

85.6.12 Describes sources of geometric data including:
- engineering drawings
- translators
  - DXF
  - IGES

85.6.13 Describe methods of generating programs including:
- manual programming
- machine control interaction
- CAD/CAM systems

Evaluation Structure:

Theory Testing: 60%

Application Exercises: 0%

Final Assessment: 40 %

Instructional and Delivery Strategies

Lecture
Demonstration
Practical Lab Assignments
E-Learning

Reference Material (not limited to)

Pattern Making Technology Foundry Practices

Number: 86.0

Title: Casting Technology

Duration: 66 Total Hours
Theory: 50 hours Practical: 16 hours

Prerequisites: L1 -CC - Units 2.0, 3.0, 4.0, 5.0, 8.0, 9.0, 10.0
PM L2 - Units 76.0, 77.0, 78.0, 81.0, 82.0

Co-requisites: PM L3 - Units 83.0, 84.0, 85.0

Cross-Reference to Learning Outcomes/Performance Objectives
PM - U5514, U5515, U5516, U5517

General Learning Outcome:

The apprentice will be able to inspect castings for common defects, describe types of destructive and non-destructive material testing. They will be able to describe the application of polystyrene patterns and describe the investment casting process.

Hrs.	No.	Outcomes
12	86.1	Describe the methods of casting inspection and list common defects and the causes.
9	86.2	Describe expanded polystyrene foam pattern production manufacturing and the applications.
9	86.3	Describe the investment casting method.
9	86.4	Describe the die casting process.
1	86.5	Observe safe working procedures associated with heat-treating furnaces.
6	86.6	Describe ferrous metal heat-treating processes.
1	86.7	Describe hardness testing methods.
10	86.8	Describe elements and machineability of non-ferrous metals.
4.5	86.9	Describe various types of production mould machines.
4.5	86.10	Describe various types of production core boxes.

Learning Content:

86.1.0 Describe the methods of casting inspection and list common defects and the causes.

86.1.1 Describe the common types of casting defects including:
- cracks
- porosity
- shrinkage
- surface defects
- misrun
- shift
- sink hole
- core floatation
- cold shut
- core shift
- burn in
- swell
- scale

86.1.2 List and describe the types of destructive and non-destructive tests used in casting inspection including:
- visual
- chalk testing
- x-ray
- manual
  - height gages
  - layout table
  - callipers
  - templates
- checking fixtures
- coordinate measuring machine
- pressure testing
- test bars
  - Rockwell hardness testing
  - tensile testing
  - shear testing
- dye penetrate testing
- cross sections

Learning Content:

86.2.0 Describe expanded polystyrene foam pattern production manufacturing and the applications.

86.2.1 Review the types of expanded polystyrene (EPS) aluminium production moulds including:
- vented
  - general consumer products
  - cylinder heads
  - cylinder blocks
  - manifolds
  - pump casings
- ventless
  - production EPS patterns

86.2.2 List and describe the types of general consumer products produced from EPS moulds including:
- packaging
- insulation
- recreational products
- automotive
- aircraft
- mining
- food packaging

86.2.3 Describe in detail the expanded polystyrene moulding process used in the dry silica sand.

86.2.4 Describe the advantages and disadvantages of the automotive EPS moulding process including:
- surface finish
- absence of cores
- consistency of product
- sand reclamation

86.2.5 List and describe the patternmaking considerations when producing patterns for the EPS process.

Learning Content:

86.2.6 Describe the fabricated polystyrene pattern moulding process including:
- refractory coating
- gating
- moulding
- pouring
- pattern removal

86.2.7 Discuss casting applications and volumes required of fabricated polystyrene patterns.

86.2.8 Describe the Pattern Maker's considerations when producing fabricated polystyrene patterns.

Learning Content:

86.3.0 Describe the investment casting method.

86.3.1 List and describe the advantages and disadvantages of investment casting including:
- accuracy
- repeatability
- surface finish
- no flash
- no draft
- no core
- small complex shapes
- climate controlled environment required
- expensive process
- casting quality

86.3.2 Describe the investment casting process including:
- create wax pattern
- tree
- slurry
- bake
- curing process
- shake out

86.3.3 List and describe the Pattern Maker's considerations when producing tooling for the investment casting process.

86.3.4 Compare the investment casting method to the EPS moulding process including:
- advantages
- disadvantages

86.3.5 Describe the impact of rapid prototyping technology on the investment casting process.

Learning Content:

