

## 22.2.0 TOOL ROOM PROCESSES TECHNOLOGY II

### 22.2.1 Introduction

This module unit is designed to equip the trainee with the necessary skills, knowledge and attitudes in using specialized machines for production of products.

The module is intended to build on the skills and knowledge learned in Module I of this course in the manufacturing of industrial components, thus trainees taking this module unit will require knowledge of Technical Drawing, Mathematics, Engineering Science, Materials Science and Tool Room Processes I.

### 22.2.2 General Objectives

By the end of the module unit the trainee should be able to:

- a) understand the basic principle and operation of specialized machines
- b) use and operate the relevant specialized machines safely
- c) design, develop and produce engineering articles using specialized machines.

### 22.2.3 Module Unit Summary and Time Allocation

#### TOOL ROOM PROCESSES TECHNOLOGY II

Code	Sub-Module Unit	Content	Theory Hrs	Pract Hrs	Time (Hrs)
22.2.01	Specialised Milling - Cam milling	<ul style="list-style-type: none"><li>• Types of cams</li><li>• Parts of cam milling attachment</li><li>• Cam milling cutters</li><li>• Calculation of cam milling parameters</li><li>• Work setting of cam milling attachment</li><li>• Calculation of cam milling parameters</li></ul>	2	4	6

22.2.02	Specialised Milling - Helical Milling	<ul style="list-style-type: none"> <li>• Types of helical milling cutters -end mill, fly cutter</li> <li>• Care and maintenance of helical milling attachment</li> <li>• Indexing for helical milling</li> <li>• Calculation of speeds and feeds gear ratio, lead of machine, lead of work, helix angle (x), angle of table swivel (o)</li> <li>• Set up for helical milling</li> </ul>	2	4	6
22.2.03	Specialised Grinding	<ul style="list-style-type: none"> <li>• Types of surface grinding machines</li> <li>• Construction features of a surface grinder</li> <li>• Types of cutters</li> <li>• Safety precaution</li> <li>• Work setting for grinding operations</li> </ul>	2	4	6
22.2.04	Cylindrical Grinding	<ul style="list-style-type: none"> <li>• Types of cylindrical grinding machines</li> <li>• Construction features</li> <li>• Work setting and tool holding</li> <li>• Calculation of speeds and feeds</li> <li>• Cylindrical grinding operation</li> </ul>	4	4	8
22.2.05	Centreless Grinding	<ul style="list-style-type: none"> <li>• Types of centreless grinding machine</li> <li>• Construction features of a centreless grinding machine</li> <li>• Classification of tools</li> <li>• Work setting</li> <li>• Calculation of speeds and feeds</li> <li>• Centreless grinding</li> </ul>	2	4	6

		operations			
22.2.06	Cutter Grinding	<ul style="list-style-type: none"> <li>• Construction features of a cutter grinder</li> <li>• Classification of cutter grinding wheels</li> <li>• Uses of cutter grinders</li> <li>• Calculation of grinding cutters parameters</li> <li>• Work setting</li> </ul>	4	4	8
22.2.07	Gear Cutting	<ul style="list-style-type: none"> <li>• Types of gears</li> <li>• Gear manufacturing methods</li> <li>• Calculation of time and cost</li> <li>• Work setting and work holding for a given operation</li> </ul>	2	4	6
22.2.08	Gear Finishing	<ul style="list-style-type: none"> <li>• Gear finishing operations</li> <li>• Work setting for a given gear finishing process</li> <li>• Methods of gear finishing processes</li> </ul>	2	2	4
22.2.09	Broaching	<ul style="list-style-type: none"> <li>• Types of broaching machines</li> <li>• Types of broaches</li> <li>• Types of materials</li> <li>• Operation of broaches</li> <li>• Calculation of various parameters for broaching</li> <li>• Work setting</li> </ul>	2	6	8

22.2.10	Boring	<ul style="list-style-type: none"> <li>• Types of boring machines</li> <li>• Constructional features of a boring machine</li> <li>• Boring machine operations</li> <li>• Work setting</li> <li>• Operations of a boring machine, care and maintenance</li> <li>• Calculation of speeds and feeds</li> </ul>	2	4	6
22.2.11	Non-Conventional Machining	<ul style="list-style-type: none"> <li>• Methods of non-conventional machining processes</li> <li>• Diagrammatic representation of various processes</li> <li>• Operation of non-conventional machining plant.</li> <li>• Calculation of the metal removal rate for various processes</li> </ul>	2	4	6
22.2.12	Mechanics of Metal Cutting	<ul style="list-style-type: none"> <li>• Classification of cutting methods</li> <li>• Identify the types of chips</li> <li>• Features of a two component tool force dynamometer</li> <li>• Calibration of a tool force dynamometer Operation of a simple tool force dynamometer</li> <li>• Calculation of tool parameters for a given job</li> <li>• Calculation of tool life variables for a given tool</li> </ul>	2	4	6

