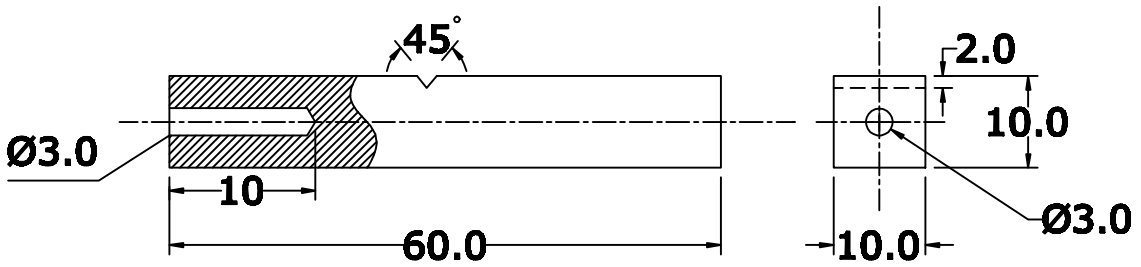
APPENDIX - III

INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

DEPT. OF MECH. ENGG./CENTRAL WORKSHOP



CHARPY IMPACT SPECIMEN

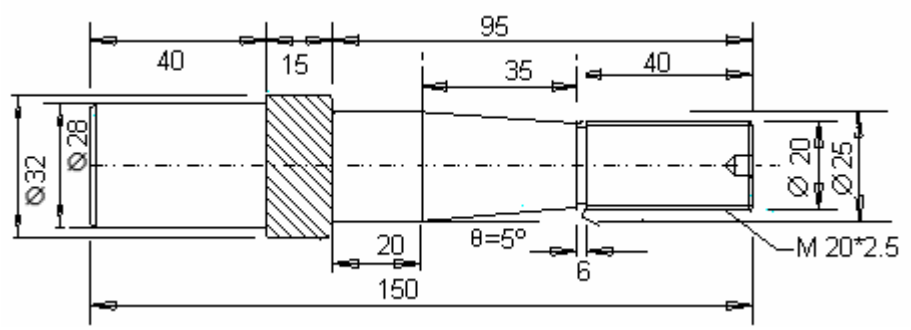
All dimensions are in mm

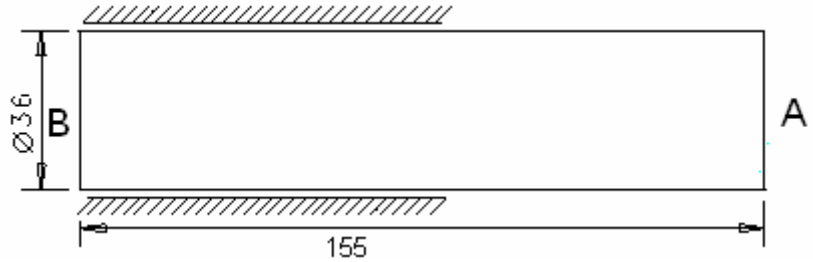
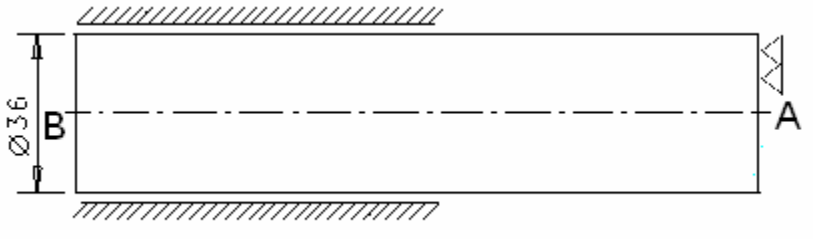
SCALE - Not to Scale

CHARPY IMPACT SPECIMEN
QTY: 6
MATERIAL: MILD STEEL

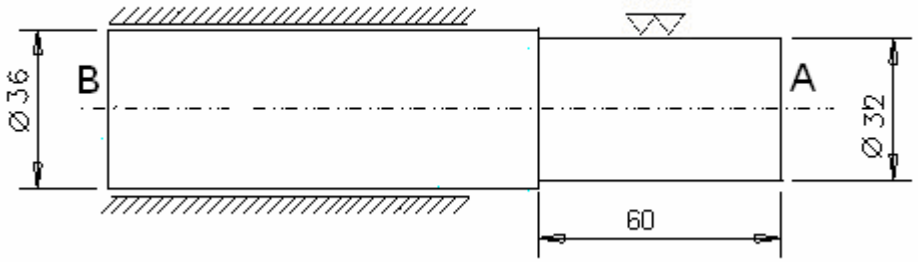
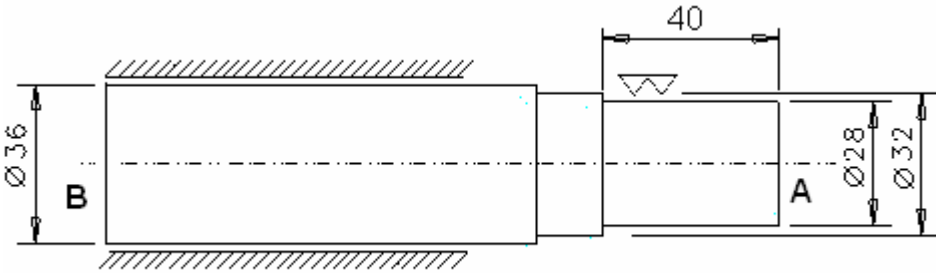
ME213: Sample process sheet- Lathe

