2.28 In a normal turning operation the tool life varies with cutting speed as shown in the following table:

Cutting speed, V, m/min	Tool Life, T, min
25	30
70	2

Estimate the tool life for this operation at a speed of 60 m/min. [2.99 minutes]

2.29 A carbide cutting tool has tool life exponent $n = 0.27$. It gives a tool life of 60 minutes while machining a mild steel work piece at a cutting speed of 120 m/min. Compute the tool life if it is to be cut at a 20% higher cutting speed. Also what is the cutting speed if the tool life is to be doubled?

[30.39 minutes, 99.387 m/min]

2.30 Free cutting steel work pieces of 200 mm long and 100 mm in diameter are to be turned on a lathe using a feed of 0.15 mm/rev and a depth of cut of 2 mm. It is possible to use brazed and throw away type cemented carbide tools for the operation. The overhead cost is ₹80 per hour, while the tool life constants are $n = 0.25$ and $C = 200$. Compare the minimum cost and maximum productivity times and costs of these with the following data:

Brazed tools	Throw away tools
Tool cost = ₹90	₹30
No of regrinds = 10	No. of edges = 4
Regrinding cost = ₹15	
Tool change time = 3 min	1 min

2.31 In a metal cutting experimentation, the tool life were found to vary with cutting speed in the following manner:

Cutting speed, V, m/min	Tool Life, T, min
100	120
130	50

Derive the Taylor's tool life equation for this operation and estimate the tool life at a speed of 2.5 m/s. Also estimate the cutting speed for a tool life of 80 minutes. [31.1867 minutes, 113.072 m/min]

2.32 A bar of 150 mm long and 60 mm in diameter is to be turned with a feed rate of 0.25 mm/rev. The machine and labour overhead is ₹150 per hour. The tool cost is ₹15 per edge and the tool changing time is 1 minute. Two different work materials A and B satisfy the requirements of the operation whose tool life constants are given below:

Material	n	C
A	0.15	125
B	0.16	150

Compute the economical work material for this operation. [Material B]

Multiple Choice Questions

2.1 Rake angle of a cutting tool can be defined as
(a) Angle between rake face and flank face of a cutting tool
(b) Angle between rake face of the cutting tool and normal to the machined surface
(c) Angle between flank face of the cutting tool and normal to the machined surface
(d) Angle between flank face of the cutting tool and the machined surface

2.2 Clearance angle of a cutting tool can be defined as
(a) Angle between rake face and flank face of a cutting tool
(b) Angle between rake face of the cutting tool and normal to the machined surface
(c) Angle between flank face of the cutting tool and normal to the machined surface
(d) Angle between flank face of the cutting tool and the machined surface

2.3 Continuous chip can form during the cutting of
(a) Ductile materials
(b) Brittle materials
(c) Any material at low cutting speeds
(d) Any metal at high depths of cut

2.4 Discontinuous chip can form during the cutting of
(a) Ductile materials
(b) Brittle materials
(c) Any material at high cutting speeds
(d) Any metal at low depths of cut

2.5 Built-up-edge can form during the cutting of
(a) Soft materials at high cutting speeds
(b) Brittle materials at low cutting speeds
(c) Hard material at low cutting speeds
(d) Soft materials at low cutting speeds

2.6 An important assumption of Merchant's cutting force analysis is
(a) The cutting tool is perfectly sharp
(b) Rake angle of the cutting tool is positive
(c) Rake angle of the cutting tool is negative
(d) Chip thickness is proportional to the rake angle

2.7 A positive rake angle is generally preferred for
(a) Brittle work piece materials to reduce cutting forces
(b) Cutting tool materials that are hard and brittle
(c) Ductile work piece materials to reduce cutting forces
(d) Cutting tool materials that have poor thermal conductivity

2.8 Shear angle in orthogonal cutting is
(a) The angle between the flank face and the shear plane
(b) The angle between the rake face and the shear plane
(c) The angle between the flank face and the machined surface
(d) The angle between the rake face and the machined surface

2.9 A negative rake angle is generally preferred for
(a) Brittle work piece materials to reduce cutting forces
(b) Cutting tool materials that are hard and brittle
(c) Ductile work piece materials to reduce cutting forces
(d) Cutting tool materials that have higher shock resistance

2.10 *P* grade cemented carbide cutting tool bit is used for
(a) Ferrous material with short chips
(b) Ferrous material with long chips
(c) Non-ferrous material with short chips
(d) Any non-ferrous metal

2.11 Ceramic cutting tools should be used
(a) With cutting fluid
(b) With low cutting speeds because of their brittleness
(c) With very high cutting speeds
(d) With old machine tools

2.12 Tool life criterion normally used is
(a) Crater wear
(b) Flank wear
(c) Crater wear and flank wear
(d) Crater wear and nose wear

2.13 Cutting fluids are used during the machining operation to
(a) Cool the work piece only
(b) Cool the cutting tool and work piece
(c) Clean the work piece
(d) Clean the machine tool

2.14 Water soluble cutting fluids are mainly used to
(a) Cool the cutting tool and work piece
(b) Clean the work piece
(c) Clean the machine tool
(d) Lubricate the cutting tool and work piece interface

2.15 Why is the cutting speed of 150 m/min better than 30 m/min when using cemented carbide cutting tools?
(a) There would be better shaped chips
(b) Less heat is produced at 150 m/min than at 30 m/min
(c) The higher speed is less likely to burn the edge of a carbide tool
(d) The higher speed would produce a better finish

2.16 When using low cutting speeds and negative rake tools to cut soft metals, the result is often
(a) A long, and uniform coiled chip
(b) The metal splitting ahead of the tool
(c) A built-up edge
(d) A good surface finish

2.17 Cutting tools with negative rake angle require
(a) Frequent resharpening
(b) Less frequent resharpening
(c) More horse power for a given cut
(d) Less horse power for a given cut

2.18 Effect of hardness of work material on its machinability
(a) No effect
(b) Increases machinability
(c) Decreases machinability
(d) Very little effect on machinability

2.19 Effect of rake angle of cutting tool on machinability
(a) No effect
(b) Increases machinability up to a certain limit
(c) Decreases machinability
(d) Very little effect on machinability

2.20 The cutting speed for maximum profit rate should be chosen as
(a) Below the speed for minimum cost
(b) In between the speeds for minimum cost and maximum production rate
(c) Equal to the speed for minimum cost
(d) Higher than the speed for maximum production rate

Answers to MCQs

2.1 (b)	2.2 (d)	2.3 (a)	2.4 (b)	2.5 (d)
2.6 (a)	2.7 (c)	2.8 (b)	2.9 (b)	2.10 (a)
2.11 (c)	2.12 (b)	2.13 (b)	2.14 (a)	2.15 (d)
2.16 (c)	2.17 (c)	2.18 (c)	2.19 (b)	2.20 (b)

- Lead screws are used in machine tools to convert rotary motion to linear motion, which is used to move the table or cutting tool depending upon the type of machine tool.
- Recirculating ball screws are used for more efficient load transmission.
- Antifriction guideways are used in a majority of the modern machine tools, while the conventional guideways are also used.
- A number of work holding systems are possible based on the part geometry.