22.2.13	Copying Systems	<ul style="list-style-type: none"> <li>• Types of copying systems</li> <li>• Diagrammatic representation of the various copying systems</li> <li>• Types of copying machines</li> <li>• Limitations of copying systems</li> <li>• Analysis of the principle of servo operated copying system</li> <li>• Care and maintenance of copying machine</li> <li>• Analysis for accuracy and response in copying system</li> </ul>	2	4	6
22.2.14	Press Tool Design	<ul style="list-style-type: none"> <li>• Types of presses</li> <li>• Parts of the press tool</li> <li>• Operations of press tool</li> <li>• Design of press tool</li> <li>• Work set up</li> <li>• Types of press tool dies</li> <li>• Operation of press tools safely</li> <li>• Calculation of press tool parameters</li> <li>• Work layout</li> </ul>	2	4	6
<b>Total Time</b>			<b>32</b>	<b>56</b>	<b>88</b>

<b>22.2.00</b>	<b>SPECIALISED MILLING - CAM MILLING</b>	vi) Performing cam milling operations safely
	<b>Theory</b>	vii) Cleaning
22.2.01T0	<i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:	viii) produce a cam and camshaft
	a) outline the types of cams	<i>Content</i>
	b) describe the parts of cam-milling attachment	22.2.01T1 Types of cams
	c) explain cutters used for cam milling operation	- disc
	d) describe work set up for cam milling	- cylindrical
	e) calculate cam milling parameters	22.2.01T2 Parts of cam milling attachment
		- dividing head
		- spindle
		- worm wheel
		- gear train
		- protractor
		22.2.01T3 Cam milling cutters
		- end mill
		- fly cutter
		22.2.01T4 Work setting of cam milling attachment
		- arrangement of gear train
22.2.03C	<i>Competence</i> The trainee should have the ability to:	22.2.01T5 Calculation of cam milling parameters
	i) Identify types of cams	- table setting
	ii) Identify cam milling attachments	- angle of swivel
	iii) Use milling cutters to produce cam profiles	- rise (lobe)
	iv) Set up work for cam milling operations	- gear ratio
	v) Calculating cam milling parameters to facilitate working	<b>Practice</b>
		22.2.01P0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:
		a) identify cutters used for cam milling

	<ul style="list-style-type: none"> <li>b) set up work for cam milling</li> <li>c) calculate cam milling parameters</li> <li>d) operate the milling machine safely</li> </ul>		<ul style="list-style-type: none"> <li>d) calculate gear ratio, speeds and feeds for helical milling.</li> <li>e) explain how to care for and maintain helical milling attachment</li> </ul>
	<i>Content</i>		
22.2.01P1	Cam milling cutters <ul style="list-style-type: none"> <li>- end mill</li> <li>- fly cutter</li> </ul>	22.2.03C	<i>Competence</i> The trainee should have the ability to produce a helical gear
22.2.01P2	Work setting of cam milling attachment <ul style="list-style-type: none"> <li>- arrangement of gear train</li> </ul>		
22.2.01P3	Calculation of cam milling parameters <ul style="list-style-type: none"> <li>- table setting</li> <li>- angle of swivel</li> <li>- rise (lobe)</li> <li>- gear ratio</li> </ul>	22.2.02T1	<i>Content</i> Types of helical milling cutters -end mill, fly cutter
22.2.01P4	Safety precautions	22.2.02T2	Set up for helical milling
		22.2.02T3	Indexing for helical milling <ul style="list-style-type: none"> <li>- Simple indexing</li> <li>- Differential</li> </ul>
22.2.02	<b>SPECIALISED MILLING - HELICAL MILLING</b>	22.2.02T4	Calculation of speeds and feeds gear ratio, lead of machine, lead of work, helix angle (x), angle of table swivel (o)
	<b>Theory</b>	22.2.02T5	Care and maintenance of helical milling attachment
22.2.02T0	<i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:		
	<ul style="list-style-type: none"> <li>a) outline helical milling cutters</li> <li>b) describe work set up for helical milling</li> <li>c) describe indexing operation for helical milling</li> </ul>	22.2.02P1	<i>Practice</i> <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: <ul style="list-style-type: none"> <li>a) set up work for helical milling</li> </ul>