LATHE JOB

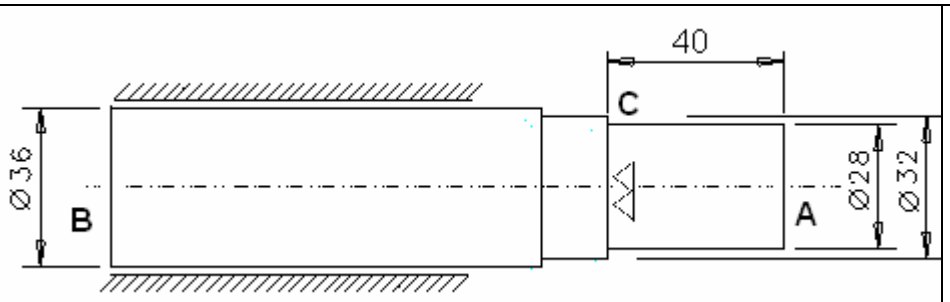
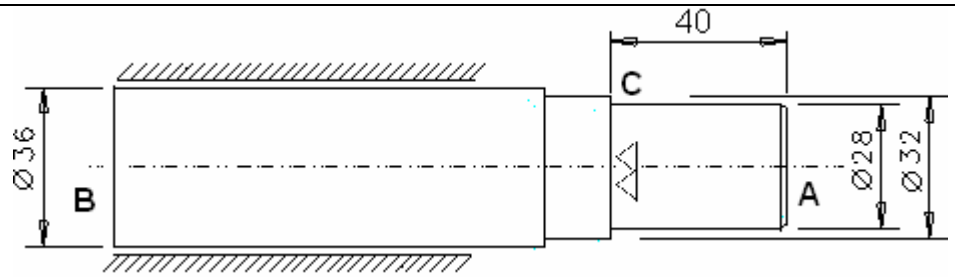
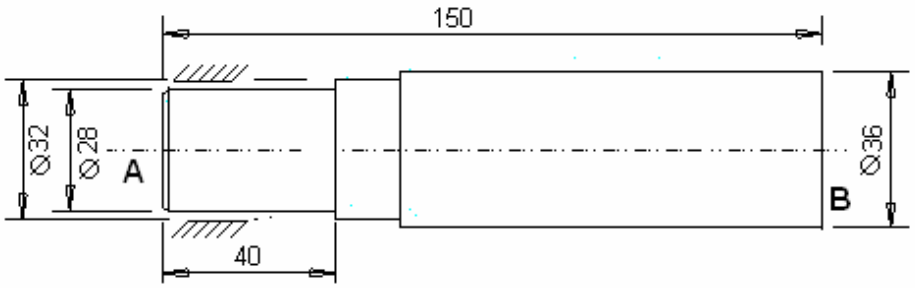
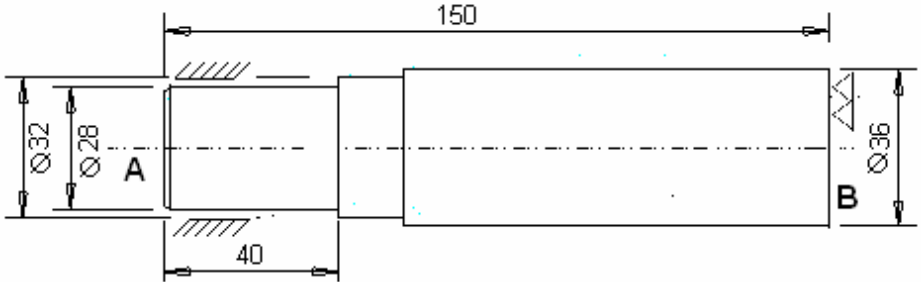


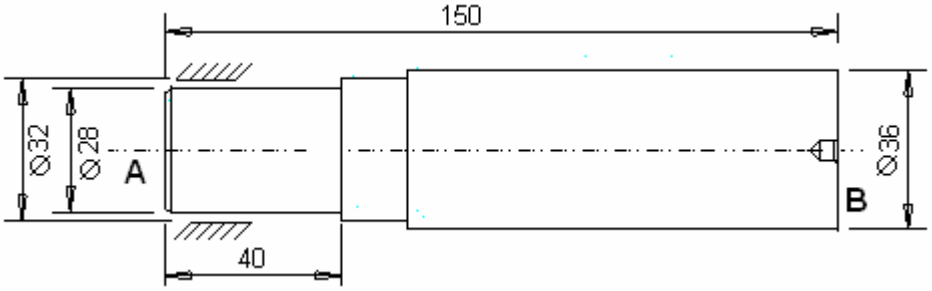
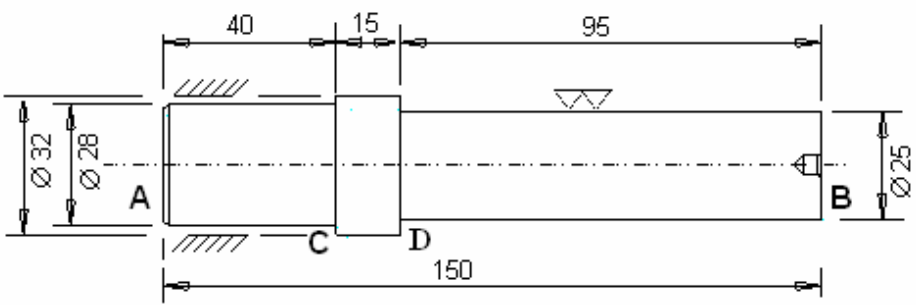
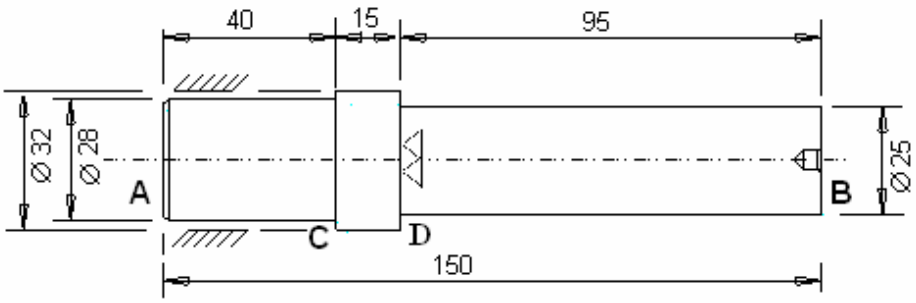
Sr. No.	Operation	Job diagram	Time
1.	Initial size of the raw material: L=155 mm, Ø36 a) Clamp side B (Keep the job 80mm outside) b) Set the tool		1 min 2 min
2.	Machining of side 'A' ('Facing') a) Rough facing (L=R=36/2=18) [N=433 rpm, l=20 mm, F=0.5 mm/rev D= 1 mm] b) Finish facing [N=433 rpm, l=20 mm, F=0.25 mm/rev D= 0.5 mm]		0.1848 min 0.1848 min
3.	Adjust the tool for turning		2 min

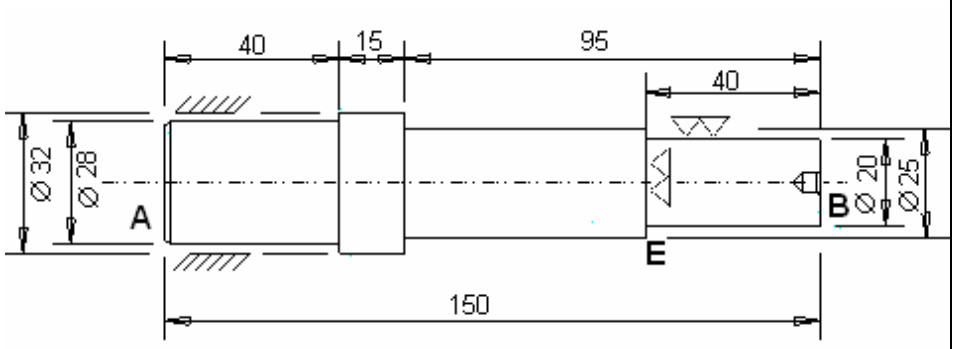
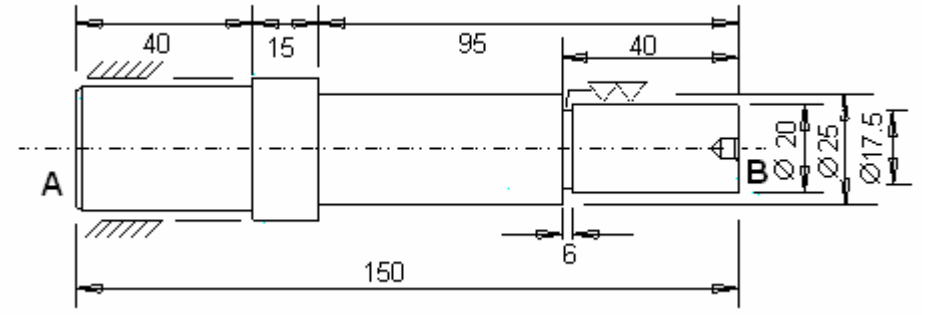
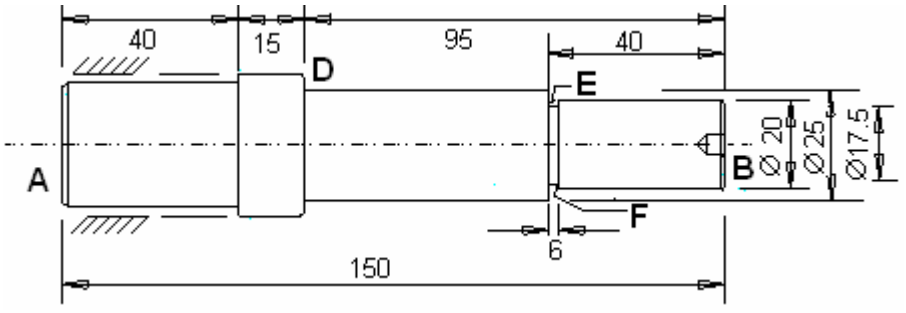
ME213: Sample process sheet- Lathe

