SAULT COLLEGE QF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

Course Title:	THEORY & PRACTICAL
Code No.:	Semester I - MCH 107 & MCH 117 Semester II - MCH 120 & MCH 124
Program:	MACHINE SHOP
Semester:	I & II
Date:	JANUARY 1989
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APPROVED:

Chairperson Date

CALENDAR DESCRIPTION

THEORY & SHOP	MCH 107/MCH 117/MCH 120/MCH 12
Course Name	Course Number

PHILOSOPHY/GOALS:

To familiarize the student with the machinery and tools used in an industrial type machine shop. To cultivate a level of skill in each student, based on their individual abilities, to prepare them either for an apprenticeship if they are successful/ or return to accept the challenge of the more diversified topics in the'second year.

METHOD OF ASSESSMENT (GRADING METHOD):

PRACTICAL	LAB ASSIGNMENTS & PROJECTS	75%
	ATTENDANCE/COOPERATION/INITIATIVE	25%
THEORY	CLASS TESTS	75%
	ATTENDANCE & WRITTEN ASSIGNMENTS	25%

(NOTE: 1% PER HOUR OF ABSENTEEISM WILL BE DEDUCTED FROM TOTAL MARK, IF ATTENDANCE BECOMES A PROBLEM)

TEXTBOOK

Technology of Machine Tools Kear Oswald (3rd edition)

OBJECTIVES

To bring each student to as high a level of competency in the knowledge and skills required in the trade as time permits. To develop a good work ethic. To make each student aware of the opportunities available to them when they complete the course, and where they can branch out to later in their careers.

UNIT	TOPIC	THEORY	PRACTICAL	TOTAL	PAGE
1	SAFETY				
2	BLUEPRINTS				
3	BENCH TOOLS	4	10	14	
4	HAND TOOLS	4	10	14	
5	MEASUREMENT	12	6	18	
6	REFERENCE TABLES	3 *	–	3	
8	OCCUPATIONAL CAL (MATHEMATICS)	10	–	10	
9	LAYOUT	4	**20**	24	
10	HEAT TREAT	4	**10**	14	
11	MATERIALS	5	–	5	
12	TOOLS	5	10	15	
13	HACKSAW	–	2	**2**	**21**
14	BANDSAW	3	40	**43**	21-2
15	RADIAL DRILL & SENSITIVE DRILL	5	50	**55**	**23**
16	LATHE	20	100	120	26-2
	MILLING - VERTICAL & HORIZONTAL	22	75	**97**	32-3
	(ON SEPARATE COURSE OUTLINE – CARBIDE TOOLING	30	–	**30)**	
22	SURFACE GRINDER	5	**15**	**20**	**36**
26	N.C.	12	**12**	**24**	**37**
	TOTAL	**150**	**360**	**510**	

UNIT 1 SHOP SAFETY

1.01. Machine Shop Safety

a) Acceptable behaviour
b) Equipment
c) Health hazards
d) Compressed air hazards
e) Accident reporting procedures
f) Personal safety
g) Proper lifting procedures
h) Safe working conditions

1.02. Protective Clothing

a) Safety hazards
b) Proper fit
c) Optimum protection
d) Applications

1.03'.*. Head Protectors

a) Safety hazards
b) Proper fit
c) Optimum protection
d) Applications

1.04. Eye Protectors

a) Safety hazards
b) Proper fit
c) Optimum protection
d) Maximum visibility

1.05. Hand Protectors

a) Safety hazard
b) Proper fit
c) .Optimum protection
d), Applications

1.06. Foot Rrotectors

a) Safety hazard
b) Proper fit
c) Optimum protection
d) Applications

UNIT 3 MECHANICAL BENCH/ASSEMBLY HAND TOOLS AND OPERATIONS

3.01. Screw Drivers

a) Type and size
b) Safest fit
c) Torque
d) Accessibility
e) Maintenance

3.02. Wrenches

a) Type and size
b) Safest fit
c) Speed of operation
d) Torque
e) Proper handling techniques

3.03. Pliers

a) Type and size
b) Type of operation to be performed
c) Size and shape of workpiece
d) Location accessibility
e) Gripping pressure
f) Cutting characteristics
g) Proper handling and storage

3.04. Vice Grips

a) Type of operation to be performed
b) Size and shape of workpiece
c) Accessibility of location
d) Gripping pressure
e) Correct method of jaw adjustment
f) Handling and storage

3.05. Hand Hammers

a) Types and shapes
b) Applications
c) Striking impacts
d) Proper head fastening
e) Handling and storing

3.06. Punches

a) Types and shapes for operations to be performed
b) Sizes
c) Holding characteristics
d) Applications
e) Handling and storing

3.07. Letter/Number Punches

a) Type and sizes of letters
b) Type and sizes of numbers
c) Workpiece surface finish and hardness
d) Holding characteristics
e) Applications
f) Handling and storing

3.08. Vices

a) Type of clamping required
b) Size and geometry of the workpiece to be held
c) Pressure applied
d) Workpiece surface protection
e) Handling, storage and maintenance