	<ul style="list-style-type: none"> <li>b) perform indexing operation for helical milling</li> <li>c) calculate gear ratio, speeds and feeds for helical milling</li> <li>d) observe safety in helical milling operations</li> </ul>		<ul style="list-style-type: none"> <li>- Dial gauge indicator</li> <li>- Parallel strips</li> <li>- Oil</li> <li>- Grease</li> <li>- Cotton waste</li> <li>- Trainers manual</li> </ul>
		22.2.03	<b>SPECIALISED - GRINDING</b>
	<i>Content</i>		<b>Theory</b>
22.2.02P1	Set up for helical milling	22.2.03T1	<i>Specific Objectives</i>
22.2.02P2	Indexing for helical milling <ul style="list-style-type: none"> <li>- Simple indexing</li> <li>- Differential</li> </ul>		By the end of the sub-module unit, the trainee should be able to:
22.2.02P3	Calculation of speeds and feeds gear ratio, lead of machine, lead of work, helix angle, angle of table swivel		a) outline the types of surface grinding machines
22.2.02P4	Care and maintenance of helical milling attachment		b) outline the construction features of a surface grinder
	<i>Suggested Learning Resources</i>		c) identify types of cutters used in grinding
	<ul style="list-style-type: none"> <li>- Milling machine</li> <li>- Helical cutters</li> <li>- End mill</li> <li>- Fly cutters</li> <li>- Helical milling attachment</li> <li>- Indexing head</li> <li>- Gear train arrangement</li> <li>- Safety</li> <li>- Vernier calipers</li> <li>- Micrometers</li> <li>- Depth gauge micrometer</li> </ul>	22.2.03C	d) outline work set up for surface grinding operation
			e) state safety precautions to be observed when surface grinding
			<i>Competence</i>
			The trainee should have the ability to:
			i) Demonstrate selection of cutter for a given surface grinding task



- ii) Setting up work for surface grinding
- iii) Operate surface grinder to produce a desired surface

- a) identify types of cutters used in grinding
- b) set up work for surface grinding operation
- c) operate surface grinder safely.

*Content*

- 22.2.03T1 Types of surface grinding machines
  - Planner type
  - Rotary type
    - o Horizontal type
    - o Vertical type
- 22.2.03T2 Construction features of a surface grinder
  - Base
  - Head
  - Table
- 22.2.03T3 Types of cutters
  - Straight
  - Tapered
  - One side recessed
  - Two side recessed
  - Straight cup
  - Conical cup
  - Dish
  - Thread

- Content*
- 22.2.03P1 Types of cutters
    - Straight
    - Tapered
    - One side recessed
    - Two side recessed
    - Straight cup
    - Conical cup
    - Dish
    - Thread

- 22.2.03P2 Work setting for grinding operations
  - Planning
  - Forming

- 22.2.03P3 Care and maintenance

*Suggested Learning Resources*

- Surface grinder
- Vernier calipers
- Micrometer
  - Spirit level
  - Safety goggles
  - Grease
  - Coolant trainers
  - Manual
  - Surface grinding cutters

**Practice**

- 22.2.03P1 *Specific Objectives*  
By the end of the sub-module unit, the trainee should be able to:

22.2.04	<b>CYLINDRICAL GRINDING</b>				<ul style="list-style-type: none"> <li>- Plain, cylindrical grinder</li> <li>- Roll grinder</li> <li>- Piston grinder (crankshaft grinder)</li> </ul>
	<b>Theory</b>				
22.2.04T0	<i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:				
	a) outline types of cylindrical grinding machines	22.2.04T2		Construction features	<ul style="list-style-type: none"> <li>- Base</li> <li>- Column</li> <li>- Headstock</li> <li>- Spindle</li> </ul>
	b) describe the constructional features of cylindrical grinder	22.2.04T3		Types of tools used in cylindrical grinding	<ul style="list-style-type: none"> <li>- Plunge cut grinding tools</li> <li>- Form grinding tools</li> <li>- Ordinary grinding disc</li> </ul>
	c) state the tools used in cylindrical grinding	22.2.04T4		Work setting and tool holding	
	d) describe work set up for cylindrical grinding	22.2.04T5		Cylindrical grinding operation	<ul style="list-style-type: none"> <li>- Plain grinding</li> <li>- Internal grinding</li> <li>- Crankshaft grinding</li> <li>- Piston grinding</li> </ul>
	e) explain the operation of cylindrical grinding machines	22.2.04T6		Calculation of speeds and feeds	
	f) calculate speeds and feeds of cylindrical grinding machine				
				<b>Practice</b>	
22.2.04C	<i>Competence</i> The trainee should have the ability to	22.2.04P0		<i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:	
	<ul style="list-style-type: none"> <li>- grind dies and punches</li> <li>- grind a given crankshaft</li> </ul>			a) identify the constructional features of cylindrical grinder	
	<i>Content</i>				
22.2.04T1	Types of cylindrical grinding machines				

- b) select the tools used in cylindrical grinding
- c) set up work for cylindrical grinding
- d) operate cylindrical grinding machines
- e) calculate speeds and feeds of cylindrical grinding machine
- f) observe safety