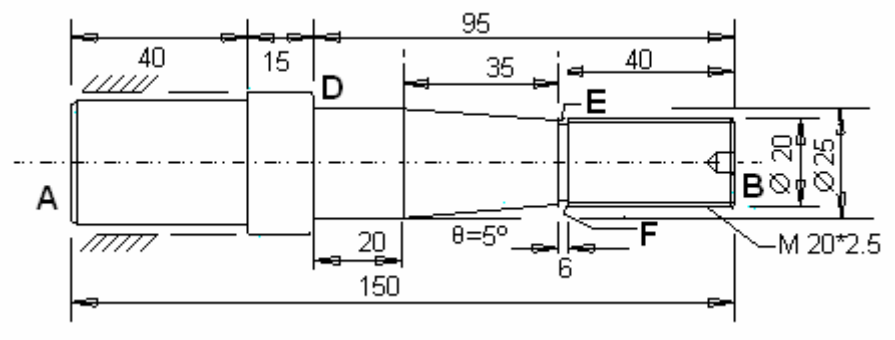
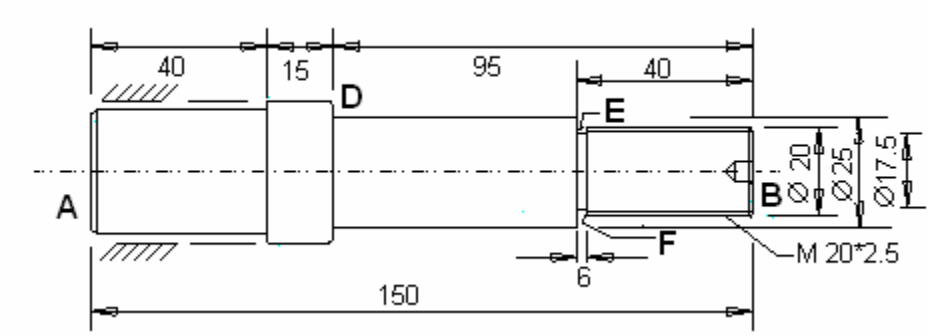
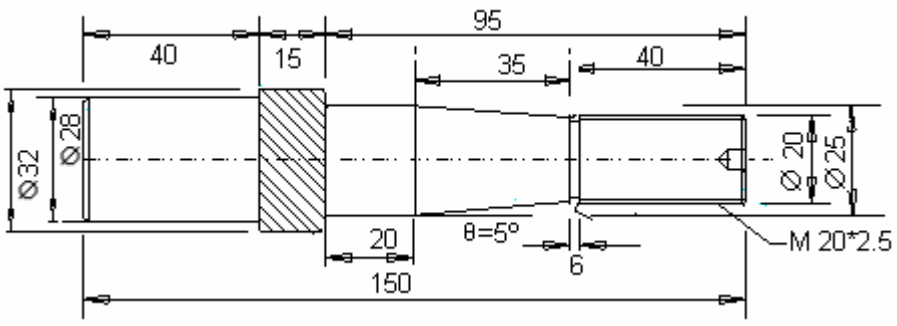
4.	Turn OD:∅32; L =60, a) Rough turning [OD to Ø33, L=60] [N=433 rpm, l=60 mm, F=0.5 mm/rev, D= 1.5 mm] b) Finish turning [OD to Ø32, L=60] [N=433 rpm, l=60 mm, F=0.25 mm/rev, D=0.5 mm]		0.554 min 1.109 min
5.	Turn OD:∅28; L =40, a) Rough turning [OD to Ø29, L=45] [N=433 rpm, l=45 mm, F=0.5 mm/rev, D= 1.5 mm] b) Finish turning [OD to Ø28, L=45] [N=433 rpm, l=45 mm, F=0.25 mm/rev, D= 0.5 mm]		0.4157 min 0.8314 min
6.	Adjust the tool for facing		2 min

ME213: Sample process sheet- Lathe

7.	Face side ‘C’ (L=32-28/2=2) [N=433 rpm, l=4 mm, F=0.25 mm/rev, D= 0.5 mm]		0.03695 min
8.	Adjust the tool for chamfering by swiveling the compound slide Chamfer ‘A’ (3×45º) [N=433 rpm, l=4.24 ≈5 mm, F=0.25 mm/rev]		2.0 min 0.0462 min
9.	Clamp side ‘A’		2.0 min
10.	Adjust the tool for facing Face side ‘B’ so that the total length becomes L=150 mm a) Rough facing (L=R=36/2=18) [N=433 rpm, l=20 mm, F=0.5 mm/rev, D= 1 mm]		2 min 0.1848 min

	b) Finish facing [N=433 rpm, l=20 mm, F=0.25 mm/rev D= 0.5 mm]		0.1848 min
11.	Center drill 'B' using the drill chuck and the centre drill.		2 min
12.	Adjust the tool for turning		2 min
13.	Turn OD:Ø25; L =95, a) Rough turning [OD to Ø26, L=100] [N=433 rpm, l=100 mm, F=0.5 mm/rev, D= 2 mm] b) Finish turning [OD to Ø25, L=100] [N=433 rpm, l=100 mm, F=0.25 mm/rev, D= 0.5 mm]		2.3095 min 1.848 min
14.	Adjust tool for facing. Face 'D', (L=R=(32-25)/2=3.5) [N=433 rpm, l=5 mm, F=0.25 mm/rev]		0.5 min 0.04619 min