3.09. Clamps

a) Type of clamping required
b) Size and geometry of the workpiece to be held
c) Amount of pressure to be applied
d) Workpiece surface protection
e) Applications
f) Storage and maintentance

3.10. Threaded Fasteners

a) Component assemblies
b) Types, sizes and fits
c) Working length
d) Holding capability
e) Thread deformation
f) Thread classes
g) Head characteristics
h) Hardness and finishes
i) Thread symbols
j) Torque limitations
k) Use and type of washers

3.12. Tap Extractors

a) Type and size
b) Accessibility of location
c) Holding characteristics
d) Type and size of tap wrench required

3-14. Screw Extractors

a) Type and size
b) Holding characteristics
c) Type and size of broken screw to be removed
d) Accessibility of location

UNIT 4 METAL-REMOVING HAND TOOLS AND OPERATIONS

4.01. Tap/Reamer and Threading Die Holding Devices

a) Type and size of tool to be mounted
b) Operations to be performed
c) Accessibility to location of operation
d) Tool holding capacity
e) Applications
f) Handling, storing and maintenance

4.02. Hand Reamers

a) Type of material to be reamed
b) Size and shape of hole to be produced
c) Rough and or finish cuts necessary
d) Tool holding devices
e) Economical tool life
f) Cutting edge materials
g) Cutting fluids necessary
h) Surface finish quality
i) Correct method of adjustment
j) Handling, storage, and maintenance

4.03. Hand Taps

a) Types/shapes
b) Type of material to be tapped
c) Types, sizes, and lengths of threads to be produced
d) Pre-and-finish tapping
e) Tool holding device required
f) Most economical tool life
g) Cutting characteristics
h) Cutting edge material
i) Operational torque
j) Surface finish quality
k) Handling,' storing, and maintenance

4.04. Hand Threading Dies

a) Types/shapes
b) Type of material to be threaded
c) Types and sizes of threads to be produced
d) Pre-and finish threading
e) Tool holding devices
f) Most economical tool life
g) Cutting characteristics
h) Operational torque
i) Cutting fluid requrements
j) Handling, storage, and maintenance

4.05. Metal Hand Hack-Saws

a) Frame types and sizes
b) Saw types
c) Pitch of blades
d) Cutting edge materials
e) Type and surface condition of the material to be sawed
f) Sizes and shapes of workpiece
g) Most economical tool life
h) Sawing tensions
i) Length of saw blade tool life
j) Handling, storing and maintenance

4.06. Metal Hand Files

a) Types/shapes
b) Sizes
c) Holding characteristics and requirements
d) Type and surface condition of the material to be filed
e) Shape of workpiece produced
f) Rough and/or finish cuts necessary
g) Cutting edge material
h) Most economical tool life
i) File cleaning operations
j) Handling, storage, and maintenance

4.07. Metal Chisels

a) Types/shapes
b) Sizes
c) Cutting edge materials
d) Type and surface condition of the material to be chipped
e) Shape of workpiece
f) Most economical tool life
g) Handling, storing, and maintenance

4.08. Metal Hand Scrapers

a) Types/shapes
b) Sizes
c) Cutting edge materials
d) Type and surface condition of the material
e) Workpiece shapes
f) Tool holding/mounting requirements
g) Most economical tool life
h) Cutting and shaping characteristics
i) Handling, storage, and maintenance

4.09. Abrasive Cloth

a) Types
b) Sizes
c) Type and surface condition of the material to be polished
d) Required finished shape
e) Polishing speeds
f) Quality of surface finishes.

UNIT 5 MEASURING TOOLS AND OPERATIONS

5.01.1 Vernier Measuring Tools

a) Types
b) Components, working principles, and adjusting mechanism
c) Values of graduations
d) Measuring range
e) Accessibility to location
f) Applications
g) Temperature variations
h) Excess pressure
i) Checking devices
j) Handling, storing, and maintaining

5.01.2 Micrometer Measuring Tools

a) Types, including extension rods and inter-changeable anuils
b) Components, working principles, and adjusting mechanism
c) Values of graduations
d) Obtainable measuring accuracy
e) Applications
f) Temperature variations
g) Accessibility to location
h) Excess pressure
i) Checking, setting and locking at predetermined values
j) Handling, storing, and maintaining

5.01-3 Dial Indicators

a) Types
b) Components, working principles and adjusting mechanisms
c) Values of graduations
d) Obtainable measuring accuracy
e) Measuring ranges
f) Temperature variations
g) Applications
h) Mounting characteristics
i) Accessibility to location
j) Handling, storing, and maintaining

5.02.1 Dial Indicator Sets

a) Types
b) Functional parts, working principles, and adjusting mechanisms
c) Values of graduations
d) Obtainable accuracy
e) Measuring ranges
f) Excess vibration
g) Accessibility to location
h) Mounting characteristics
i) Predetermined values
j) Temperature variations
k) Handling, storing, and maintaining