*Content*

- 22.2.04P1 Construction features
- Base
  - Column
  - Headstock
  - Spindle

- 22.2.04P2 Types of tools used in cylindrical grinding
- Plunge cut grinding tools
  - Form grinding tools
  - Ordinary grinding disc

- 22.2.04P3 Work setting and tool holding

- 22.2.04P4 Cylindrical grinding operation
- Plain grinding
  - Internal grinding
  - Crankshaft grinding
  - Piston grinding

- 22.2.04P5 Calculation of speeds and feeds

- 22.2.04P6 Safety, care and maintenance

*Suggested Learning Resources*

- Cylindrical grinding machine
- Assorted grinding mills
- Vernier calipers
- Micrometer
- Depth gauge
- Safety goggles
- Emery cloth
- Oil
- Grease
- Cotton waste
- Trainer's guide

22.2.05

**CENTRELESS GRINDING**

**Theory**

22.2.05T0

*Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) outline the types of centreless grinding machine
- b) explain the construction features of a centreless grinder
- c) outline types of centreless grinding tools
- d) explain work set up for centreless grinding
- e) explain the operation of centreless grinding machine

	f) calculate speeds and feeds in centreless grinding.	22.2.05T5	Centreless grinding operations
		22.2.05T6	Calculation of speeds and feeds
22.2.05C	<i>Competence</i> The trainee should have the ability to:		<b>Practice</b>
	i) select the correct tool for a given task in centreless grinding	22.2.05P0	<i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:
	ii) set work for a given task in centreless grinding		a) identify centreless grinding tools
	iii) operate centreless grinding machine safely		b) set work for centreless grinding
	iv) calculate the speeds and feeds		c) operate centreless grinding machine
			d) calculate speeds and feeds in centreless grinding
			e) use the centreless grinder safety
22.2.05T1	<i>Content</i> Types of centreless grinding machine		<i>Content</i>
	- Internal centreless grinding machine	22.2.05P1	Classification of tools
	- External centreless grinding machine		- Internal grinding tools
22.2.05T2	Construction features of a centreless grinding machine	22.2.05P2	- External grinding tools
	- Grinding wheel	22.2.05P3	Work setting
	- Work rest	22.2.05P4	Centreless grinding operations
	- Regulating wheel	22.2.05P5	Calculation of speeds and feeds
	- Guide		Care and maintenance of centreless grinding machine
22.2.05T3	Classification of tools		
	- Internal grinding tools		<i>Suggested Learning Resources</i>
	- External grinding tools		- Centreless grinding machine
22.2.05T4	Work setting		

	<ul style="list-style-type: none"> <li>- Assorted centreless grinding discs</li> <li>- Coolant</li> <li>- Vernier caliper</li> <li>- Micrometer</li> <li>- Depth gauge</li> <li>- Safety goggles</li> <li>- Oil</li> <li>- Grease</li> <li>- Cotton waste</li> <li>- Trainer's manual</li> </ul>	<ul style="list-style-type: none"> <li>i) Set work for a given cutter grinding operation</li> <li>ii) Calculate cutter grinding parameters</li> <li>iii) Sharpen lathe cutting and milling cutters</li> </ul>
		<i>Content</i>
22.2.06	<b>CUTTER GRINDING</b>	22.2.06T1 Construction features of a cutter grinder
		<ul style="list-style-type: none"> <li>- Work head</li> <li>- Tailstock</li> <li>- Grinding attachment</li> <li>- Swivel vice</li> <li>- Magnetic chuck</li> </ul>
	<b>Theory</b>	22.2.06T2 Classification of cutter grinding wheels
22.2.06T0	<i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:	<ul style="list-style-type: none"> <li>- Plain cylindrical</li> <li>- Angular cutters</li> <li>- End mills</li> <li>- Side mills</li> <li>- Form cutters</li> <li>- Circular forming tools</li> <li>- Reamer</li> <li>- Saws</li> </ul>
	a) outline construction features of a cutter grinder	22.2.06T3 Uses of cutter grinders
	b) classify the types of cutter grinding wheels	22.2.06T4 Work setting
	c) explain uses of cutter grinder	22.2.06T5 Calculation of grinding cutters parameters
	d) explain work set up for cutter grinding	<ul style="list-style-type: none"> <li>- Angle of set over</li> <li>- Tool clearance</li> <li>- Speed and feeds</li> <li>- Depth of cut</li> </ul>
	e) calculate cutter grinding parameters to facilitate working	
		<b>Practice</b>
22.2.06C	<i>Competence</i> The trainee should have the ability to:	22.2.06P0 <i>Specific Objectives</i> By the end of the sub-module unit, the