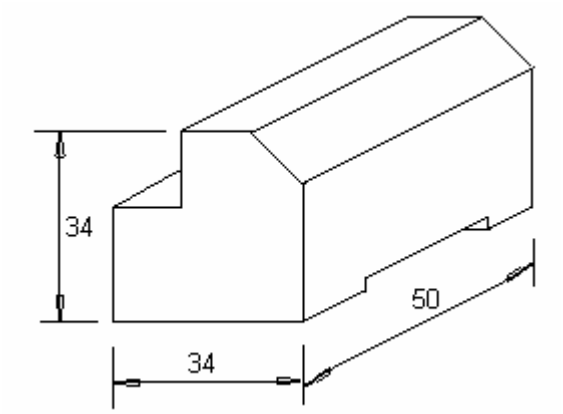
15.	Turn OD:∅20; L =40, a) Rough turning [OD to Ø21, L=44] [N=433 rpm, l=44 mm, F=0.5 mm/rev, D= 2 mm] b) Finish turning [OD to Ø20, L=44] [N=433 rpm, l=44 mm, F=0.25 mm/rev, D= 0.5 mm] & Face 'E' (L=25-20=5) [N=433 rpm, l=5 mm, F=0.25 mm/rev, D= 0.5 mm]		0.406 min 0.813 min 0.0462 min
16.	Grooving with parting tool OD:∅17.5; L=6 mm,		0.5 min
17.	Adjust tool for chamfering Chamfer side 'B' Chamfer side 'D' Chamfer side 'C'		0.5 min 0.0196 min 0.0196 min 0.0196 min

18.	Adjust the compound rest slide to θ=5º Adjust the tool for tuning Taper turn : L=35 mm		2 min 1.0 min 0.65 min
19.	Set the screw cutting tool for threading Thread: Pitch, p=2.5, L=34; (RH thread : movement from R- L) [N=108 rpm (back gear drive) L=36 mm, F=p= 2.5 mm, No. of cuts=5.]		5 min 0.666 min
20.	Adjust the tool for knurling Knurl OD-∅32, L=15. [N=108 rpm (back gear drive) L=15 mm, F= 0.25 mm]		1.0 min 0.555 min
21.		Total Time taken	38.63 min ≈40 min

FORMULAE USED:

Cutting Speed: CS = (π* d * N)/ 60,
Time taken to machine: t = l/ (F*N),
Where, l: Length of cut,
F: feed,
N: Speed
Total time taken=T =t* no. of cuts performed.

SHAPING JOB



Formulae to be used to calculate the machining time:

- Time taken for the cutting stroke = $\frac{\text{Length of stroke (L) (in meters)}}{\text{Cutting speed (CS) (in meters/min)}}$
  Where, L = Clearance (say 25 mm) + actual length of stroke (l)

- Time taken for the return stroke = m* $\frac{\text{Length of stroke (in meters)}}{\text{Cutting speed (in meters/min)}}$

  Where, m= $\frac{\text{Return stroke time}}{\text{Cutting stroke time}} = \frac{\text{Return stroke angle}}{\text{Cutting stroke angle}} = \frac{140^\circ}{220^\circ} = 0.6363636$

- Time taken to complete a single stroke = $\frac{(1+m)* \text{Length of stroke (in meters)}}{\text{Cutting speed (in meters/min)}}$

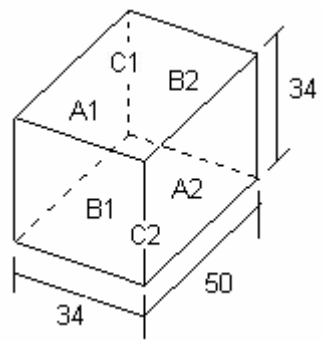
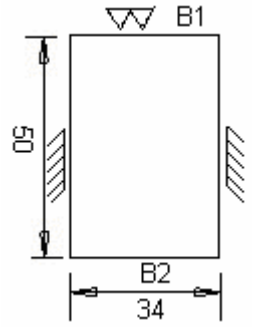
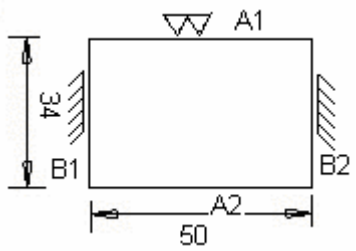
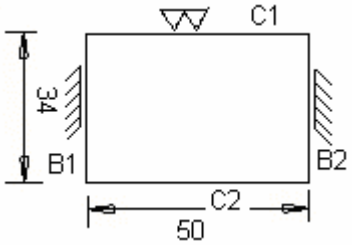
- No. of strokes/min.,N = $\frac{\text{Cutting speed (in meters/min)}}{(1+m)* \text{Length of stroke (in meters)}}$

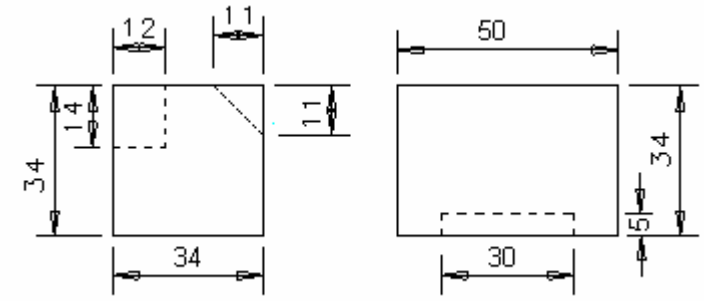
- Total number of strokes required to complete the job= $\frac{\text{Width of the workpiece (B)}}{\text{Feed (F)}}$

- Total machining time,T = $\frac{(1+m) * L * B}{CS * S}$

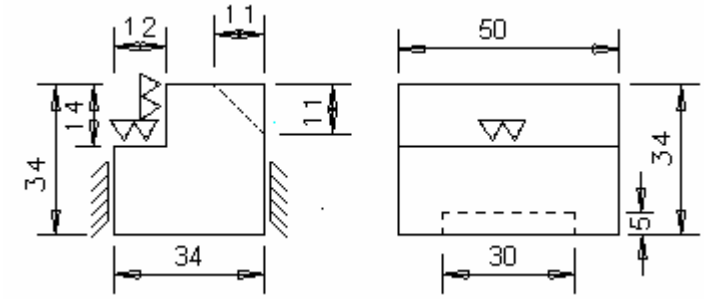
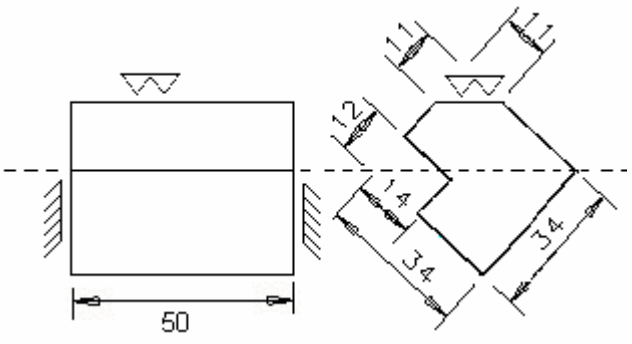
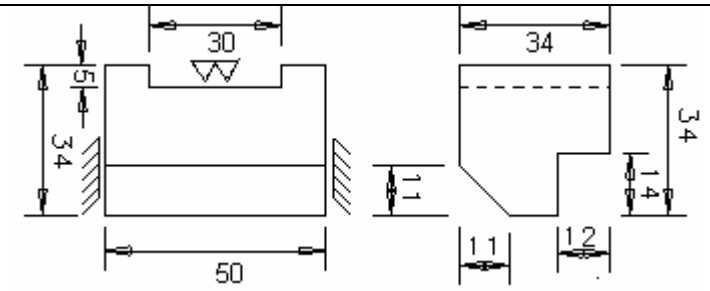
- Total number of cuts,n = $\frac{\text{Height (depth to be cut) (h)}}{\text{Depth of cut (d)}}$