Questions

3.1 How do you classify the various machine tools based on the motions used for generating the surfaces? Explain with the help of suitable block diagram.

3.2 What are the various methods available for generating plane (flat) surfaces with machine tools?

3.3 Compare Generating and Forming with reference to metal cutting machine tools.

3.4 Explain the term 'Machine Tool' and how is it different from machine.

3.5 Explain the classification of machine tools based on production capacity. Give the relative advantages with reasons and applications.

3.6 How do you select a machine tool for a given application? Give your answer with an application.

3.7 What are the various elements present in a machine tool for the purpose of generating any specified surface? Explain their relevance from the viewpoint of the final requirement.

3.8 What are the materials used for the manufacture of support structures in machine tools? Give their applications and disadvantages.

3.9 What are the types of slideways used in machine tools with particular reference to a centre lathe? Explain why such a geometry is preferred.

3.10 How do you classify various manufacturing machines based on the motions of the machine axes? Show the example surfaces generated for each of them.

3.11 What are the types of guide-ways used in machine tools? Explain about the various types generally used in lathe machines.

3.12 What is the function served by a lead screw in a machine tool?

3.13 Give the advantages derived by the use of re-circulating ball screws.

3.14 Write a brief note on linear motion elements used in machine tools.

Multiple Choice Questions

3.1 General purpose machine tools are used
(a) For high production rates
(b) In normal workshops and repair shops
(c) For large production volumes
(d) For automated production

3.2 Generating a surface compared to forming is
(a) Requires less power
(b) Less accurate
(c) More accurate
(d) Requires more power

3.3 Steel structure with welding is preferred to cast iron for machine tool structure because they

(a) Absorb impact loads
(b) Reduce noise
(c) Are heavier
(d) Repair of welded structure is easy

3.4 V slideway is preferred in lathe bed because it

(a) Is easy to manufacture
(b) Adjusts clearance under the weight of the moving member
(c) Is a simple design
(d) No specific advantage

3.5 Speeds in a gear box of a machine tool are chosen to follow the geometric progression because it

(a) Allows to have fixed speed difference between any two consequent speeds
(b) Appears more geometrical
(c) Allows more uniform dispersion of speeds in the entire range
(d) Allows more speeds in the maximum speed range

3.6 Recirculating ball screws are used because

(a) They are easy to manufacture
(b) Power required for driving them is small due to small friction
(c) Frictional resistance is more compared to Acme threads
(d) Variable friction present due to the recirculating balls

3.7 The following system has the lowest frictional resistance

(a) Dove tail slideway
(b) Round slideway
(c) Linear motion device used in the slideway
(d) V-slideway

3.8 Ribs are provided in machine tool structures to

(a) Increase the weight of the structure
(b) Increase the rigidity of the structure
(c) Improve the appearance of the structure
(d) Store the chips during the machining operation

3.9 Flat surface can be produced on a machine tool

(a) Using a single point tool moving along the axis of rotation of work piece
(b) Using a single point tool moving perpendicular to the axis of rotation of work piece
(c) Using a single point tool moving at an angle to the axis of rotation of work piece
(d) Using a single point tool moving along the axis of rotation of work piece

3.10 The following process provides best surface finish

(a) Hand grinding
(b) Cylindrical grinding
(c) Cylindrical turning
(d) Milling

3.11 The following process provides highest dimensional accuracy

(a) Cylindrical turning
(b) Jig boring
(c) Shaping
(d) Milling

3.12 The most complete definition of a machine tool is that

(a) converts the energy from one type to other
(b) holds the work piece and provides rotary motion
(c) holds the work piece and the cutting tool to remove metal
(d) holds the cutting tool to remove metal

3.13 Special purpose machine tools (SPM) are used

(a) For small batch manufacture
(b) In normal workshops and repair shops
(c) For large production volumes
(d) For one off production of complex geometries

3.14 Production machine tools are

(a) Used for small batch manufacture
(b) Normal machine tools fitted with jigs or fixtures
(c) Used for large production volumes
(d) For one off production of complex geometries

3.15 Forming a surface by a machine tool is done by
(a) Controlling the motion of the cutting tool to generate the profile
(b) Transferring the shape of the cutting tool directly to the work piece
(c) Controlling the motion of the cutting tool and the work piece to generate the profile
(d) Controlling the motion of a general purpose cutting tool to generate the profile

Answers to MCQs

3.1 (b)	3.2 (c)	3.3 (d)	3.4 (b)	3.5 (c)
3.6 (b)	3.7 (c)	3.8 (b)	3.9 (b)	3.10 (b)
3.11 (b)	3.12 (c)	3.13 (c)	3.14 (b)	3.15 (b)

Multiple Choice Questions

4.1 Lathe specification of swing over bed specifies
(a) Maximum diameter of job that can be turned in the lathe
(b) Minimum diameter of job that can be turned in the lathe
(c) Maximum radius of job that can be turned in the lathe
(d) Minimum radius of job that can be turned in the lathe

4.2 Lathe specification of distance between centres specifies
(a) Minimum length of the job that can be turned
(b) Maximum length of the job that can be turned
(c) Minimum diameter of the job that can be turned
(d) Maximum diameter of the job that can be turned

4.3 Spindle of a lathe is housed in
(a) Tailstock
(b) Headstock
(c) Carriage
(d) Apron

4.4 3-jaw chuck is used in a lathe to clamp
(a) Cylindrical work piece to locate the axis of rotation
(b) Eccentric work piece to locate the axis of rotation
(c) Square bar to locate the axis of rotation
(d) Any type of work piece to locate the axis of rotation

4.5 4-jaw chuck is used in a lathe to clamp
(a) Only for cylindrical work piece to locate the axis of rotation
(b) Only for eccentric work piece to locate the axis of rotation
(c) Only for square bar to locate the axis of rotation
(d) Any type of work piece to locate the axis of rotation