5.02.2 Gauge Block Sets

a) Degree of accuracy
b) Calibrating ranges
c) Classes
d) Accuracy
e) Temperature variations
f) Checking devices
g) Selection for build-up
h) Wringing
i) Handling, storing, and maintaining

5.03.1 Steel Measuring Rules

a) Type of measuring
b) Measuring range
c) Accessibility to location
d) Values of graduations
e) Applications
f) Handling, storing, and maintaining

5.03.2 Precision Combination Squares

a) Type of measuring
b) Components and working principles
c) Measuring range
d) Accessibility to location
e) Values of graduations
f) Applications
g) Protractor readings
h) Handling, storing, and maintaining

5.03.3 Vernier Height Gauges

a) Components, working principles, and adjusting Mechanisms
b) Attachments
c) Graduation values
d) Obtainable accuracy
e) Temperature variations
f) Excess pressure
g) Measuring range
h) Accessibility to location
i) Handling, storing, and maintaining

5.03.4 Universal Vernier Bevel Protractor

a) Components
b) Working principles, and adjusting mechanisms
c) Graduation values
d) Obtainable measuring accuracy
e) Measuring ranges
f) Holding characteristics for measuring
g) Checking"and layout operations
h) Applications
i) Verifying measuring accuracy using checking devices
j) Handling, storing, and maintaining

5,04.5 Thread Pitch Gauge Sets

a) Types of thread forms (profile)
b) Checking ranges
c) Graduations
d) -Applications
e) Handling, storing, and maintaining

5.04.6 Thickness (Feeler) Gauge Sets

a) Checking ranges
b) Graduations
c) Applications
d) Temperature variations
e) Excess pressure
f) Checking devices
g) Blade combinations
h) Handling, storing, and maintaining

5.04.7 Surface Finish Comparator Sets

a) Types
b) Checking ranges
c) Micro-finish graduations
d) Applications
e) Surface comparison
f) Handling, storing, and maintaining

5.04.8 Cutting Tool Geometry Check Gauges

a) Types
b) Checking values
c) Holding characteristics
d) Handling, storing, and maintaining

5.05.1 Precision Straight Edges

a) Lengths/widths
b) Holding characteristics
c) Applications
d) Temperature variations
e) Checking accuracy
f) Handling, storing, and maintaining

5-05.2 Precision Steel Squares

a) Length of right angle legs
b) Accessibility to location
c) Construction
d) Types
e) Sizes
f) Applications
g) Temperature variations
h) Checking accuracy
i) Handling, storing, and maintaining

5.05.3 Radius/Fillet Gauge Sets

a) Checking ranges
b) Individual values
c) Holding characteristics
d) Applications
e) Handling, storing, and maintaining

1 Layout Dyes/Chalks

a) Types
b) Colour effect
c) Adhesive properties
d) Applications
e) Material and surface condition
f) Duration of stain
g) Chemical properties
h) Foreign matter
i) Solution preparation
j) Neutralization of solutions
k) Optimum visible effects for scribing and marking
1) Handling and storing

2 Layout Scribing Tools

a) Type of operation
b) Dimensional ranges
c) Types
d) Sizes
e) Holding characteristics
f) Applications
g) Components, working principles, and adjusting mechanisms
h) Accessibility to location
i) Hardening, sharpening and honing
j) Setting to predetermined values
k) Handling, storing, and maintaining

3 Marking Punches

a) Types
b) Point angles
c) Holding characteristics
d) Applications
e) Excessive force
f) Reference points and intersections
g) Starting centres
h) Scribed outlines
i) Hardening and grinding
j) Handling, storing, and maintaining

5.06,4 Contour "Layout Templates

a) Types
b) Sizes
c) Contours
d) Holding characteristics
e) Applications
f) Handling, storing and maintaining

5.07.1 Precision Supporting/Positioning Devices

a) Required type
b) Size and geometry of workpiece
c) Types
d) Applications
e) Excessive force
f) Dimensional accuracies
g) Handling, storing, and maintaining

5.07.2 Sine Bars

a) Types
b) Components and working principles
c) Measuring/checking ranges
d) Size and geometry of the workpiece
e) Holding characteristics
f) Applications
g) Temperature variations
h) Excessive force
i) Setting/positioning using gauge block build-ups
j) Handling, storing, and maintaining

5.08.1 Measure Linear Dimensions

a) Steel measuring rules
b) Combination square
c) Verniers
d) Micrometers
e) Vernier height gauges complete with attachments
f) Dial indicators
g) Obtain the maximum measuring and reading accuracy

5.08.2 Measure Linear Differentials

a) Straight
b) Flat
c) Parallel
d) Round
e) Using the dial indicator, and indicator sets
f) Obtain the maximum measuring and reading accuracy

5.08,3 Angular Measurement

a) Acute
b) Obtuse
c) Compound
d) Precision combination squares with protractors
e) Universal vernier bevel protractors
f) Sine bars in conjunction with gauge blocks and dial indicator sets
g) Surface plates
h) Maximum measuring and reading accuracy
i) Measuring angles on conical surfaces