ME 213: Sample process sheet - Shaping

Sr no.	Operation	Diagram	Time
1.	[Initial size of the raw material-40*40*55] Clamp the raw material in the machine vice		2 min
2.	Set the ram's position and stroke		2 min
3. a) b) c) d)	Steps to machine all the six faces of the cuboidal job to correct overall dimensions (50*34*34): Machine the entire surface area of face B1. [l= 34 mm, L= 25+ 34 =59 mm, B = 34 mm, CS= 24,000 mm/min. F =0.25 mm, m = 0.63636] Machine surface B2. (Clean) Clamp faces B1 &B2 against the fixed jaw of the machine vice (in order to machine A1, A2, C1&C2). Machine face A1 (ensure that face C1 is approximately at a right angle to A1 using a set square) [l= 50mm, L= 25+ 50=75 mm, B = 34 mm, CS= 24,000 mm/min. F =0.25 mm, m = 0.63636]	  Fig.1  Fig.2  Fig.3	0.547 min 0.547 min 1 min 0.695 min

e)	Machine face C1 at right angle to face A1. [l= 50mm, L= 25+ 50=75 mm, B = 34 mm, CS= 24,000 mm/min. F =0.25 mm, m = 0.63636]		0.695 min
	[Now faces A1,B1 and C1 are at right angles to each other]		
f)	Make markings on faces A2, B2, and C2, to dimension & punch the markings.		3.0 min
g)	Machine these faces by resting the machined surface against the fixed jaw to the required size. (Ensure that they are at right angles to the adjacent faces).		0.695 min 0.695 min
4.	Mark to dimension the other features viz. right angled edge, 45º slant edge and the bottom slot on the job. Punch these markings.		4 min 5 min
5.	Adjust the tool Clamp the job in the machine vice. [Follow the shop floor instructions for machining these features].		1 min 1 min

ME 213: Sample process sheet - Shaping

6.	Machine the right angled edge. [l= 50mm, L= 25+ 50=75 mm, B = 12 mm, CS= 24,000 mm/min. F =0.25 mm, m = 0.63636, n= Σ h = 12+2 = 8] d 2 1		1.964 min
7.	Clamp the job at an inclination of 45º. Machine the slant face. [l= 15.556 mm, L= 25+15.56=40.556mm, B = 50 mm, CS= 24,000 mm/min. F =0.25 mm, m = 0.63636, h = 7.778mm≈ 8 mm, n= Σ h = 5] d		1 min 2.765 min
8.	Invert and clamp the job. Machine the bottom slot. [l= 34 mm, L= 25+ 34=59 mm, B = 30 mm, CS= 24,000 mm/min. F =0.25 mm, m = 0.63636, h = 5mm, n= Σ h = 4+1 = 3] d 2 1		1 min 1.448 min
		Total Time	32.05 min.

APPENDIX-V

Specification of All geared lathe machine; PSG LATHE TYPE 141E	
Capacity	
Height of centre	177.5/200 mm
Admit between centres	800/1000 mm
Swing over bed, Swing over saddle	355/400 mm; 276/320 mm
Swing over cross slide; Swing in gap	200/250 mm; 520/565 mm
Length of gap in front of face plate	126 mm
Width of bed; length of bed	242 mm; 1785/1985mm
Head Stock	
spindle bore; spindle speeds	40 mm; 8
spindle speed range	45-1200 rpm
Taper in spindle; Taper in centre	MT 5; MT 3
Feeds and threads	
Number of feeds	30
Range of longitudinal feeds	0.05 to 3.96 mm/rev
Range of transverse feeds	0.017 to 1.35 mm/rev
Metric threads	0.25 to 10 mm
Whithworth threads	96 to 15/8 tpi
Diameter of feed shaft	18 mm
Diameter of leadscrew	28 mm
Pitch of lead screw	6 mm
Slides	
Saddle traverse; Cross slide traverse	800/1000 mm; 180 mm
Tool slide traverse	108 mm
Maximum section of tool	20 *20 mm
Apron dial graduation	0.2 mm/div
Cross slide dial graduation	0.05 mm/div
Tool slide graduation	0.05 mm/div
Tool slide angle of rotation	90 ^{0} on either side
Tail stock	
Diameter of tailstock spindle	45 mm
Spindle traverse of tailstock	180 mm
Taper in spindle	MT 3
Tailstock dial graduation	0.05 mm/div
Main motor drive power	2.2 kw(3 HP);1440 rpm; 3Ph; 415 V, 50 hz, AC
Motor for coolant pump	0.09 kw (0.0125 HP); 1440 rpm; 3Ph; 415 V, 50 hz, AC 30 lit/min
Floor area of machine	2300/2500 *1000
Approx. net and gross weight	950/1000 kgf and 1200 / 1250 kgf

Sagar Shaping machine specifications		
SPECIFICATIONS		
CAPACITY	**12"**	**18"**
LENGTH OF RAM STROKE	305	457
LENGTH OF RAM	660	990
LENGTH & WIDTH OF RAM BEARINGS	660X178	762X267
MAX & MINIMUM DISTANCE FROM TABLE TO RAM	257X41	407X89
TABLE		
WORKING SURFACE OF TABLE	305X228	407X292
MAX TABLE RAVEL-HORIZONTAL	419	508
MAX TABLE RAVEL- VERTICAL	140	330
ANGULAR MOVEMENT OF TABLE ON EITHER SIDE	60L 60R	60L 60R
TOOL HEAD		
MAXIMUM SIZE OF TOOL SHANK ACCOMMODATED	16X22	32X16
MAX.VERTICAL TRAVEL OF TOOL SLIDE	140	150
MAX.SWIVEL OF TOOL HEAD	60LX60R	60L X 60R
SPEEDS & FEEDS		
DIA OF CLUTCH PULLEY	235	311
RANGE OF RAM SPEEDS (STROKE PER MINUTE)	30,60,90	17,25,50,75
DIA OF MOTOR PULLEY	76	89
RANGE OF TABLE FEED PER STROKE OF RAM	0.229	0.229
RANGE OF TOOL HEAD FEED	Hand Feed	Hand Feed
DRIVE & ELECTRICAL EQUIPMENTS		
3 PHASE ELECTRIC MAIN DRIVE MOTOR	1.5 HP	2 HP
SPEED R.P.M.	960	960
V-BELT SECTION	B-35	B-55
MAIN SWITCH STARTER PUSH BUTTON)	3.5 AMP	3.5 AMP