4.6 A face plate is used in a lathe to clamp
(a) Only for cylindrical work piece to locate the axis of rotation
(b) Only for eccentric work piece to locate the axis of rotation
(c) Only for square bar to locate the axis of rotation
(d) Any odd shaped work piece to locate the axis of rotation

4.7 The most common included angle for the centre hole is
(a) 45° (b) 60°
(c) 90° (d) 75°

4.8 A collet chuck is used for holding
(a) Cylindrical work piece to locate the axis of rotation quickly
(b) Eccentric work piece to locate the axis of rotation quickly
(c) Square bar to locate the axis of rotation quickly
(d) Any type of work piece to locate the axis of rotation quickly

4.9 For proper cutting, the cutting tool in a lathe should be set
(a) Slightly below the axis of the work piece so that no rubbing takes place
(b) Exactly at the centre of the axis of the work piece
(c) Slightly above the axis of the work piece so that no rubbing takes place
(d) Anywhere, since the work piece is actually rotating

4.10 Facing operation in a lathe is used for producing
(a) A cylindrical surface
(b) A plane surface
(c) A tapered surface
(d) A hole

4.11 Knurling operation in a lathe is used for producing
(a) A plane surface
(b) A cylindrical surface
(c) A serrated surface
(d) A tapered surface

4.12 Boring operation in a lathe is used for
(a) Generating a plane surface
(b) Enlarging a hole
(c) Generating a serrated surface
(d) Generating threads

4.13 Taper turning using the compound slide is used for
(a) Only for small tapers over long length
(b) Only for large and steep tapers
(c) Only for small and steep tapers
(d) For all types of tapers

4.14 Taper turning using the tailstock offset method is used for
(a) Only for small tapers over long length
(b) Only for large and steep tapers
(c) Only for small and steep tapers
(d) For all types of tapers

4.15 Taper turning using the taper turning attachment is used for
(a) Only for small tapers over long length
(b) Only for large and steep tapers
(c) Only for small and steep tapers
(d) For all types of tapers

4.16 Thread chasing is required in cutting screw threads because
(a) It improves surface finish
(b) It is necessary to follow the thread
(c) It increases the threading tool life
(d) It reduces the cutting forces

4.17 Giving the depth of cut using the plunge cutting method in thread cutting in a lathe is
(a) Preferred because it improves the surface finish
(b) Preferred because it increases the threading tool life
(c) Not preferred because the surface finish is poor
(d) Preferred because it produces accurate thread

4.18 Giving the depth of cut using the compound cutting method in thread cutting in a lathe is
(a) Preferred because it improves the surface finish
(b) Not preferred because it decreases the threading tool life
(c) Not preferred because the surface finish is poor
(d) Preferred because it produces accurate thread

4.19 Centre lathe is used
(a) For high production rates
(b) In normal workshops and repair shops
(c) For large production volumes
(d) For automated production

4.20 The lead screw of a centre lathe is 6 mm. If a thread of 1.5 mm pitch is to be cut on a work piece, which is rotating at 120 rpm, what should be the rpm of the lead screw?
(a) 20 rpm (b) 30 rpm
(c) 120 rpm (d) 180 rpm

Answers to MCQs

4.1 (a)	4.2 (b)	4.3 (b)	4.4 (a)	4.5 (d)
4.6 (d)	4.7 (b)	4.8 (a)	4.9 (b)	4.10 (b)
4.11 (c)	4.12 (b)	4.13 (c)	4.14 (a)	4.15 (d)
4.16 (b)	4.17 (c)	4.18 (a)	4.19 (b)	4.20 (b)

5.2 Describe with a simple sketch the operation of a Swiss type (sliding headstock) automatic ... in terms of operations possible, tools used, method of setting and types of components made ...

5.3 What are the differences between automatic lathe and capstan lathe? Give an example ... suited for capstan lathe with dimensions.

5.4 What is the classification method that could be used for the different type of automatic ... the industry? Explain briefly about each of the types in two sentences.

5.5 What is the importance of tool layout in automats? Explain with an example any one ... component sketch.

5.6 Briefly explain with neat sketches the types of work holding devices that are commonly ... automatic lathes. Specify the limitations of them.

5.7 Describe the method of operation of the Swiss type automatic lathe, with applications and ... What is its speciality?

5.8 List three most commonly employed types of single spindle automatics.

5.9 Sketch four parts suitable for production on a Swiss-type automatic.

5.10 Sketch four parts not suited for production on a single spindle automatic.

5.11 What are the steps of procedure involved in changing over to a new part production on a Swiss auto?

5.12 List the items of specification of a Swiss-type of automatic lathe.

5.13 Name the industry in which the Swiss type of automatic lathes are used.

5.14 How does an automatic cutting- off machine differ from a Swiss type machine?

5.15 List the number of tool locations on the Swiss-type auto.

5.16 State the features of machine construction, which lead to the attainment of high accuracy of the ...

5.17 What is the accuracy requirement of the bar stock for this machine?

5.18 Give a sketch illustrating the principle of operation of the Swiss-type automatic.

Multiple Choice Questions

5.1 Automatic lathes are used
 (a) For automated production
 (b) In repair shops
 (c) For single piece production
 (d) For small batch production

5.2 Capstan lathes can be used
 (a) For fully automated production
 (b) In repair shops
 (c) For single piece production
 (d) For small batch production

5.3 In a capstan or turret lathe the tool motion is stopped
 (a) By cams mounted on the lead screw
 (b) By trip dogs mounted on the feed rod
 (c) By special mechanism
 (d) When it reaches the end of the work piece

5.4 A box tool is normally used in turret lathe
 (a) For turning jobs with multiple tools
 (b) For short turning jobs
 (c) Long turning jobs since it supports the work piece to reduce its deflection due to cutting force
 (d) For facing operation

5.5 In an automatic lathe the motion of the tool is controlled
 (a) By cams
 (b) By trip dogs
 (c) By special mechanism
 (d) By motors

5.6 Automatic lathes of cutting-off type are used only for
   (a) Any type of parts
   (b) Simple parts produced by cross feeding tools
   (c) Small parts with different contours
   (d) Long parts

5.7 Swiss type automatic lathes are used only for
   (a) Small axi-symmetric parts
   (b) Long parts
   (c) Simple parts produced by cross feeding tools
   (d) Parts with cross holes

5.8 Special feature of the Swiss type automatic lathe is
   (a) Any type of tool motion is possible
   (b) Headstock slides for feeding the tools
   (c) Simple parts can be produced by cross feeding tools
   (d) Parts with cross holes can be produced

5.9 In a progressive action type multi-spindle automatic lathe, the spindles are arranged in such a way that
   (a) Each spindle produces identical parts
   (b) Each spindle has different types of tools and produce different surfaces on the same part
   (c) Some spindles carry only the parting-off tool
   (d) Some spindles carry only the drill

Answers to MCQs

5.1 (a)	5.2 (d)	5.3 (b)	5.4 (c)	5.5 (a)
5.6 (b)	5.7 (a)	5.8 (b)	5.9 (b)	

6.10 A shaper is operated at 2 cutting strokes per second and is used to machine a work piece of 150 mm length at a cutting speed of 0.5 m/s using a feed of 0.4 mm per stroke and a depth of cut of 6 mm.
(a) Calculate the total machining time to produce 800 components each 100 mm in width.
(b) If the forward stroke is over 230°, calculate the percentage of the time when the tool is not contacting the work piece. State any assumptions made.