86.4.0 Describe the die casting process.

86.4.1 Describe in detail the die casting process and the types of dies including:
- gravity feed
- pressure feed

86.4.2 Discuss the type of products produced by the die casting process including:
- toys
- pump casings
- automotive brackets

86.4.3 List and describe the Pattern Maker's considerations when producing moulds for the die casting process.

86.5.0 Observe safe working procedures associated with heat-treating furnaces.

86.5.1 Describe furnace heat-treating safety procedures and equipment including:
- gloves
- aprons
- arm shields
- face shields
- checking workpieces
- toxic fumes
- accident reporting
- safe working habits

Learning Content:

86.6.0 Describe ferrous metal heat-treating processes.

86.6.1 Describe the process for hardening of ferrous metals including:
- heat-treating specifications
- quenching media
- metallurgical structural change
- hardness obtainable
- strength
- toughness
- wear resistance
- machineability
- distortion
- work preparation procedures
- time-temperature cycle
- depth of hardness
- quenching procedures
- pre-heating
- cooling

86.6.2 Describe the process for tempering of ferrous metals including:
- heat-treating specifications
- metallurgical structural change
- hardness
- strength
- toughness
- wear resistance
- machineability
- type of furnace
- work preparation procedures
- temperature colours
- workpiece application colours

86.6.3 Describe the process for annealing of ferrous metals including:
- heat- treating specifications
- internal stresses
- machineability
- type of furnace
- cooling procedures

Learning Content:

86.6.4 Describe the process for normalizing of ferrous metals including:
- heat- treating specifications
- internal stresses
- grain refinement
- machineability
- type of furnace
- cooling procedures

86.7.0 Describe hardness testing methods.

86.7.1 Identify hardness testing methods and procedures.

86.7.2 Describe the types and operating principles of hardness testers including:
- Rockwell
- Brinell

86.7.3 Identify the range and values of hardness tester scales.

86.8.0 Describe elements and machineability of non-ferrous metals.

86.8.1 Describe elements and machinability of cast metals including:
- shapes
- sizes
- tolerances
- surface conditions
- SAE/ASTM code classifications
- manufacturer's code classifications
- applications
- chemical/physical properties
- alloying elements
- tensile strength
- malleability
- ductility
- machinability
- castability
- weight comparison
- hardness
- corrosion resistance
- wear resistance
- colour
- melting point

Learning Content:

86.9.0 Describe various types of production mould machines.

86.9.1 Describe various types of production mould machines including:
- squeeze
- roll -over
- carousel
- vertical
- horizontal
- jolt squeeze

86.9 .2 Describe the application of various types of production mould machines.

86.10.0 Describe various types of production core machines.

86.10.1 Describe various types of production core machines including:
- cold box
  - vertical
  - horizontal
- hot box

86.10.2 Describe the application of various types of production core machines.

86.10.3 List and describe the types of ejector system for production coreboxes including:
- hot box
- cold box

Evaluation Structure:

Theory Testing: 55%

Application Exercises: 15%

Final Assessment: 30%

Instructional and Delivery Strategies

Lecture
Demonstration
Practical Lab Assignments
E-Learning

Reference Material (not limited to)

Pattern Making Technology Foundry Practices

Number: 87.0

Title: **PATTERN MAKING TECHNOLOGY**

Duration: 105 hrs
Theory: 68 hours Practical: 37 hours

Prerequisites: CC - Units 2.0, 3.0, 4.0, 5.0, 8.0, 9.0, 10.0

Co-requisites: PM L2 - Units 76.0 to 86.0

Cross-Reference to Learning Outcomes/Performance Objectives
PM - U5510 to U5518

General Learning Outcome:

The apprentice will be able to plan for the pattern build process, describe resin pattern tooling fabrication, applications of resins, catalysts and fillers. They will be able to describe the layout process, inspection processes and gating systems.