5.10.1 Telescoping Gauges

a) Sizes
b) Components and working principles
c) Checking ranges
d) Applications
e) Excess pressure
f) Accessibility to location
g) Checking accuracy
h) Holding characteristics
i) Handling, storing, and maintaining

5.10.2 Small Hole Gauges

a) Sizes
b) Components and working principles
c) Checking ranges
d) Applications
e) Excess pressure
f) Accessibility to location
g) Checking accuracy
h) Holding characteristics
i) Handling, storing, and maintaining

5.10-3 Screw Thread Micrometers

a) Components, working principles, and adjusting mechanisms
b) Values of graduations
c) Obtainable measuring accuracy
d) Applications
e) Temperature variations
f) Excess pressure
g) Checking, setting and locking at predetermined values
h) Pitch diameters
i) Parts of threads
j) Tolerance limitations
k) Handling, storing, and maintaining

UNIT 6 OCCUPATIONAL REFERENCE TABLES/CHARTS

6.01 Conversion Tables/Charts

a) Types
b) E'ormat
c) Magnitudes and dimensions
d) Graduations
e) Limitations
f) Accuracy
g) Abbreviations
h) Terminology
i) Applications

6.02 Material and Product-Related Specification and Value Tables/Charts

a) Types
b) Format
c) Magnitudes and dimensions
d) Standards
e) Abbreviations
f) Terminology
g) Graduations
h) Accuracy
i) Limitations
J) Applications

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UNIT 8 THREAD CALCULATIONS FOR SINGLE POINT CUTTING

8.01 a) National Threads
b) Metric Threads
c) Unified Threads
d) Square Threads
e) National Acme
f) Pipe Acme

8.02 Taper calculations.

8.03 Calculate gauge block build up for sine bar.

8.04 Chordal distance of holes on a bolt circle.

8.05 Distance across corners on a hexagon.

8.06 Gear ratios and speed calculations.

8.07 Determine length of blade for band saw.

8.08 Calculate surface speeds of cutters and work.

8.09 Determine weight of material by volume.

8.10 Calculations of angles on shop drawings which are omitted

UNIT 9 LAYOUT OPERATIONS

9.01 Geometrical Configurations

a) Layout sequences
b) Surface preparation
c) Tool manipulation
d) Accuracy and clarity of appearance
e) Construction
f) Predetermined tolerances, Linear -.005"; Angular $\pm$10'
g) Prick punch markings
h) Centre punch markings

Use of:

i) Layout dyes/chalks
j) Marking punches
k) Layout scribing tools
1) Precision straight edges
m) Steel measuring rules
n) Precision steel squares
o) Vernier height gauges
p) Universal vernier bevel protractors
q) radius/fillet gauge sets
r) Contour templates
s) Multi-purpose precision devices
t) Workpiece holding/clamping devices

UNIT 10 HEAT TREATING OPERATIONS

10.02 Heat Treatable Ferrous Metals

a) Applicable heat treating processes
b) Hardenability
c) Application
d) Decalescence point
e) Recalescence point
f) Lower critical temperature
g) Upper critical temperature
h) Critical range
i) Pearlite
j) Cementite
k) Austenite
1) Eutectoid steel
m) Hypereutectoid stee1
n) Carbon content
o) Toughness
p) Tensile strength
q) Wear resistance
r) Hardenability
s) Application
t) Machinability
u) Weldability

Carbon content and alloying elements in terms of:

10.03 Heat Treating Charts

a) Types
b) Format
c) Graduations
d) Limitations
e) Ranges
f) Abbreviations
g) Terminology
h) Temperature
i) Material properties
j) Applications
k) Case depth relative to temperature and time
1) Tempering colours .
m) Hardness conversion relative to Rockwell,
n) Brinell, Vickers
o) Tempering temperatures
P> Annealing temperature range
q) Maximum cooling rate for annealing
r) Annealing hardness (B.H.N.)
s) Preheating temperatures
t) Austenitizing temperatures
Quenching medium

UNIT 11 MACHINABLE WORKPIECE MATERIALS

11.01 Machinable Ferrous Metals

a) Size, shape, and surface condition
b) Machinability
c) Corrosion resistance
d) Wear resistance
e) Tensile strength
f) Surface finish
g) S.A.E./A,I.S.I, code identification
h) A.S.T.M. code identification
i) Manufacturer's colour code
j) Applications

Effects of carbon content on properties with regard to

k) Tensile strength
1) Hardness
m) Ductility
n) Malleability
o) Elasticity
p) Wear resistance

UNIT 14 VERTICAL BAND SAW/POWER HACK SAW

14.01 Operate Vertical Band Saw

a) Operating principles
b) Types, functions, and locations of main components
c) Controls and standard accessories
d) Speeds and feeds
e) Table settings
f) Control settings
g) Butt welding, annealing and grinding of blades
h) Blade mounting
i) Tension adjustment
j) Size identification
k) Sawing capacity
1) Routine maintenance tasks