	trainee should be able to:	22.2.07	<b>GEAR CUTTING</b>
	a) set work for cutter grinding		<b>Theory</b>
	b) calculate cutter grinding parameters to facilitate working	22.2.07T0	<i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:
	c) operate cutter grinding machines safely		a) outline the types gears
22.2.06P1	<i>Content</i> Work setting		b) describe various methods of gear manufacture
	22.2.06P2 Calculation of grinding cutters parameters		c) explain work set up for various gear cutting methods
	- Angle of set over		d) calculate in terms of time and cost the economical method of gear manufacture
	- Tool clearance		
	- Speed and feeds		
	- Depth of cut		
22.2.06P3	Cutter grinding operations	22.2.07C	<i>Competence</i> The trainee should have the ability to:
	- Surface grinding		i) Set up work for a given task
	- Milling cutters		ii) Calculate time and cost of manufacture
	- Lathe tools		iii) Operate gear cutting machine safely
	- Drill bits		iv) Cut a gear for a given drive
	<i>Suggested Learning Resources</i>		<i>Content</i>
	- Cutter grinder	22.2.07T1	Types of gears
	- Assorted cutter grinding tools and attachment		- spur gear
	- Vernier caliper		- helical gear
	- Micrometer		- bevel gear
	- Coolant		- worm gear
	- Oil		- pinion and rack
	- Safety goggles		
	- Grease		
	- Cotton waste		
	- Trainers manual		

<p>22.2.07T2 Gear manufacturing methods</p> <ul style="list-style-type: none"> <li>- milling</li> <li>- shaping</li> <li>- planning</li> <li>- hobbling</li> <li>- fly-cutting</li> </ul> <p>22.2.07T3 Work setting and work holding for a given operation</p> <p>22.2.07T4 Calculation of time and cost</p> <p><b>Practice</b></p> <p>22.2.07P0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> <li>a) set up work for various gear cutting methods</li> <li>b) calculate in terms of time and cost the economical method of gear manufacture</li> <li>c) operate given gear cutting machine safely</li> </ul> <p><i>Content</i></p> <p>22.2.07P1 Work setting and work holding for a given operation</p> <p>22.2.07P2 Calculation of time and cost</p> <p>22.2.07P3 Operation of the gear cutting machine</p> <ul style="list-style-type: none"> <li>- care and maintenance</li> </ul>	<p>22.2.08 <b>GEAR FINISHING</b></p> <p><b>Theory</b></p> <p>22.2.08T0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> <li>a) outline various methods of gear finishing processes</li> <li>b) outline work set up for a given gear finishing operation.</li> <li>c) explain operation of a gear finishing machine for a given task.</li> </ul> <p>22.2.08C <i>Competence</i> The trainee should have the ability to:</p> <ul style="list-style-type: none"> <li>i) set work for a given gear finishing process</li> <li>ii) operate a gear finishing machine</li> </ul>	<p><i>Suggested Learning Resources</i></p> <ul style="list-style-type: none"> <li>- Gear cutting machine</li> <li>- Assorted gear cutter</li> <li>- Vernier caliper</li> <li>- Micrometer</li> <li>- Depth gauge</li> <li>- Safety goggles</li> <li>- Oil</li> <li>- Coolant</li> <li>- Grease</li> <li>- Cotton waste</li> <li>- Trainer's manual</li> </ul>
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to produce a standard gear

*Suggested Learning Resources*

- 22.2.08T1 *Content*  
Methods of gear finishing processes
- gear shaving
  - gear burnishing
  - gear grinding
  - gear lapping
  - gear honing
- 22.2.08T2 Work setting for a given gear finishing process
- 22.2.08T3 Gear finishing operations

- Gear finishing machines
- Assorted finishing tools
- Coolant
- Vernier caliper
- Micrometer
- Depth gauge
- Oil
- Safety goggle
- Cotton waste
- Trainer's manual

22.2.09

**BROACHING**

**Practice**

**Theory**

- 22.2.08P0 *Specific Objectives*  
By the end of the sub-module unit, the trainee should be able to:
- a) set up work for a given finishing operation
  - b) operate a gear finishing machine for a given task safely
  - c) care and maintain a gear finishing machine,

22.2.09T0

- Specific Objectives*  
By the end of the topic trainee should be able to:
- a) outline the types of broaching machines
  - b) state types of broaches
  - c) outline broach tool material
  - d) outline work set up for broaching operation.
  - e) calculate parameters for broaching
  - f) explain the operation of a broaching machine.