[27.78 hours, 36.11%]

Multiple Choice Questions

6.1 Which of the following machine tools has only linear motion for the cutting tool and the work piece for generating any type of surface?
(a) Lathe machine
(b) Shaper
(c) Milling machine
(d) Grinding machine

6.2 In which of the following machines, the work piece reciprocates while the cutting tool remains stationary during cutting?
(a) Planer
(b) Shaper
(c) Milling machine
(d) Grinding machine

6.3 For generating flat surfaces with large material removal rates, the following process is the most economical
(a) Facing
(b) Shaping
(c) End milling
(d) Surface Grinding

6.4 One of the advantages of a hydraulic shaper compared to the mechanical shaper is
(a) Variable cutting speed during the cutting stroke
(b) Cutting speed remains constant throughout the cuttings stroke
(c) Higher cutting speed at the start
(d) Higher cutting speed in the end

6.5 One of the disadvantages of a hydraulic shaper compared to the mechanical shaper is
(a) Stopping point of the cutting stroke can vary depending upon the resistance offered to cutting
(b) Less strokes per minute
(c) Power available varies during the cutting stroke
(d) Cutting speed remains constant throughout the cuttings stroke

6.6 The cutting tool moves in a vertical reciprocating motion in this machine tool
(a) Shaper
(b) Slotter
(c) Planer
(d) Vertical Lathe

6.7 In a planer the reciprocating motion of the table is obtained by
(a) Slider crank and connecting rod mechanism
(b) Cams and trip dogs
(c) Rack and pinion with associated belt drives and trip dogs
(d) None of the above

6.8 In a shaper the reciprocating motion of the table is obtained by
(a) Slider crank and connecting rod mechanism
(b) Cams and trip dogs
(c) Rack and pinion with associated belt drives and trip dogs
(d) None of the above

6.9 The best machine tool to cut an internal spine in steel is
(a) Milling machine
(b) Slotting machine
(c) Lathe
(d) None of the above

6.10 In which of the following machines the cutting tool reciprocates while the work piece remains stationary during cutting?

(a) Lathe machine
(b) Shaper
(c) Milling machine
(d) Grinding machine

6.11 The best machine tool to cut T-slots on a large milling machine table is
(a) Slotter
(b) Shaper
(c) Planer
(d) Milling machine

6.12 More than one tool head can be used in which of the following machine tools?
(a) Slotter
(b) Shaper
(c) Planer
(d) Milling machine

6.13 The standard work table in the following machine tool can have rotary motion in addition to the translatory motion
(a) Slotter
(b) Shaper
(c) Planer
(d) Milling machine

6.14 The machine tool that has the cutting stroke (removes material) when the ram moves towards the body is
(a) Universal shaper
(b) Draw cut Shaper
(c) Mechanical shaper
(d) Vertical shaper

Answers to MCQs

6.1 (b)	6.2 (a)	6.3 (b)	6.4 (b)	6.5 (a)
6.6 (b)	6.7 (c)	6.8 (a)	6.9 (b)	6.10 (b)
6.11 (c)	6.12 (c)	6.13 (a)	6.14 (b)	

Multiple Choice Questions

7.1 An important characteristic of a milling process unlike any other machining processes is
(a) Interrupted cutting
(b) Small size chips
(c) Variable chip thickness
(d) All of the above

7.2 Identify the machine tool that is most versatile from the following list of machine tools
(a) Gap bed lathe
(b) Vertical axis milling machine
(c) Pillar drilling machine
(d) Surface grinding machine

7.3 The following type of milling machine is normally used for very high production rates
(a) Horizontal knee and column milling machine
(b) Vertical knee and column milling machine
(c) Simplex bed type milling machine
(d) Duplex bed type milling machine

7.4 The following milling cutter is used for machining rectangular slots on a horizontal knee and column milling machine
(a) Slab milling cutter
(b) Face mill
(c) Side and face milling cutter
(d) Shell end mill

7.5 The following milling cutter is used for machining rectangular slots on a vertical knee and column milling machine
(a) End mill
(b) Ball end mill
(c) Slitting saw
(d) Side and face milling cutter

7.6 Advantage of down milling (climb milling) compared to up milling (conventional milling) is
(a) Can be used in machines without backlash eliminator
(b) Can be used for machining castings or rolled steel directly
(c) Work piece need not be clamped tightly
(d) Can only be used for rigid parts

7.7 Disadvantage of down milling (climb milling) compared to up milling (conventional milling) is
(a) Cannot be used in machines without backlash eliminator
(b) It requires more power to cut
(c) Work piece need to be clamped tightly
(d) Can only be used for rigid parts

7.8 String milling is used for
(a) Large work pieces
(b) Small work pieces
(c) Heavy work pieces
(d) All of the above

7.9 Gang milling is used for
(a) Large work pieces
(b) Small work pieces
(c) A number of milling cutters are used to cut simultaneously
(d) Only one milling cutters is used to cut heavy work piece

7.10 To cut an involute gear on a milling machine the following is required
(a) Angle milling cutter
(b) Differential indexing head
(c) Slab milling cutter
(d) None of the above

7.11 Poor surface finish on the milled work pieces is caused by
(a) Higher feed rates
(b) Milling cutter is worn out and needs resharpening
(c) Cutting speed is low
(d) All of the above

7.12 Chatter (large amplitude vibration) during milling is caused by

(a) Milling machine is less rigid
(b) High depth of cut increasing the cutting force
(c) No cutting fluid is applied
(d) All of the above

7.13 An end mill having 4 teeth is rotating at 250 RPM. If the feed per tooth is given as 0.1 mm, what is the table feed in mm/min?