Thakoor Drilling Machine	
(Bench type-sensitive drilling machine) BDM/13	
Drilling capacity in steel (60 kg./sq.mm)/cast Iron	Ø 13/Ø 16
Spindle nose taper (T)	JT-6(Male)
Spindle stroke (S)(Drilling Depth)	100
No.of spindle speeds	4
Spindle speed range	580-820-1140-1550
Distance from column to spindle(throat)	155
Spindle nose to work table (min to max)	0-205
Spindle nose to base table (max)	445
Spindle feed	Manual
Column diameter	60
clamping area of work table	180*200
clamping area of base plate	230*230
T slots on work table (size/pitch/Nos.)	12/100/2
Power of motor 3 ph. (KW/HP) TEFC	0.37/0.5
Motor RPM	1500
Electric supply	415 V,3Ph,50 Hz
control voltage	220 V,1Ph,50 Hz
Overall size of base plate (W* L)	300*425
Overall size of machine(W* L* H)	365 * 615 * 975
Machine weight in Kgs with motor (+_5%)	90

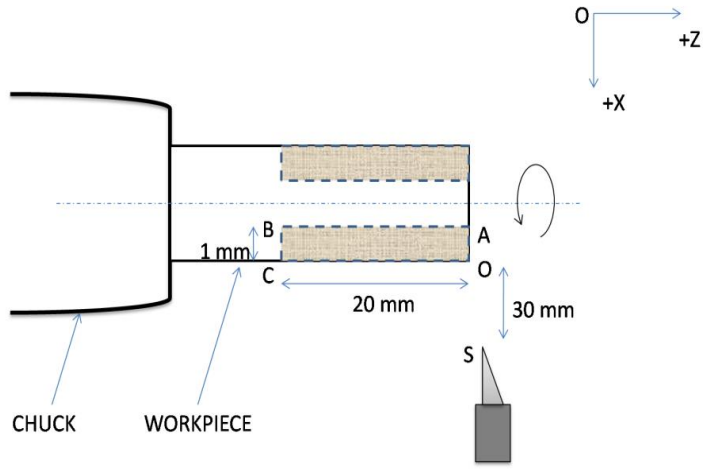
Milling machine (BFW Make-UF1 Type)	
Overall table size	1175*230
Table clamping area	1000*230
Nominal size of T slot,Number/Spacing	14,3/45
Table travel Longitudinal (manual/auto)	590/560
Table travel Transverse (manual/auto)	270/250
Table travel Vertical (manual/auto)	340/--
Swivel of Table/milling head to either side	45
Distance of spindle axis/face to table clamping surface min/max	10/330
Distance of inner face of table of vertical column guideways min/max	40.5/290.5
Distance of spindle axis to bottom of overarm	115
Width of column,knee,bed,overarm guideways	180,335,120,150
Max. job weight to be loaded on table	170 kgs
Type & size of spindle nose	40
No.& range of spindle speeds	12/45-2000
No.& range of feeds-Longitudinal & transverse (manual/auto)	18/16-800
Total number of speed gears used	14
Total number of feed gears used	32
Number of motor used,Total power	2,4.25 KW
Power & supply connections	3 Ph 415 V,50 Hz,4 wire
Main motor frame size,enclosure,Power,Speed	100 L,TEFC,3 Kw,1500
Auxilary motor frame size,enclosure,output,speed	80 N,TEFC, 0.75,1500
Hardness of table,knee,column,overarm	BHN 180-220
Hardness of main spindle,gears	58-60 HRC
Overall height of machine	1600 mm

ME 213: MANUFACTURING PRACTICE LABORATORY
CNC Machining Lectures

Lecture 1

Basic Information

G-Codes	**G00** – Rapid interpolation (used for air-cutting i.e. tool traverse at highest speed possible in machine) *Syntax:* **G00 X(final position) Z(final position)** *e.g.* **G00 X10 Z-15** ; This command will lead the tool at (10,-15) from its current position **G01** – Linear interpolation *Syntax:* **G01 X(final position) Z(final position) F(value of feed in mm/min)** *e.g.* **G01 X10 Z-15 F40** ; This command will lead the tool at (10,-15) from its current position at the speed of 40 mm/min. **G90** – Absolute coordinate system (ACS) **G91** – Incremental coordinate system
M-Codes	**M03** – Spindle start Clockwise (Syntax: **M03 S500** ; Here 500 is the RPM of the spindle) **M04** – Spindle start Anti-Clockwise **M05** – Spindle stop **M06** – Tool change
Work and Machine coordinate systems	Will be taught with upcoming example.

Generating a part program	**Considering point O as (0,0)** - What should be the tool path to cut hatched region? - Write a part program for the required tool path using G & M codes
	**Solution:** **Tool path should be S-O-A-B-C-S.** Part program- G90 ; ACS M03 S800 ; spindle start at 800 rpm CW G00 X0 Z0 ; Point S to O G01 X-1 F30 ; Point O to A Z-20 ; Point A to B X0 ; Point B to C G00 Z0 X30 ; Point C to S

Note:

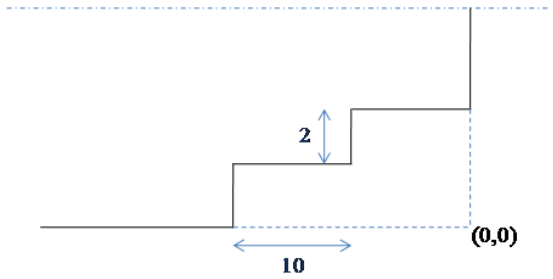
Procedure for setting zero work position

Bring the cutting tool to the face of workpiece and set z = 0 as reference as shown below:

Setup ⟶ Zero Position ⟶ Z = 0

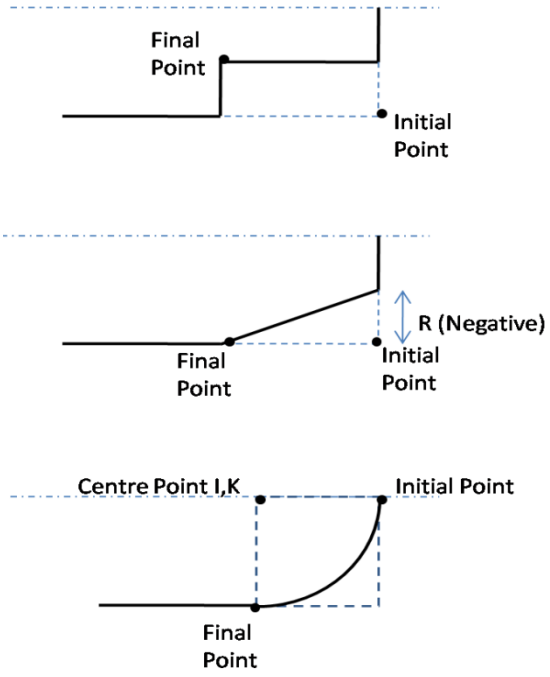
Then bring the tool to the circumference of workpiece and set x = 0 as reference as shown below:

Setup ⟶ Zero Position ⟶ X = 0.