13.02 Operate Power Hack Saw

a) Size identification
b) Sawing capacity
c) Operating principles
d) Types, functions, and locations of main components and controls
e) Speeds and feeds
f) Mounting and adjustment of saw blades
g) Set-up
h) Coolant supply
i) Routine maintenance tasks

14.05 Metal Band Saw Blades

a) Types of blades
b) Tooth types and pitch
c) Sizes
d) Holding/mounting characteristics
e) Cutting edge materials
f) Cutting and shaping characteristics
g) Length of saw blade tool life
h) Type and surface condition of material
i) Sizes and shapes of workpiece produced
j) Blade stability

14.06 Metal Band Saw Files

a) Types
b) Tooth shapes
c) Sizes
d) Holding/mounting characteristics
e) Cutting edge materials
f) Cutting and shaping characteristics
g) Rough and finish filing
h) Operational feed and speed
i) Cutting fluid requirements
j) Metal removal efficiency
k) Surface finish quality
1) Tool life
m) Type and surface condition of material to be filed
n) File stability
o) Economical tool life
p) Handling, storing, and maintaining

UNIT 15 BENCH AND RADIAL DRILL PRESSES

15.01.1 Bench & Pedestal Drill Press Operation

a) Size identification
b) Cutting capacity
c) Operating principles
d) Types, functions, and locations, of main components and controls
e) Spindle speeds
f) Holding characteristics (work)

15.01.2 Set-Up Radial Drill Press

a) Size identification
b) Cutting capacity
c) Machining sequences
d) Workpiece supporting requirements
e) Setting of speed and feed controls
f) Feed travel limitations
g) Accessibility to location
h) Working formula for cutting speed and feeds
i) Excessive vibration
j) Feed rate selection
k) Securing of workpiece
1) Tool positioning (location to layout)

15.02 Operate Radial Drill Press

a) Operating principles
b) Types
c) Functions and locations of main components and controls
d) Standard accessories
e) Speed and feed control values
f) Graduation values for spindle feed
g) Control settings
h) Spindle travel
i) Mounting and securing of workpiece holding and supporting devices
j) Cutting fluid requirements
k) Routine maintenance tasks

12.01 Metal Drills

a) Types/shapes
b) Sizes (number, letter, fractional)
c) Shank taper sizes
d) Holding/mounting characteristics
e) Cutting edge materials (solid, tipped)
f) Cutting and shaping characteristics
g) Drill diameters for hole enlargements
h) Rough and finish drilling
i) Hole size accuracy
j) Surface finish
k) Tool life
1) Type and surface condition of material
m) Sizes, diameter tolerances
n) Shapes of holes produced
o) Set-up rigidity
p) Cutting feeds and speeds
q) Handling, storing, and maintaining

12.02 Counterbore/Spot Facers

a) Types/shapes
b) Sizes
c) Pilot sizes
d) Holding/mounting characteristics
e) Cutting edge materials for solid, tipped and removable insert
f) Cutting and shaping characteristics
g) Applications
h) Speeds and feeds
i) Cutting fluid requirements
j) Metal removal efficiency
k) Surface finish quality
1) Tool life length
m) Type and surface condition of material
n) Tool rigidity
o) Handling, storing, and maintaining

12.03 Machine Reamers

a) Types/shapes
b) Fractional and decimal sizes
c) Taper sizes, accordance with number system
d) Holding/mounting characteristics
e) Cutting edge materials for solid, tipped, and removable insert
f) Cutting and shaping characteristics
g) Rough and .finish reaming

h) Operational speed and feed
i) Surface finish quality
k) Tool life length
1) Adjustment to predetermined sizes
m) Type of material to be reamed
n) Size of hole
o) Handling, storing, and maintaining

04 Machine Taps

a) Types/shapes
b) Thread types and sizes
c) Holding/mounting characteristics
d) Cutting edge materials
e) Cutting characteristics
f) Applications for pre and finish tapping
g) Operational speed
h) Cutting fluid requirements
i) Material removal efficiency
j) Finish quality
k) Tool life length
1) Type of material to be tapped
m) Lengths of threads produced
n) Tool rigidity
o) Handling, storing, and maintaining

11 Taper Sleeves/Sockets

a) Types
b) External and internal taper sizes
c) Holding/mounting characteristics
d) Applications
e) Inserting, positioning, and securing
f) Taper size of tool shank
g) Accessibility to area of machining
h) Sizes according to machine tool used
i) Handling, storing, and maintaining

12 Drill Chucks

a) Types
b) Straight or taper shanks
c) Holding/mounting characteristics
d) Type of tool
e) Capacity
f) Operating principles
g) Applications
h) Insertion and securing
i) Accessibility to location
j) Rigidity of tool
k) Handling, storing, and maintaining