Hrs.	No.	Outcomes
.05	87.1	Observe safe working habits when performing pattern tooling fabrication procedures.
12	87.2	Devise and detail a plan for the pattern-build process.
12	87.3	Organize the pattern-build process.
9	87.4	Sectionalize an engineering drawing.
4	87.5	Describe building aids used in pattern construction.
6	87.6	Describe the process of creating a pattern equipment layout.
6	87.7	Describe the assembly of pattern sections.
3	87.8	Describe assembly techniques and processes.
3	87.9	Describe the resin pattern tooling fabrication process.
3	87.10	Describe the process of fabrication a resin pattern support frame.
3	87.11	Describe the methods required to produce an aluminum support casting for resin pattern tooling.
1.5	87.12	Describe the application of release agents.
3	87.13	Describe the types and application of resins, catalysts and fillers.
3	87.14	Describe the process of pouring resin to produce resin pattern Tooling
1	87.15	Describe the lay-up process to gel coated surface.
2	87.16	Describe the process of stabilizing reinforcing material.
3	87.17	Describe the steps required to produce and inspect a pressure cast match plate.
12	87.18	Describe the methods of fabricating and installing gating systems.
1	87.19	Describe the process of producing pattern tooling from metal stock, castings or resin tooling board.
9	87.20	Describe the types of plastic forming/moulding processes.
8	87.21	Describe the core box set-up process.

Learning Content:

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

87.1.1 Describe safety hazards which may occur during the building of a mould.

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

87.2.0 Devise and detail a plan for the pattern-build process.

87.2.1 Visualize 3D model of the work piece from orthographic views.

87.2.2 Determine 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

87.2.3 Evaluate the drawing for errors and missing information.

87.2.4 Identify machined surfaces.

87.2.5 Identify datum locations and centre lines.

87.2.6 Identify set-up points.

87.2.7 Evaluate tolerances and allowances.

87.2.8 Determine casting material/shrink from job specifications including:
- draft
- moulding process
- pattern/casting identification

87.2.9 List sources and types of reference material.

Learning Content:

87.2.10 Determine material requirements based on moulding process and production volume including:
- select the type of material for the required production process

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

87.2.12 Select the required pattern components from a specific drawing.

87.3.0 Organize the pattern-build process.

87.3.1 Develop a pattern-build plan including:
- document the sequencing process
- develop a fabrication process
- develop a pattern assembly process

Learning Content:

87.4.0 Sectionalize an engineering drawing.

87.4.1 Produce a layout which includes:
- full size
- contraction
- joint lines
- core prints
- draft angles
- loose piece location

87.4.2 Describe types of pattern joints used in pattern construction.

87.4.3 Determine the core shape and size.

87.4.4 Determine core print sizes

87.4.5 Determine core print clearances.

87.4.6 Determine parting lines

Learning Content:

87.5.0 Describe building aids used in pattern construction.

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

87.5.2 Describe types of material used to produce building aids including:
- wood
- metals
- plastics

87.5.3 Describe methods of establishing and checking building aid contours including:
- mylar drawings
- plotter printouts
- drawings and layouts created in a CAD system

87.6.0 Describe the process of creating a pattern equipment layout.

87.6.1 Describe the reasons for producing a pattern layout including:
- pattern construction engineering
- full size building aid
- dimensional verification
- core print location
- loose piece location
- mould plate size

Learning Content:

87.7.0 Describe the assembly of pattern sections.

87.7.1 Identify timber characteristics as they apply to the assembly of thin wall sections, ribs, rings including:

- grain direction
- quarter sawn
- basic timber cuts
- wood deformities
- moisture content
- timber characteristics
- sheet materials

87.8.0 Describe assembly techniques and processes.

87.8.1 Describe building a pattern on the layout from datum's and centre lines including:

- backbone/spine assembly
- assemble from a main body frame assembly
- dry joints/tool datum's

87.8.2 Describe the use of building aids, tools and equipment used in the assembly process.

87.8.3 Describe temporary materials and their application in the assembly process as building aids including:

- building aids used to produce parts
- building aids used to position parts on the work piece

87.9.0 Describe the resin pattern tooling fabrication process.

87.9.1 Describe the application of resin materials including:

- plastic patterns/core boxes
- splash/core plug/pattern mould for fit
- jigs and fixtures
- stamping dies
- impeller vanes

Learning Content:

87.10.0 Describe the process of fabrication a resin pattern support frame.

87.10.1 Describe the production steps to produce a resin pattern support frame including:

- materials
- construction
- fasteners

87.11.0 Describe the methods required to produce an aluminium.

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

- determine casting wall thickness
- lay-out wall sections, strengthening ribs and bolt down bosses on sheet polystyrene
- rough cut wall sections strengthening ribs and bolt down bosses
- assemble polystyrene pattern components
- shrinkage allowance
- determine the outside sizes of casting by subtracting the required thickness of resin from the outside profiles of either the pattern or the core cavities

87.12.0 Describe the application of release agents.

87.12.1 Describe defects caused by the application or release agents including:

- inspect surface for defects
- air pockets
- sink holes
- depressions/undercuts
- coarse spots
- stress cracks
- soft spots
- repair defects with polyester putty
- sand to specified finish
- discus sealer/release agent compatibility
- seal surface with sealer