(a) 100 mm/min
(b) 10 mm/min
(c) 250 mm/min
(d) 25 mm/min

Answers to MCQs

7.1 (d)	7.2 (b)	7.3 (d)	7.4 (c)	7.5 (a)
7.6 (c)	7.7 (a)	7.8 (b)	7.9 (c)	7.10 (b)
7.11 (d)	7.12 (d)	7.13 (a)		

8.15 Explain the differences between drilling, reaming and tapping.
8.16 Write a brief note on trepanning.
8.17 Describe with the help of a neat diagram the construction and working of a precision horizontal boring machine? And also mention some salient design features?
8.18 Briefly discuss about the following types of boring machines:
(a) Floor type boring machine
(b) Planer type boring machine.
(c) Multiple head type boring machine.
8.19 Write short note on the following:
Lip, Helix and Rake angle in drilling

Problems

8.1 A series of 5 mm holes (total number 6) are to be drilled in a circle of 150 mm diameter on a 6 mm glass sheet. Describe the method of manufacture to be used with a neat sketch of the setup. What are the process variables to be controlled giving their effect on the final hole quality and the production rate? [Normal drilling cannot be done but use USM]

8.2 A hole of 25 mm diameter and 35 mm deep is to be drilled in mild steel component. The cutting speed can be taken as 35 m/min and the feed rate as 0.20 mm/rev. Calculate the machining time and the material removal rate. [0.511 minutes, 43 197 mm^3/min]

Calculate the drilling torque and thrust force acting in the above example.

[969.373 N mm, 686.35 N]

In C40 steel sheet of 25 mm thickness, 3 holes of 15 mm diameter are to be drilled. The cutting speed can be taken as 30 m/min and the feed rate as 0.15 mm/rev. Calculate the machining time and the material removal rate. [0.6984 minutes, 16 700 mm^3/min]

Multiple Choice Questions

8.1 Back taper is provided on a drill to
(a) Increase the strength of the drill
(b) Provide longitudinal clearance
(c) Decrease the cutting thrust
(d) Decrease the cost of the drill

8.2 Axial rake angle of a drill is
(a) The angle between the leading edge of the land and the axis of the drill
(b) The angle between the face and the line parallel to the drill axis
(c) The angle formed by the portion of the flank adjacent to the land and a plane at right angles to the drill axis
(d) None of the above

8.3 Helix angle of a drill is
(a) The angle between the leading edge of the land and the axis of the drill
(b) The angle between the face and the line parallel to the drill axis
(c) The angle formed by the portion of the flank adjacent to the land and a plane at right angles to the drill axis
(d) None of the above

8.4 The lip clearance angle of a drill is
(a) The angle between the leading edge of the land and the axis of the drill
(b) The angle between the face and the line parallel to the drill axis

(c) The angle formed by the portion of the flank adjacent to the land and a plane at right angles to the drill axis
(d) None of the above

8.5 The lip angle used in a drill for common drilling applications is
(a) 128°
(b) 136°
(c) 118°
(d) 125°

8.6 The following type of drill cannot be used for drilling into a solid material (can only enlarge an existing hole)
(a) Twist drill
(b) Core drill
(c) Spade drill
(d) Oil hole drill

8.7 A 15 mm through hole is to be drilled in a mild steel plate of 20 mm thickness. Take the over travel of the drill as 5 mm. What is the drilling time if the feed rate is 125 mm/min.
(a) 2 min
(b) 0.2 min
(c) 0.02 min
(d) 0.1 min

8.8 The cause for experiencing a lot of drill chatter (large vibrations)
(a) Loose moving parts of the machine
(b) Reduce overhang
(c) Fixture not properly clamped
(d) All of the above

8.9 The cause for very poor surface finish of the hole being drilled is
(a) Point improperly ground
(b) High feed rate
(c) Fixture not rigid
(d) All of the above

8.10 The machining operation used to enlarge an existing hole is termed as
(a) Drilling
(b) Boring
(c) Counter sinking
(d) Reaming

8.11 Boring operation is used for
(a) Drilling a hole
(b) Enlarging a hole
(c) Drilling a stepped hole in solid material
(d) None of the above

8.12 The operation to be used for obtaining smooth and close toleranced hole is
(a) Drilling
(b) Reaming
(c) Tapping
(d) Gun drilling

8.13 The type of reamer used for rough reaming operation is
(a) Left hand reamer with right hand helix
(b) Right hand reamer with left hand helix
(c) Right hand reamer with right hand helix
(d) None of the above

Answers to MCQs

8.1 (b)	8.2 (b)	8.3 (a)	8.4 (c)	8.5 (c)
8.6 (b)	8.7 (b)	8.8 (d)	8.9 (d)	8.10 (b)
8.11 (b)	8.12 (b)	8.13 (c)		

Problems

9.1 A flat surface of C70 steel of size 75 × 150 mm is to be ground using a vertical axis surface grinder. The grinding wheel to be used is 200 mm diameter with a thickness of 20 mm. Calculate the machining time required for finishing. Assume any suitable values for the grinding process parameters wh... justifying. If the same surface is to be ground on a horizontal axis grinding machine with a grinding wheel of 250 mm diameter and wheel thickness of 25 mm, what would be the grinding time? From the two times obtained compare the performance of the two grinding machines regarding their application. [0.6875 min, 0.244 ...]

9.2 A high speed steel (70W18Cr4V1 variety) rod of size 22 mm diameter × 250 mm long with a tolerance of *j*6 from a bar stock of 25 mm diameter, is to be manufactured in a lot of 100. Describe the process to be used with a neat sketch and the suggested process parameters to be used in the manufacturing process. If the same job is to be produced in quantities of 50,000 per month, what production process will be best suited? Explain your answer. [Cylindrical grind...]

Multiple Choice Questions

9.1 Grinding is a process used for
(a) Machining materials which are too hard for other machining processes
(b) Close dimensional accuracy
(c) High degree of surface smoothness
(d) All of the above

9.2 Among the conventional machining processes, the most inefficient process is
(a) Turning
(b) Grinding
(c) Drilling
(d) Milling

9.3 For grinding steels, the preferred abrasive is
(a) Silicon carbide
(b) Aluminium oxide
(c) Diamond
(d) Cubic boron nitride (CBN)

9.4 For grinding non-ferrous materials, the preferred abrasive is
(a) Silicon carbide
(b) Aluminium oxide
(c) Diamond
(d) Cubic boron nitride (CBN)

9.5 In grinding to get good surface finish, the grain size of the abrasive to be used is
(a) Coarse
(b) Fine
(c) Grain size does not affect surface finish
(d) None of the above