UNIT 16 SET UP/OPERATE ENGINE. LATHE

16.01 Set Up Engine Lathe

a) Size, swing, and cutting capacity
b) Machining sequences
c) Tool holding and supporting requirements
d) Correct setting for all speeds and feeds
e) Feed travel limitations
f) Positioning, mounting, and holding of workpiece
g) Rigidity of workpiece and tools
h) Workpiece deformation
i) Operational and running clearances
j) Continued accessibility of cutting tool
k) Vibrations during machining operations
1) Over and under tightening of workpieces
m) Incorrect tool positioning in relation to its centre line

16.02 Operate Engine Lathe

a) Types, functions, and locations of its main components and controls
b) Operating principles
c) Speed and feed or pitch control values
d) Graduation values of micrometer collars
e) Angular values for compound settings
f) Linear values on tailstock spindle
g) Setting of all spindle speeds and tool feed motions
h) Activating automatic tool motions over predetermined distances
i) Carriage stops
j) Tool post indexing
k) Tailstock offsets
1) Workpiece securing and supporting devices
m) Running clearances for centre mount workpieces
n) Running clearances for steady rest supported workpieces
o) Cutting fluid supply
p) Routine maintenance tasks

16 - 04 Surfaces/Shapes

Rough and finish turning
Finish allowance required
Finish tolerance permissible
Surface finish obtained
Type and amount of material to be removed
Speeds and feeds applied
Cutting fluid requirements
Cutting and shaping characteristics of tool
Rigidity of mounting
Rigidity of workpiece
Cutting capacity of tool
Inefficient cutting chip development and flow

Causes and remedies for operation failures

Accuracy
Surface finish
Tool pressure
Inefficient chip development and flow
Rough, uneven, or out-of-round surfaces
Rapid wear or damage to tool cutting edges
Breakage of tools

16.07 Threads ("V" Form)

a) Efficient cutting chip development and flow
b) Single and multi-start threads concentric with axis •
c) Finish tolerance permissible
d) Surface finish obtained
e) Application of speeds and pitch feeds
f) Cutting fluid requirements
g) Type, cutting and shaping characteristics of tool
h) Rigidity of tool
i) Rigidity of workpiece
j) Cutting capacity of machine tool
k) Pitch, geometrical form and dimensional thread tolerances

Possible causes and remedies for operation failures

1) Classification of fits
m) Predetermined surface finishes
n) Inefficient chip development and flow
o) Rough, uneven, or out-of-round surfaces
p) Rapid wear or damage to tool cutting edges
q) Tool breakage

16.08 Machine Drilling Cylindrical Holes

a) Correct methods of drilling small, large, deep and close tolerance holes
b) Finish hole diameter and permissible tolerance
c) Obtainable surface finish
d) Rough and/or finish cuts required
e) Type and amount of material removed
f) Speeds and feeds
g) Cutting fluid applications
h) Type, cutting, and shaping characteristics of drill used
i) Drill rigidity
j) Workpiece rigidity

Possible causes and remedies for operation failures

k) Cutting capacity of machine tool
1) Inefficient and/or unequal chip development
m) Oversized, out-of-round, or rough surfaced holes
n) Holes out of alignment
o) Rapid wear of, or damage to cutting edges
p) Tool breakage

16,09 Counterboring/Spot Facing Cylindrical Holes

a) Correct methods of counterboring/spotfacing small, large, deep and close tolerance holes
b) Finish hole diameter and permissible tolerance
c) Obtainable surface finish
d) Rough and/or finish cuts required
e) Type and amount of material removed
f) Speeds and feeds
g) Cutting fluid applications
h) Type, cutting, and shaping characteristics of drill used
i) Drill rigidity
j) Workpiece rigidity

Possible causes and remedies for operation failures

k) Cutting capacity of machine tool
1) Inefficient and/or unequal chip development
m) Oversized, out-of-round, or rough surfaced holes
n) Holes out of alignment
o) Rapid wear of, or damage to cutting edges
p) Tool breakage

16.11 Reaming Cylindrical Tapered Holes

a) Rough and finish machine reaming
b) Finish tolerance permissible
c) Surface finish obtainable
d) Rough or finish cuts required
e) Type and amount of material to be removed
f) Speeds and feeds
g) Cutting fluid applications
h) Cutting characteristics

Possible causes and remedies for operation failures

i) Workpiece rigidity
j) Inefficient material removal and flow
k) Over and undersized, or rough surfaced holes
1) Holes out of alignment
m) Rapid wear of, or damage to cutting edges
n) Reamer breakage

16.12 Hand Tapping

a) Tap drill and hole sizes
b) Type of thread
c) Classes of fit
d) Number of cuts required
e) Type and amount of material removal
f) Type of hole (through, blind)
g) Thread surface finish
h) Cutting fluid applications

Possible causes and remedies for operation failures

i) Workpiece rigidity
j) Inefficient material removal and flow
k) Over and undersized threads
1) Threads out of alignment
m) Rapid wear of, or damage to cutting edges
n) Tool breakage

16.13 Knurling Cylindrical Surface Patterns

a) Number and depth of passes required
b) Type of material
c) Amount of material to be displaced
d) Specified finishes obtained
e) Lubricant applications
f) Speeds and feeds
g) Workpiece rigidity