Learning Content:

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

87.13.1 Describe advantages and disadvantages of resins, catalysts and fillers including:
- chemical compatibility
- heat resistance
- wear factor
- workability

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

87.14.1 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

87.14.2 Describe the steps required to finish a component produced in a closed mould including:
- de-mould the part
- remove the feeder
- remove the vents
- remove fins and flash
- inspect for surface defects

87.14.3 Describe techniques used to repair defects in a resin mould or part including:
- putty
- machine pocket and pour
- machine away resin and re-pour

Learning Content:

87.15.0 Describe the lay-up process to gel coated surface

87.15.1 Describe types of reinforcing materials and backup resin including:

- grades of fibreglass
- chop strand mat
- interwoven mat
- chop strand
- filler material
- chop gun

87.15.2 Describe the uses of reinforcing materials including:

- strength
- rigidity
- stability
- exothermic heat reduction
- weight reduction

87.15.3 Describe the process of applying reinforcement material in the lay up process including:

- cut the fibreglass to the required shape and size
- mix resin
- soak fibreglass with resin
- apply layer on gel coat
- apply second coat overlapping the first coat
- apply further coats to develop required thickness

Learning Content:

87.16.0 Describe the process of stabilizing reinforcing material.

87.16.1 Describe the types of reinforcing material and back up resins including:
- back filler
- backing clay
- polyester resin
- stone flour
- plywood
- chop strand
- micro balloons

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

87.16.3 Describe the process of stabilizing the reinforcing material including:
- mix resin
- add chop strand, back filler or flour
- apply to lay up material
- mix two part backing clay to the same colour
- roll to the required thickness

87.16.4 Describe the extraction process for mould/part/tooling including:
- compressed air
- draw bar
- bridges and levers
- draw plates
- jacks
- lag bolts

Learning Content:

87.16.5 Describe the types of tools and equipment used for the extraction of the moulded part/tooling including:

- claw hammer
- screw driver
- brace
- air nozzle
- jack

87.16.6 Describe the application of types of extraction methods including:

- small moulds
  - hammer
  - compressed air
- medium moulds
  - lag bolts
  - wedges & levers
- large moulds
  - draw plates with threaded rod
  - jacks

Learning Content:

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

87.17.1 Describe the steps required to produce a pressure cast match plate including:
- produce a parting line
- pour a plaster mould
- remove master pattern from mould
- oven dry complete plaster mould
- add spacer to produce match plate thickness and sand locks
- add chills and reinforcing as required
- cast the aluminium match plate under pressure
- clean and inspect finished match plate

87.17.2 Describe structural defects of pressure cast match plates and their causes including:
- gas porosity
- draws
- sinks
- miss-match
- blow holes
- stress cracks
- chilled areas

87.17.3 Describe pressure cast match plate checking procedures including:
- visual
- straight edge
- height gauge

87.17.4 Perform inspection on pressure cast match plate and describe procedures to correct defects including:
- inserts
- fillers
- welding
- reject match plate

Learning Content:

87.18.0 Describe the methods of fabricating and installing gating systems.

87.18.1 Describe the impact of the design features of components of gating including:

- down sprue & basin
- runner bars
- filter
- in gates
- riser & riser necks/breaker
- exothermic sleeve
- cope vents
- core gas vent
- flow by dirt trap
- chokes

87.19.0 Describe the process of producing pattern tooling from metal stock, castings or resin tooling board.

87.19.1 Describe the factors affecting choice of material used for fully machined pattern tooling including:

- aluminium
- cast-iron
- casting to include machining allowance
- tooling resin board
- brass
- bronze
- steel

Learning Content:

87.20.0 Describe the types of plastic forming/moulding processes.

87.20.1 Describe forming/moulding processes including:

- injection moulding
- blow moulding
- thermo vacuum forming
- rotational moulding

87.21.0 Describe the core box set-up process.

87.21.1 Describe the items and their applications in the core box set-up process including:

- ejection systems
- backing plates
- seals
- vents
- blow tubes
- gassing plates
- blow plates
- dowels

Evaluation Structure:

Theory Testing: 25%

Application Exercises: 45%

Final Assessment: 30%

Instructional and Delivery Strategies

Lecture
Demonstration
Practical Lab Assignments
E-Learning

Reference Material (not limited to)

Pattern Making Technology Foundry Practices