- 22.2.08P1 *Content*  
Work setting for a given gear finishing process
- 22.2.08P2 Gear finishing operations
- 22.2.08P3 Care and maintenance of gears

22.2.09C

*Competence*  
The trainee should have the ability to:



	<ul style="list-style-type: none"> <li>i) demonstrate work set up for a given broaching operation</li> <li>ii) produce splines</li> </ul>	22.2.09P0	<p><i>Specific Objectives</i></p> <p>By the end of the topic trainee should be able to:</p> <ul style="list-style-type: none"> <li>a) set up work for broaching operation.</li> <li>b) calculate parameters for broaching</li> <li>c) operate a broaching machine to produce splines, socket screw and plain surfaces</li> </ul>
22.2.09T1	<p><i>Content</i></p> <p>Types of broaching machines</p> <ul style="list-style-type: none"> <li>- horizontal broaching machine</li> <li>- vertical broaching machine</li> <li>- surface broaching machine</li> <li>- surface broaching machine</li> <li>- rotary broaching machine</li> <li>- electro-mechanical broaching machine</li> <li>- 22.2.09T2 horizontal broaching machine</li> <li>- vertical broaching machine</li> <li>- surface broaching machine</li> <li>- surface broaching machine</li> <li>- rotary broaching machine</li> <li>- electro-mechanical broaching machine</li> </ul>	22.2.09P1	<p><i>Content</i></p> <p>Work setting</p>
		22.2.09P2	<p>Calculation of</p> <ul style="list-style-type: none"> <li>- pitch</li> <li>- rake and relief angle</li> <li>- depth of cut</li> <li>- metal thickness</li> <li>- no of cutting teeth</li> <li>- power</li> </ul>
		22.2.09P3	<p>Operation of broach</p> <p><i>Suggested Learning Resources</i></p> <ul style="list-style-type: none"> <li>- Broaching machines</li> <li>- Assorted broaching tools</li> <li>- Vernier calipers</li> <li>- Micrometer</li> <li>- Safety goggle</li> <li>- Oil</li> <li>- Grease</li> <li>- Cotton waste</li> <li>- Trainer's manual</li> </ul>
	<p>rake and relief angle</p> <ul style="list-style-type: none"> <li>- depth of cut</li> <li>- metal thickness</li> <li>- number of cutting teeth</li> <li>- power</li> </ul>		
22.2.09T6	Operation of broach		
	<b>Practice</b>	22.2.10	<b>BORING</b>

	<b>Theory</b>			
22.2.10T0	<i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:			
	a) outline the types of boring machines			- precision boring machine
	b) describe the construction features of a boring machine	22.2.10T2	Constructional features of a boring machine	- jig boring machine
	c) explain the operation of a boring machine			- head stock
	d) Explain work set up work for boring	22.2.10T3	Boring machine operations	- spindle
	e) calculate speeds and feeds of boring machine			- bed
	f) explain operation of a boring machine.	22.2.10T4	Work setting	- table
		22.2.10T5	Calculation of speeds and feeds	- base
		22.2.10T6	Operations of a boring machine, care and maintenance	
22.2.10C	<i>Competence</i> The trainee should have the ability to:			
	i) Set up work for boring tasks			<b>Practice</b>
	ii) calculate speeds and feeds in boring operation	22.2.10P0	<i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:	
	iii) operate boring machine to produce a bush/cylinder bore			a) set work for boring
				b) calculate speeds and feeds of boring machine
				c) operate a boring machine safely
22.2.10T1	<i>Content</i> Types of boring machines			
	- horizontal boring machine	22.2.10T1	Work setting	<i>Content</i>
	- vertical boring machine	22.2.10T2	Calculation of speeds and feeds	

22.2.10T3	Operations of a boring machine, care and maintenance	conventional machining process d) explain operation of a non-conventional machining plant.
	<i>Suggested Learning Resources</i>	
	<ul style="list-style-type: none"> <li>- Boring machine</li> <li>- Assorted boring tools</li> <li>- Vernier calipers</li> <li>- Micrometers</li> <li>- Depth gauge</li> <li>- Coolant</li> <li>- Oil</li> <li>- Grease</li> <li>- Cotton waste</li> <li>- Trainers manual</li> </ul>	<p>22.2.11C <i>Competence</i> The trainee should have the ability to:</p> <ul style="list-style-type: none"> <li>i) Sketch diagrammatic representation of a given non-conventional machining process</li> <li>ii) Calculate the metal removal rate of a given non-conventional machining process</li> <li>iii) Operate non-conventional machining plant to plain surfaces and make dies.</li> </ul>
22.2.11	<b>NON-CONVENTIONAL MACHINING</b>	
	<b>Theory</b>	
22.2.11T0	<i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:	
	<ul style="list-style-type: none"> <li>a) outline the methods of non-conventional machining processes</li> <li>b) illustrate with the aid of a diagram diagrammatic representations of non-conventional machining processes</li> <li>c) calculate the metal removal rate for a given non-</li> </ul>	<p>22.2.11T1 <i>Content</i> Methods of non-conventional machining processes</p> <ul style="list-style-type: none"> <li>- Electro Discharge Machining (EDM)</li> <li>- Electro Chemical Machining</li> <li>- Electro Chemical Grinding (ECG)</li> <li>- Ultrasonic Machining</li> <li>- Abrasive Jet</li> </ul> <p>22.2.11T2 Diagrammatic representation of various processes</p>

- 22.2.11T3 Calculation of the metal removal rate for various processes
- 22.2.11T4 Operation of non-conventional machining plant.