9.6 In grinding the grade of the grinding wheel should be chosen based on the hardness of the work material.
(a) Yes. Hard grinding wheels are chosen for hard materials
(b) Yes. Soft grinding wheels are chosen for hard materials
(c) Yes. Soft grinding wheels are chosen for soft materials
(d) No. Hard grinding wheels are preferred over soft wheels for all types of materials

9.7 In a cylindrical grinding machine
(a) Grinding wheel rotates while the work does not rotate
(b) Both grinding wheel and the work rotate in the same direction and same speed
(c) Both grinding wheel and the work rotate in the opposite directions
(d) Both grinding wheel and the work rotate in the same direction but work rotates slowly compared to the grinding wheel

9.8 The grinding machine suitable for grinding large flat areas is
(a) Surface grinder with a horizontal spindle and rotating table
(b) Surface grinder with a vertical spindle and rotating table
(c) Surface grinder with a horizontal spindle and reciprocating table
(d) Surface grinder with a vertical spindle and reciprocating table

9.9 The grinding machine suitable for grinding cylindrical work pieces without actually fixing them in the machine is
(a) Cylindrical grinding machine
(b) Surface grinding machine
(c) Centre less grinding machine
(d) Internal grinding machine

9.10 One of the main advantages of centre less grinding is
(a) There is no need for having and maintaining centres and centre holes
(b) Less grinding allowance may be required, because the out-of-roundness is corrected across the diameter rather than the radius.
(c) Work pieces may often be loaded into the machine by the automatic feeding devices.
(d) All of the above

9.11 One of the main disadvantage of centre less grinding is
(a) Setup time for a centre less grinding operation is usually large.
(b) Grinding allowance required is large.
(c) Work pieces cannot be fed automatically
(d) Work piece is not properly supported

9.12 Higher grinding wheel speeds cause
(a) Increased chip size
(b) Increased wheel wear
(c) Chip size is not affected
(d) Decreased wheel wear

9.13 Higher feed rates in grinding cause
(a) Increased chip size
(b) Increased wheel wear
(c) Improve surface finish
(d) Decreased wheel wear

9.14 Higher work speeds in grinding cause
(a) Increased heat produced
(b) Increased wheel wear
(c) Improve surface finish
(d) Decreased wheel wear

9.15 The main difference between creep feed grinding and the conventional grinding operation is
(a) In creep feed grinding hard grinding wheels are used
(b) In creep feed grinding the entire depth of cut is completed in one pass only using very small in feed rates
(c) In creep feed grinding higher feed rates are used
(d) In creep feed grinding higher work speeds are used

9.16 The characteristics of the work piece produced by honing is
(a) Out of roundness is corrected
(b) Higher dimensional accuracy
(c) Axial distortion is corrected
(d) All of the above

9.17 The characteristics of the work piece produced by lapping is
(a) Correction of minor imperfection of shape
(b) Extreme accuracy of dimension
(c) Close fit between mating surfaces
(d) All of the above

9.18 The abrasive process that uses a loose abrasive grit is
(a) Honing
(b) Lapping
(c) Grinding
(d) Creep feed grinding

Answers to MCQs

9.1 (d)	9.2 (b)	9.3 (b)	9.4 (a)	9.5 (b)
9.6 (b)	9.7 (d)	9.8 (b)	9.9 (c)	9.10 (d)
9.11 (a)	9.12 (d)	9.13 (b)	9.14 (b)	9.15 (b)
9.16 (d)	9.17 (d)	9.18 (b)		

Multiple Choice Questions

10.1 In sawing operation, the saw blade large (coarse) tooth spacing is used
(a) For sawing soft materials
(b) For sawing hard materials
(c) For thin materials
(d) For non-ferrous materials

10.2 You need to cut a piece of 20 mm diameter C20 CRS steel into four equal length pieces. The original stock is 550 mm long. If the saw blade produces a 1.5 mm kerf, how long will each piece of material be after cutting?
(a) 137.500 mm
(b) 136.375 mm
(c) 136.000 mm
(d) 135.000 mm

10.3 In sawing operation, the saw blade with straight tooth set is used for
(a) Ferrous materials
(b) General purpose work
(c) Non-ferrous materials
(d) None of the above

10.4 Which of the following machining operations does **not** utilise reciprocating action for cutting metal
(a) Broaching
(b) Sawing
(c) Turning
(d) Shaping

10.5 Which of the following machining operations utilises reciprocating action for cutting metal
(a) Broaching
(b) Turning
(c) Gear hobbing
(d) Milling

10.6 Which of the following machining operations can be used only with very large volume manufacture because of the high cost of the tooling used
(a) Broaching
(b) Sawing
(c) Gear hobbing
(d) Slotting

10.7 Advantage of broaching operation is
(a) It is the fastest way of finishing an operation with a single stroke.
(b) Final cost of the machining operation is one of the lowest for mass production.
(c) Broaching can do many surfaces that are very difficult or impossible by other methods. For example, square holes and internal splines.
(d) All of the above

10.8 Disadvantage of broaching operation is
(a) It is the slowest way of finishing an operation.
(b) Overall cost of machining with a broach is very high compared to other machining operations
(c) Broaching can only be carried out on the work piece whose geometry is such that there is no interference for the broach movement for the cutting.
(d) Final dimensional tolerances are poor compared to other machining operations

10.9 Which of the following operations produces a gear which is not very accurate
(a) Gear forming
(b) Gear shaping
(c) Gear hobbing
(d) Gear planing

10.10 Internal gears cannot be produced by which process.
(a) Gear shaping
(b) Gear hobbing
(c) Gear forming
(d) Gear planing

10.11 Which of the following is **not** a gear generating process

(a) Gear shaping
(b) Gear hobbing
(c) Gear forming
(d) Gear planing

10.12 The process used for cutting a gear on a milling machine is called

(a) Gear forming
(b) Gear shaping
(c) Gear hobbing
(d) Gear planing

Answers to MCQs

10.1 (b)	10.2 (b)	10.3 (c)	10.4 (c)	10.5 (a)
10.6 (a)	10.7 (d)	10.8 (c)	10.9 (a)	10.10 (c)
10.11 (c)	10.12 (a)			

11.31 Explain the advantages and disadvantages of USM.

11.32 Briefly explain the steps involved in chemical machining.

11.33 Explain the various methods used for preparing the masks for chemical machining.

11.34 Explain the process of PCM including the mask preparation process.

11.35 Give a short note on LBM.

11.36 What are the types of lasers that are generally used in LBM? Explain their significance.

11.37 Give a short note on Laser drilling.

11.38 Give a short note on Laser cutting.

11.39 A series of 5 mm holes (total number 6) are to be drilled on a circle of 150 mm diameter on a 6 mm sheet made of glass. Specify the method of manufacture to be used with a neat sketch of the setup. What are the variables and their effect in the process, which affect the final hole quality?