Possible causes and remedies for operation failures

h) Type of knurling tool and its rigidity
i) Insufficient material displacement
j) Rough or uneven patterns
k) Rapid wear of, or damage to patterns of the
1) Breakage of knurling tools

12,03 Machine Reamers

a) Type of material to be reamed
b) Size and shape of hole
c) Rough and/or finish cuts necessary
d) Type of tool holding/mounting
e) Rigidity
f) Cutting feeds and speeds
g) Types/shapes
h) Reamer sizes
i) Number system
j) Cutting edge materials for solid, tipped and removable insert
k) Cutting and shaping characteristics
1) Cutting fluid applications
m) Efficiency of material removal
n) Surface finish quality
o) Adjustments to predetermined sizes
p) Handling, storing, and maintaining

12.05 Single Point Tools

a) Types/shapes
b) Sizes
c) Holding/mounting characteristics
d) Cutting edge materials for solid, tipped, and removable insert
e) Cutting and shaping characteristics
f) Applications for rough and finish machining
g) Operational feeds and speeds
h) Cutting fluid requirements
i) Efficiency of material removal
j) Surface finish quality
k) Length of tool life
1) Rigidity of tool
m) Handling, storing, and maintaining

12.06 Knurling Tools

a) Types/patterns
b) Sizes
c) Holding mounting characteristics
d) Displacement edge materials
e) Embossing characteristics
f) Applications for rough and finish knurling
g) Operational feed and speed
h) Lubricant requirements
i) Quality of pattern finishes
j) Length of tool life
k) Handling, storing, and maintaining

11 Taper Sleeves/Sockets

a) Types
b) External and internal sizes
c) Holding/mounting characteristics
d) Applications
e) Mounting tool holders to machine
f) Handling, storing, and maintaining

13 Single Point Tool Holders

a) Types/shapes
b) Sizes
c) Holding/mounting characteristics
d) Type of tool holding/mounting
e) Tool holding capacity
f) Tool mounting angles
g) Inserting, positioning, and securing
h) Type of machining operation
i) Accessibility to machining area
j) Handling, storing, and maintaining

14 Boring Bars

a) Types/shapes
b) Sizes
c) Holding/mounting characterisitics
.d) Tool holding capacity
e) Mounting angles
f) Applications for rough and finish boring
g) Mounting to machine tool
h) Inserting, positioning, and securing
i) Adjusting to required positions
j) Type of boring operation
k) Rigidity
1) Accessibility to location
m) Handling, storing, and maintaining

15 Knurling Tool Holders

a) Types/shapes
b) Sizes
c) Holding/mounting characteristics
d) Tool holding capacity
e) Applications
f) Inserting, positioning, and securing
g) Mounting holders to machine
h) Type of operations performed
i) Rigidity of set-up
j) Accessibility to operation location
k) Handling, storing, and maintaining

UNIT 18 SET UP/OPERATE VERTICAL MILLING MACHINES

18.01 Set Up Vertical Milling Machine

a) Size and cutting capacity
b) Machining sequences
c) Tool holding and supporting devices
d) Workpiece holding and supporting devices
e) Positioning of stops to limit tool and table travel
f) Operational speeds, feeds, and tool rotation direction
g) Vibrations
h) Over or under tightening of workplaces
i) Incorrect tool positioning
j) Type and depth of cut
k) Required shaping of workpiece
1) Operational clearances
m) Accessibility of location

18.02 Operate Vertical Milling Machine

a) Operating principles
b) Types
c) Functions and locations, of its main components and controls
d) Speed and feed control values
e) Graduation values of micrometer collars
f) Angular values
g) Table and spindle limit stops
h) Workpiece mounting and securing
i) Cutting fluid supply
j) Table and saddle locking components

18.08 Drilling Cylindrical Holes

a) Finish hole diameter and permissible tolerance
b) Surface finish obtainable
c) Number of rough or finish cuts required
d) Type and amount of material removed
e) Speeds and feeds
f) Cutting fluid applications
g) Type, cutting, and shaping characteristics
h) Rigidity of mounting
i) Rigidity of workpiece

Possible causes and remedies for operational failures

j) Cutting capacity of machine tool
k) Unequal chip development and flow
1) Oversized, out-of-round, and rough surfaced holes
m) Holes out of alignment
n) Rapid wear of, or damage to cutting edges
o) Tool breakage

18-09 Counterbore/Spot Face Cylindrical Holes On Vertical Mill

a) Small, large, deep, and close tolerance holes
b) Finish hole diameter and permissible tolerance
c) Surface finish obtainable
d) Rough and/or finish cuts required
e) Type and amount of material to be removed
f) Speeds and feeds applied
g) Cutting fluid applications
h) Type, cutting, and shaping characteristics of tool
i) Diameter of hole drilled
j) Rigidity of workpiece
k) Cutting capacity of machine tool

Possible causes and remedies for operation failures

1} Inefficient and/or unequal chip development and flow
m) Oversized, out-of-round, or rough-surfaced hoi
n) Holes out of alignment
o) Rapid wear or damage to cutting edges
p) Tool breakage