### Practice

- 22.2.11P0 *Specific Objectives*  
By the end of the sub-module unit, the trainee should be able to:
- calculate the metal removal rate for a given non-conventional machining process
  - operate a non-conventional machining plant safely
  - care and maintenance of non-conventional plant.

### Content

- 22.2.11P1 Calculation of the metal removal rate for various processes
- 22.2.11P2 Operation of non-conventional machining plant.
- 22.2.11P3 Caring and maintenance

### Suggested Learning Resources

- Electro discharge machine (EDM)

- Electro Chemical Grinding Plant
- Electro Chemical Machining plant
- Ultrasonic machining plant
- Abrasive Jet machining plant
- Assorted cutting heads for the machining plant
- Vernier caliper
- Micrometer
- Safety goggles
- Oil
- Paraffin oil
- Cotton waste
- Gloves
- Trainer's manual

## 22.2.12

## MECHANICS OF METAL CUTTING

### Theory

- 22.2.12T0 *Specific Objectives*  
By the end of the sub-module unit, the trainee should be able to:
- explain the classification of metal cutting methods
  - describe the types of chips
  - outline the basic features of a two component simple tool force dynamometer
  - explain calibration of a simple tool force dynamometer

	e) explain operation of a simple tool force dynamometer.	22.2.12T3	- inhomogeneous chip Features of a two component tool force dynamometer
	f) calculate using merchant circle tool parameters for a given job	22.2.12T4	Calibration of a tool force dynamometer
	g) calculate the tool life variables for a given tool.	22.2.12T5	Operation of a simple tool force dynamometer
		22.2.12T6	Calculation of: - friction force - normal force - shear force - compressive force - shear angle - rake angle - velocity - power
22.2.12C	<i>Competence</i> The trainee should have the ability to: - Calibrate a simple tool force dynamometer - Operate a simple tool force dynamometer to analyze forces at the tool point - Calculate using merchant circle parameters of a given cutting operation - Calculate variables for a given tool life to design a tool for cutting operations	22.2.12T7	Calculation of - power consumption - tool life - forces - pressure - velocity and other variable
			<b>Practice</b>
		22.2.12P0	<i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:
22.2.12T1	<i>Content</i> Classification of cutting methods - orthogonal/ cutting - oblique cutting		a) calibrate a simple tool force dynamometer b) operate a simple tool force dynamometer safely
22.2.12T2	Identify the types of chips - segmental - continuous - continuous with build up edge		c) calculate using merchant circle

	<p>tool parameters for a given job</p> <p>d) calculate the tool life variables of a given tool</p>		
	<p><i>Content</i></p> <p>22.2.12P1 Calibration of a tool force dynamometer</p> <p>22.2.12P2 Operation of a simple tool force dynamometer</p> <p>22.2.12P3 Calculation of:</p> <ul style="list-style-type: none"> <li>- friction force</li> <li>- normal force</li> <li>- shear force</li> <li>- compressive force</li> <li>- shear angle</li> <li>- rake angle</li> <li>- velocity</li> <li>- power</li> </ul> <p>22.2.12P4 Calculation of</p> <ul style="list-style-type: none"> <li>- power consumption</li> <li>- forces</li> <li>- pressure</li> <li>- velocity and other variable</li> </ul>		
	<p><i>Suggested Learning Resources</i></p> <ul style="list-style-type: none"> <li>- Lathe tool bits</li> <li>- Dynamometer</li> <li>- Dampers (weights)</li> <li>- Calibration chart</li> <li>- Dial testing indicator</li> <li>- Cotton waste</li> <li>- Oil</li> <li>- Safety goggles</li> <li>- Trainers manual</li> </ul>		
<b>22.2.13</b>	<b>COPYING SYSTEMS</b>		
		22.2.13T0	<p><b>Theory</b></p> <p><i>Specific Objectives</i></p> <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> <li>a) outline the types of copying systems</li> <li>b) illustrate diagrammatically the various copying systems</li> <li>c) describe the types of copying system machines</li> <li>d) explain work set up for copying systems</li> <li>e) outline limitations for various copying systems</li> <li>f) analyze the principle of servo operated copying systems</li> <li>g) analyze factors which govern accuracy and response in copying systems</li> <li>h) care and maintenance of copying machines,</li> </ul>
		22.2.13C	<p><i>Competence</i></p> <p>The trainee should have the ability to:</p> <ul style="list-style-type: none"> <li>i) Illustrate diagrammatically the various types of copying systems</li> </ul>