11.40 The T55Ni2Cr65Mo30 steel block is to be used for making a progressive die for punching the following component. Specify the process used for manufacturing the punch and die along with the limitations of the process. Is an alternative process available for its manufacture? Explain why it is not used.

11.41 Explain the advantages and disadvantages of AWJM.

11.42 Write a short note on AWJM process.

11.43 Explain the principle of AWJM with a neat sketch.

11.44 Describe the factors that should be considered in selecting the abrasive in AWJM.

11.45 Explain how material is removed in AWJM.

11.46 Briefly explain the equipment used for electron beam machining.

11.47 Give the applications of electron beam machining.

11.48 Explain the advantages and limitations of electron beam machining.

11.49 Briefly write about the process of ion beam machining.

11.50 Briefly explain the plasma arc machining process.

11.51 Give the applications of plasma arc machining.

11.52 Explain the advantages and limitations of plasma arc machining.

Multiple Choice Questions

11.1 Unconventional (non-traditional) machining processes are used specifically for
- (a) Very high hardness of the work material
- (b) Complex surfaces that cannot be easily obtained by conventional machining operations
- (c) Difficult geometries that cannot be easily produced by conventional machining operations
- (d) All of the above

11.2 The dielectric fluid in electric discharge machining (EDM) process should
- (a) Ionise rapidly after the spark discharge has taken place.
- (b) Have a high viscosity
- (c) Be chemically neutral so as not to attack the electrode
- (d) Have a low flash point.

11.3 The following is **not** a dielectric fluid to be used in electric discharge machining (EDM) process

(a) Silicone-based oils
(b) Linseed oil
(c) Kerosene
(d) De-ionised water

11.4 What are the problems faced when the electrolyte is not properly flushed in electric discharge machining (EDM) process?
(a) Uneven surface finish
(b) Higher removal rate
(c) Stable arc conditions
(d) None of the above

11.5 Required characteristics of good electrode materials in electric discharge machining (EDM) process
(a) A good conductor of electricity and heat.
(b) Produce efficient material removal rates from the work pieces.
(c) Be easily machinable to any shape at a reasonable cost.
(d) All of the above

11.6 The material that is **not** a very good electrode in electric discharge machining (EDM) process
(a) Graphite
(b) Copper
(c) Gray cast iron
(d) Tungsten

11.7 Taper of hole produced in electric discharge machining (EDM) process is caused by
(a) Inaccuracy in the electrode size
(b) The side sparks between the tool and the machined surface produced
(c) Larger flow of current between the bottom of the electrode and the work piece surface
(d) None of the above

11.8 Improved surface finish of electric discharge machined (EDM) surfaces can be obtained by
(a) Increasing the current in the sparks
(b) Decreasing the frequency of sparks
(c) Increasing the frequency of sparks
(d) None of the above

11.9 Material removal rate in electric discharge machined (EDM) process can be increased by
(a) Decreasing the current in the sparks
(b) Decreasing the frequency of sparks
(c) Increasing the frequency of sparks
(d) None of the above

11.10 Function of the electrolyte used in electro chemical machining (ECM) process
(a) Completes the electrical circuit between the tool and the work piece
(b) Allow desirable machining reactions to takes place
(c) Carry away heat generated during the operation
(d) All of the above

11.11 The electrolyte used in electro chemical machining (ECM) process should have the following property
(a) Chemical stability
(b) Low viscosity and high specific heat
(c) High electrical conductivity
(d) All of the above

11.12 The non-conventional machining process that gives the highest material removal rate
(a) Electric Discharge Machining (EDM)
(b) Electro Chemical Machining (ECM)
(c) Ultrasonic Machining (USM)
(d) Chemical machining (CHM)

11.13 The non-conventional machining process that gives the best surface finish
(a) Electric Discharge Machining (EDM)
(b) Electro Chemical Machining (ECM)
(c) Ultrasonic Machining (USM)
(d) Chemical machining (CHM)

11.14 Increasing the feed rate in electro chemical machining (ECM) process results in
(a) High removal rate and improved surface finish
(b) High removal rate and decreased surface finish
(c) High removal rate and surface finish not affected
(d) None of the above

11.15 Better surface finish in electro chemical machining (ECM) process can be obtained by
(a) Low electrolyte concentration
(b) Low electrolyte temperature
(c) Low voltage
(d) All of the above

11.16 Limitation of the electro chemical machining (ECM) process
(a) Use of corrosive media as electrolytes makes it difficult to handle
(b) Poor surface finish
(c) Poor accuracy of the work piece dimensions because of the large tool wear
(d) There will be thermal damage to the work piece

11.17 The following process is suitable for machining brittle materials such as glass
(a) Electric Discharge Machining (EDM)
(b) Electro Chemical Machining (ECM)
(c) Ultrasonic Machining (USM)
(d) Chemical machining (CHM)

11.18 Limitation of the Ultrasonic Machining (USM) process is
(a) Metal removal rates are large
(b) Tool wear is high and sharp corners cannot be produced
(c) It is affected by the electrical or chemical characteristics of the work material
(d) Cannot be used with brittle materials

11.19 Advantage of laser beam machining (LBM) is
(a) Laser beam machining does not apply any direct force because it is a non-contact machining
(b) Laser beam machining can be localized to a small area thereby removing a very small amount of material
(c) Since the heat is localized, Heat Affected Zone (HAZ) in laser beam machining is small
(d) All of the above

11.20 Increasing the feed rate in abrasive water jet machining (AWJM)
(a) Improves the surface finish
(b) Decreases the drag
(c) Surface finish gets deteriorated
(d) None of the above

11.21 The machining process that will be most appropriate to drill a rectangular hole in a high strength alloy
(a) Drilling
(b) Ultrasonic Machining (USM)
(c) Electric Discharge Machining (EDM)
(d) Chemical machining (CHM)

11.22 The machining process that will be most appropriate to drill a rectangular hole in a ceramic material
(a) Drilling
(b) Ultrasonic Machining (USM)
(c) Electric Discharge Machining (EDM)
(d) Chemical machining (CHM)

11.23 The machining process that will be most appropriate to machine a turbine blade with an aerofoil cross section in a high strength material
(a) Electro Chemical Machining (ECM)
(b) Ultrasonic Machining (USM)
(c) Electric Discharge Machining (EDM)
(d) Chemical machining (CHM)

Answers to MCQs

11.1 (d)	11.2 (c)	11.3 (b)	11.4 (a)	11.5 (d)
11.6 (c)	11.7 (b)	11.8 (c)	11.9 (c)	11.10 (d)
11.11 (d)	11.12 (b)	11.13 (b)	11.14 (a)	11.15 (d)
11.16 (a)	11.17 (c)	11.18 (b)	11.19 (d)	11.20 (c)
11.21 (c)	11.22 (b)	11.23 (a)		

15.5 Five hundred guide plates must be milled to receive a locating block. The tool designer has determined three possible alternatives:

(a) Have a toolmaker, who earns ₹240.00 per hour, mill the plates at a rate of 25 per hour.