Practise question for machining	**Considering point O as (0,0)** - Discuss the tool path for the code. - Write a part program for the required tool path using G & M codes. - After writing down the code reproduce the same geometry on the CNC Lathe machines.
	**Solution:** G90 M03 S800 G00 X0 Z0 G01 X-1 F30 Z-20 G00 X1 Z0 G01 X-2 Z-20 G00 X1 Z0 G01 X-3 Z-10 G00 X1 Z0 G01 X-4 Z-10

Canned cycles

- A **canned cycle** is a way of conveniently performing repetitive CNC machine operations.
- Canned cycles are so called because they allow a concise way to program a machine to produce a feature of a part
- Canned cycles can also automate certain machining functions such as drilling, boring, threading, pocketing, etc.



Types of canned cycle

Straight turning-

Syntax:

G00 $X_{Initital}$ $Z_{initial}$

G77 X_{Final} Z_{Final} Q_ F_

G80

Taper turning -

Syntax:

G00 $X_{Initital}$ $Z_{Initial}$

G77 X_{Final} Z_{Final} Q_ F_ R

G80

Arc turning –

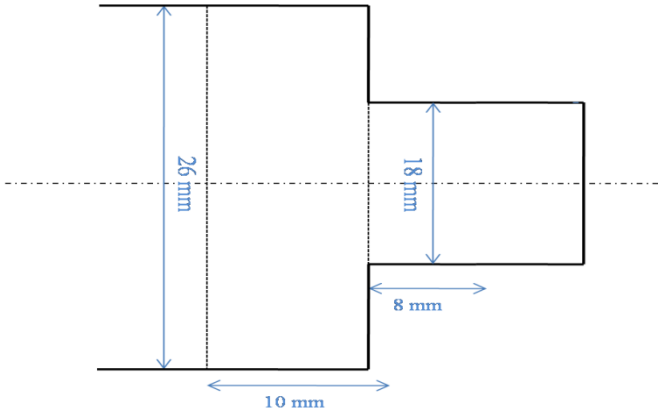
Syntax:

G00 $X_{Initital}$ $Z_{Initial}$

G72 X_{Final} Z_{Final} I_ K_ Q_ F_

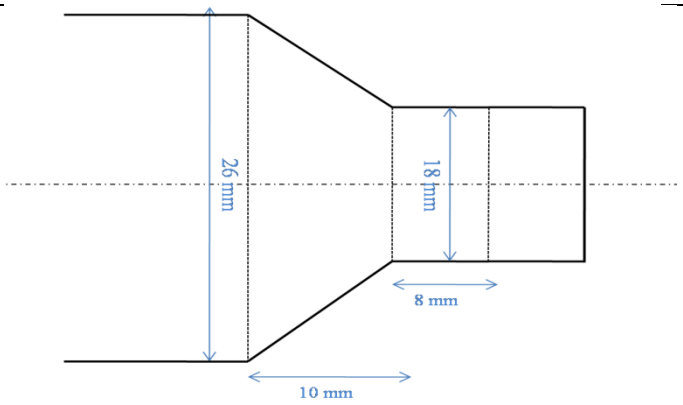
G80

Practise question for machining (Canned cycle)



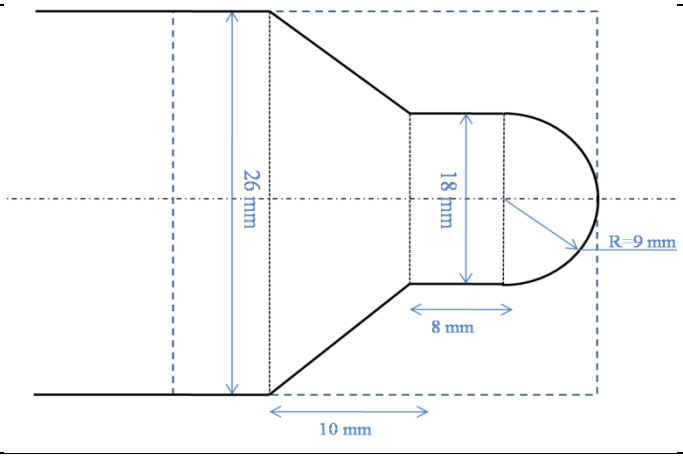
Solution
Straight turning canned cycle
G90
M03 S800
G00 X0 Z0
G77 X-4 Z-17 Q0.1 F40

Note:
This is a sample code.



Taper turning canned cycle
G00 X0 Z-17
G77 X0 Z-27 Q0.1 R-4 F40

Note:
Depth of cut and speeds may vary according to material.
It is advised that one should not use DoC more than 0.5 mm for plastics.

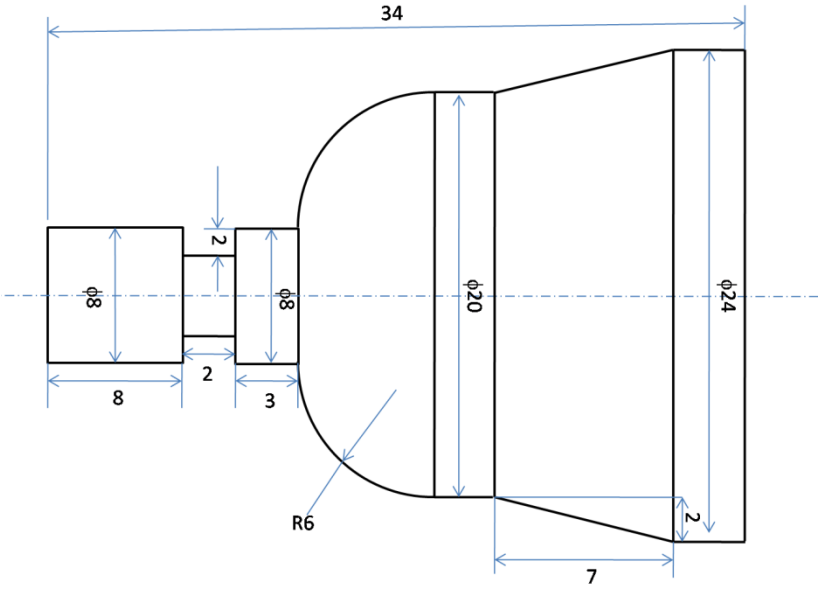


Arc turning canned cycle
G00 Z0
X-13
G72 X-4 Z-9 I-13 K-9 Q0.1 F40
G80
G00 X0 Z0
M05

Note:
Mind the tool path when head to Arc turning from taper turning. Tool may dash to workpiece.