- ii) Set up work for a given operation
- iii) Analyze the principle of a servo-operated copying systems
- iv) Analyze accuracy and response in copying system to decide on choice for production

- trainee should be able to:
- a) set up work for copying systems
  - b) outline limitations for various copying systems
  - c) analyze the principle of servo operated copying systems
  - d) analyze factors which govern accuracy and response in copying systems
  - e) operate a copying machine safely

*Content*

- 22.2.13T1 Types of copying systems
- 22.2.13T2 Diagrammatic representation of the various copying systems
  - Mechanical
  - Hydraulic
  - Electro mechanical
- 22.2.13T3 Types of copying machines
  - Work set ups for copying
- 22.2.13T4 Limitations of copying systems
- 22.2.13T5 Analysis of the principle of servo operated copying system
- 22.2.13T6 Analysis for accuracy and response in copying system
- 22.2.13T7 Care and maintenance of copying machine

**Practice**

- 22.2.13P0 *Specific Objectives*  
By the end of the sub-module unit, the

*Content*

- 22.2.13P1 Work set ups for copying
- 22.2.13P2 Limitations of copying systems
- 22.2.13P3 Analysis of the principle of servo operated copying system
- 22.2.13P4 Analysis for accuracy and response in copying system
- 22.2.13P5 Care and maintenance of copying machine

*Suggested Learning Resources*

- Copy lathe
- Hydraulic systems kit
- Pneumatic systems kit
- Electromechanical kit
- Specimens

- Templates
- Vernier caliper
- Safety goggles
- Oil
- Cotton wool
- Trainer's manual

The trainee should have the ability to:

- i) operate the relevant specialized machines safely

design, develop and produce engineering articles using specialized machines

**22.2.14 PRESS TOOL DESIGN**

**Theory**

- 22.2.14T0 *Specific Objectives*  
By the end of the sub-module unit, the trainee should be able to:
- a) describe types of presses
  - b) describe parts of press tools
  - c) outline operations performed by the press tools
  - d) explain the design of a press tool
  - e) explain work set up for press tool operation
  - f) describe the types of press tool dies
  - g) explain work layout for press tool operation
  - h) calculate parameters for a press tool design and operation
  - i) care and maintenance of press tools.

- Content*
- 22.2.14T1 Types of presses
- According to source of power supply
  - Mechanical presses
  - Hydraulic presses
  - According to methods of actuation
  - Crankshaft drive
  - Rack and pinion drive
  - According to the number slides
  - Single action
  - Double action
  - Triple action
- 22.2.14T2 Parts of the press tool
- Die block, frame, guide, plate, lower shoes, punch, traddle, upper shoe, back up, blanking tool, stripper
- 22.2.14T3 Operations of press tool Cutting, operation
- o Blanking, punching, notching, perforating, trimming, shoving,

22.2.14C **Competence**



	slitting and lancing	22.2.14P0	<i>Specific Objectives</i>
	- Forming operations, bending, drawing, redrawing and squeezing		By the end of the sub-module unit, the trainee should be able to:
22.2.14T4	Design of press tool		a) set up work for press tool operation
	- Single operation		b) identify the types of press tool dies
	- Combination operation		c) layout work for press tool operation
	- Series operation		d) calculate parameters for a press tool design and operation
22.2.14T5	Work set up		e) operate a press tool safely
22.2.14T6	Types of press tool dies according to the type		
	- According to press operation		
	o cutting dies		
	o forming dies		
	- According to the methods of operation	22.2.14P1	<i>Content</i>
	o simple dies	22.2.14P2	Work set up
	o compound dies		Types of press tool dies according to the type of press operation
	o combination dies		- cutting dies
	o progressive dies		- forming dies
	o transfer dies		- According to the methods of operation
22.2.14T7	Work layout		- simple dies
22.2.14T8	Calculation of press tool parameters		- compound dies
	- cutting force		- combination dies
	- diameter of hole		- progressive dies
	- linear length		- transfer dies
	- material thickness	22.2.14P3	Work layout
	- power	22.2.14P4	Calculation of press tool parameters
	consumption, blank size		- cutting force
22.2.14T9	Operation of press tools safely		- diameter of hole
			- linear length
			- material thickness
			- power
			consumption, blank size

**Practice**

22.2.14P5 Operation of press tools  
safely

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## **23.2.0 BUSINESS PLAN**

### **23.2.1 Introduction**

This module unit is designed to equip the trainee with knowledge, skills and attitudes to enable him/her prepare a business plan.

### **23.2.2 General Objectives**