UNIT 20 SET UP/OPERATE RAM AND TURRET TYPE VERTICAL MILLING MACHINES

20.01 Set Up Ram and Turret Type Milling Machine

a) Size and cutting capacity
b) Machining sequences
c) Workpiece and tool-holding and supporting requirements
d) Positioning of stops to limit tool and table travel
e) Operational speeds, feeds, and direction of tool rotation
f) Vibrations during machining operations
g) Over or under tightening of workpieces
h) Tool positioning
i) Rotation in relation to location
j) Type and depth of cut to be performed
k) Operational clearances

20.02 Operate Ram and Turret Type Milling Machine

a) Operating principles
b) Types, functions, and locations of main components and controls
c) Speed and feed control values
d) Graduation values of micrometer collars
e) Angular values for ram and spindle head settings
f) Limiting spindle and table motions by use of feed stops
g) Securing of component parts at predetermined locations
h) Mounting and securing of workpieces
i) Cutting fluid applications
j) Mist sprayer
k) Performing routine maintenance tasks

20.05 Mill Surfaces/Shapes

a) Rough and finish milling
b) Finish tolerance permissible
c) Surface finish obtainable
d) Type and amount of material removed
e) Speeds and feeds applied
f) Type, cutting, and shaping characteristics
g) Tool rigidity

ossible causes and remedies for operation failures

h) Rigidity of workpiece
i) Cutting capacity
j) Inefficient chip development and flow
k) Rough or uneven surfaces
1) Rapid wear of, or damage to cutting edges
m) Breakage of milling cutters

12.07 Milling Cutters

a) Types/shapes
b) Sizes
c) Holding/mounting characteristics
d) Cutting edge materials for solid, tipped, and removable insert
e) Cutting and shaping characteristics
f) Applications for rough and finish machining
g) Operational speed and feed
h) Cutting fluid applications
i) Efficiency of material removal
j) Quality of surface finishes
k) Length of tool life
1) Mounting removable tool inserts
m) Handling, storing, and maintaining
n) Type and surface condition of material to be machined
o) Size and shape of workpiece
p) Rigidity of workpiece
q) Most economical tool life

UNIT 22 SET UP/OPERATE HORIZONTAL SURFACE GRINDER

22.01 Set Up Horizontal Surface Grinder

a) Size and grinding capacity
b) Required grinding sequences
c) Workpiece and wheel holding and supporting requirements
d) Table limit stops
e) Vibrations during grinding operations
f) Over or under tightening of workpieces
g) Insufficient wheel dressing
h) Shaping of workpiece.
i) Wheel rigidity
j) Operational clearances
k) Accessibility of the wheel to location of workpiece

22.02 Operate Horizontal Surface Grinder

a) Operating principles
b) Types, functions, and locations of main components and controls
c) Speed control values
d) Values of micrometer collars
e) Table feed motions
f) Limiting table motions by use of stops
g) Coolant supply and grinding exhaust system
h) Dressing grinding wheels
i) Routine maintenance tasks

22.09 Surface Grind Surfaces/Shapes

a) Rough and finish grinding
b) Finish tolerance permissible
c) Surface finish obtainable
d) Type and amount of material to be removed
e) Speeds and feeds applied
f) Coolant application
g) Type, cutting, and shaping characteristics
h) Rigidity of mounting
i) Rigidity of workpiece
j) Cutting capacity

Possible causes and remedies for operation failures

k) Inefficient material removal
1) Rough, or uneven surfaces
m) Rapid wear, damage, or breakage of grinding wheels
n) Ringing

UNIT 26 SET UP/OPERATE NUMERICALLY CONTROLLED MACHINE TOOLS

26.01 Program Numerically Controlled Machine Tools

a) Machining operations
b) Machine tool movements
c) Tools and accessories
d) Programming and coding terminology
e) Computer-assisted and non-assisted systems
f) Converting part/product specification into code
g) Magnetic tape
h) Punched tape
i) Punched cards

26.02 Set Up Numerically Controlled Machine Tools

a) Size
b) Type
c) Cutting capacity
d) N/C modes and controls used
e) Required sequences based on program sheet
f) Workpiece, toolholding, and supporting requirements
g) Mounting positions for workpiece and tool
h) Operational speeds and feeds
i) Direction of tool rotation
j) Installation of input media (tape)
k) Control units
1) Tool movement limitations
m) Operational clearances
n) Vibrations during machining operations
o) Over or under tightening of workpieces
p) Rotation in relation to location
q) Type, and depth of cut to be performed

26.03 Operate Numerically Controlled Machine Tools

a) Operating principles
b) Types, functions, and locations of main components and control devices
c) Individual machining operations
d) Operational speeds and feeds and direction of tool rotation
e) Tool requirements
f) Mounting and securing of workpieces
g) Tool movement limitations
h) Setting tool length offsets
i) Controlling cutting fluid applications
j) Performing routine maintenance tasks