Lecture 2

Practise question for turning
(Canned cycle)

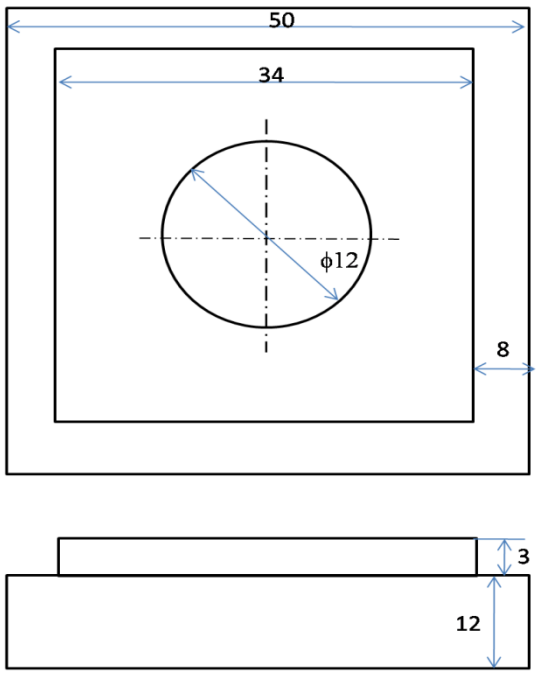



```
G90
M03 S800
G00 X0 Z0
G77 X-0.8 Z-34 Q0.1 F40
G00 X-0.8 Z0
G77 X-2.8 Z-24 Q0.1 F40
G00 X-0.8 Z0
G77 X-8.8 Z-13 Q0.5 F40
G00 X-0.8 Z-24
G77 X-0.8 Z-31 R-2 Q0.1
F40
G00 X-8.8 Z-13
G72 X-2.8 Z-19 I-8.8 K-19
Q0.1 F40
G80
G00 X20 Z20
M06 T03
G00 X-8.8 Z10
G01 X-10.8 F10
G01 X-8.8
G00 X0 Z0
M05
```

Note:
Procedure for setting zero position of parting tool
Tools ⟶ Tool Settings ⟶ Tool Select ⟶ Use Current Positions .

Lecture 3

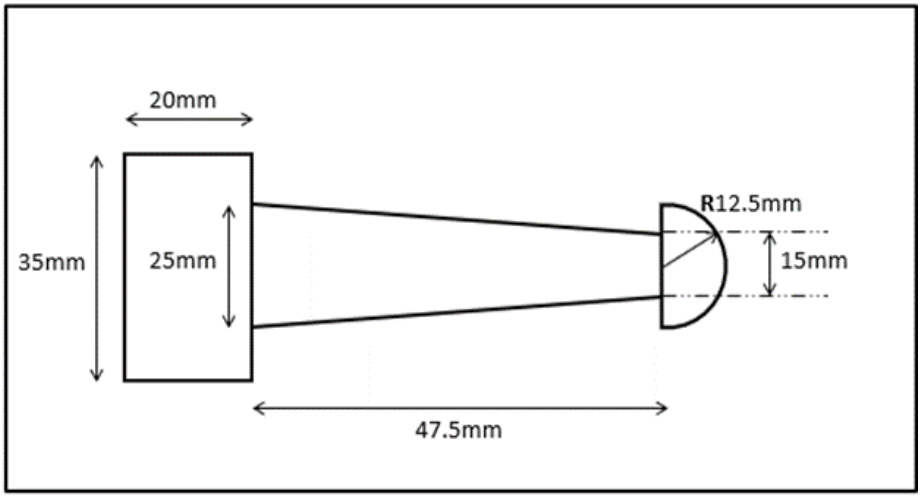
Practise question for milling
(Canned cycle)

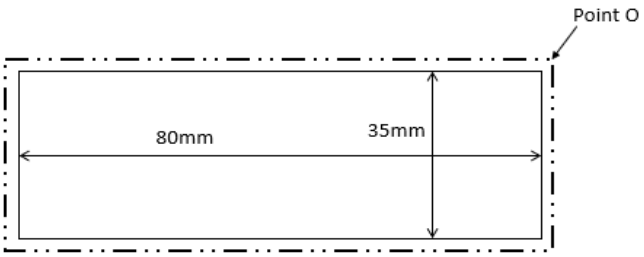
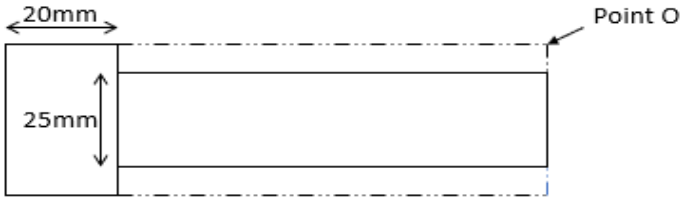


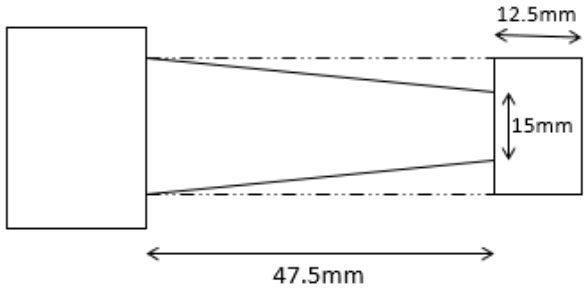
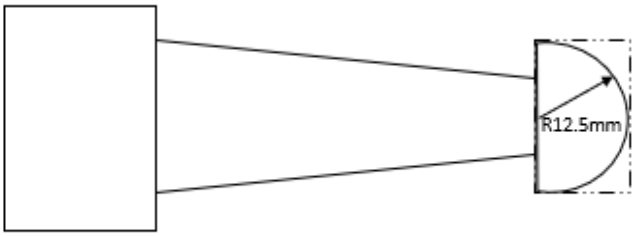

```
G90
M03 S800
G00 X3 Y0 Z0
G01 Z-1 F30
Y50
Y47
X50
X47
Y0
Y3
X0
G00 Z5
X25 Y26
G01 Z-1
G02 X25 Y26 I25 J25 F30
G00 Z20
M05
```

Lecture 4

CNC LATHE MACHINE JOB



Sr. No	Operation	Job Diagram
1	Pre-Machining (Turning & Facing) • Make Point O as work zero i.e. X37 and Z0 • G00-Rapid Interpolation • G00 X37 Z10 (close proximity) • G01 Z-80 F500 (Turning) • Reduce Dia to 35mm	
2	Turning • G01- Linear Interpolation for Turning • G01 X35 Z-60 F500 • So on till Diameter reduces to 25mm	

3	Taper Turning • Taper Turning from dia 25mm to 15mm • G00 X25 Z-12.5 (start point) • G01 X35 Z-60 F200 • Upto G01 X25 Z-60 F200	
4	Create Dome • G03- counter clockwise interpolation • G00 X0 Z5.177 • G03 X35.354 Z-12.5 R17.677 F100 • G00 X5.0 Z0.0 • G03 X35.0 Z-12.5 R17.5 F100 • G00 Z4.0 X0.0 • G03 X33 Z12.5 R16.5 F100 • So on up to…G03 X25.0 Z-12.5 R12.5 F100	

Important Codes

G00- Rapid Traverse

G01- Linear Interpolation

G03- Counter-clockwise Circular Interpolation

G54- Absolute Coordinates (first line of program)

M03- Spindle Rotation (clockwise)

M05- Spindle Stop

M08- Coolant ON

M09- Coolant OFF

M30- Program Stop