(b) Use limited tooling that costs ₹1750.00 in the production department. The machine operator in this department, who earns ₹140.00 per hour, can make a part every 1.2 minutes.

(c) Use a more expensive tool that costs ₹5500.00 but is capable of producing a part every 24 seconds. This would be done in the production department, where a machine operator earns ₹140.00 per hour.

Which alternative should the tool designer select as the most efficient and economical?

15.6 Using the listed alternatives, prepare a comparative analysis for the following tooling problem: A total of 950 flange plates require four holes accurately drilled 90 degrees apart to mate with a connector valve. Which of the listed alternatives is the most economically desirable?

(a) Have a machinist who earns ₹200.00 per hour layout and drill each part at a rate of 2 minutes per part.

(b) Use a template jig, capable of producing 50 parts per hour and costing ₹900.00, in the production department, where an operator earns ₹130.00 per hour.

(c) Use a duplex jig, which costs ₹1875.00 and can produce a part every 26 seconds, in the production department, where an operator earns ₹130.00 per hour.

Multiple Choice Questions

15.1 A diamond pin is used in conjunction with a round locator for radial location in a jig because

(a) Diamond is harder material and hence has long life

(b) Reduces jamming possibility if two round locators are used

(c) Diamond pin is less expensive to make

(d) None of the above

15.2 For locating an external cylindrical surface which of the following types of locator is used

(a) V-block

(b) Round locator

(c) Round locator with a hole whose diameter corresponds to the diameter of the cylindrical surface to be located

(d) Conical locator

15.3 For locating a part in a fixture with an already existing through hole, which of the following type of locators is used

(a) V-block (b) Round locator

(c) Dowel pin (d) Spring loaded plunger

15.4 Redundant locators in fixturing should be avoided because

(a) It reduces the cost of fixture

(b) Since the sizes of parts can vary, within their tolerances, the likelihood of all parts resting simultaneously on all surfaces is remote

(c) It is easier to manufacture

(d) None of the above

15.5 Fool proofing of a fixture helps in

(a) The operator will be able to place the part in the fixture in the correct orientation only.

(b) It reduces the cost of fixture

(c) It increases the cost of fixture

(d) It looks aesthetically better

15.6 Principle to be followed while planning the clamping arrangement in a fixture

(a) Always use simple clamps since complicated ones may lose effectiveness as they wear.

(b) Rough work pieces call for a longer travel of the clamp in the clamping range, but clamps may be made to dig into rough surfaces to hold them firmly.

(c) Clamps should not make loading and unloading of the work difficult, nor should they interfere with the use of hoists and lifting devices for heavy work.

(d) All of the above

15.7 The simplest and low cost clamp used in jigs and fixtures is

(a) Strap Clamp (b) Cam Clamp
(c) Toggle Clamp (d) Equalizer

15.8 The main difference between jig and fixture is

(a) Jigs are simpler compared to fixtures
(b) A jig guides the cutting tool during the machining operation
(c) Types of locators used are different
(d) Types of clamping arrangement used is different

15.9 The jig bush most commonly used in jigs is

(a) Liner bush
(b) Headless drill bush
(c) Headed drill bush
(d) Shaped drill bush

15.10 The following statements relate to the choice of jig bushes. Give the correct statement.

(a) Headed jig bushes require less interference (to be assembled into the jig plate) to resist drilling thrust
(b) Less-ductile jig-plate materials require more interference (to be assembled into the jig plate).
(c) Longer jig bushes in thick plates require more interference for them to be assembled into the jig plate
(d) Jig bushes with thinner walls are preferable for accuracy.

15.11 The main disadvantage of a template jig is

(a) Expensive
(b) Complex clamping arrangement
(c) Orientation of the hole pattern to work piece datums may not be as accurate as other types
(d) It is more complex than other types

Answers to MCQs

15.1 (b)	15.2 (a)	15.3 (b)	15.4 (b)	15.5 (a)
15.6 (d)	15.7 (a)	15.8 (b)	15.9 (c)	15.10 (a)
15.11 (c)				

16.13 Explain the principle of sine bar for measuring angles.

16.14 Differentiate between measurement and gauging with reference to the application and method of use.

16.15 Explain how the gauge tolerance and gauge wear are allocated in the design of limit gauges.

Multiple Choice Questions

16.1 For an interference fit
- (a) The lower limit of the shaft should be greater than the lower limit of the hole
- (b) The lower limit of the shaft should be greater than the higher limit of the hole
- (c) The higher limit of the shaft should be greater than the higher limit of the hole
- (d) The higher limit of the shaft should be greater than the lower limit of the hole

16.2 For a clearance fit
- (a) The lower limit of the shaft should be smaller than the lower limit of the hole
- (b) The lower limit of the shaft should be smaller than the higher limit of the hole
- (c) The higher limit of the shaft should be smaller than the higher limit of the hole
- (d) The higher limit of the shaft should be smaller than the lower limit of the hole

16.3 Selective assembly of parts utilizes
- (a) An interference fit
- (b) A clearance fit
- (c) All the parts produced are measured and graded into a range of dimensions within the tolerance groups and then assembled with tighter tolerances
- (d) A transition fit

16.4 The accuracy of linear measurement is more with this instrument
- (a) Steel rule
- (b) Vernier callipers
- (c) Micro meter
- (d) Scale

16.5 V-anvil micro meter is used for measuring
- (a) Screw thread pitch
- (b) Screw thread minor diameter
- (c) The diameter of objects that have odd number of symmetrical or evenly spaced features, for example for the diameter of a 3-fluted end mill.
- (d) Chip thickness

16.6 The length standard that is most commonly used in the machine shops is
- (a) Meter rod
- (b) Slip gauge
- (c) Precision scale
- (d) None of the above

Answers to MCQs

16.1 (b) 16.2 (d) 16.3 (c) 16.4 (c) 16.5 (c)
16.6 (b)

Multiple Choice Questions

17.1 The type of applications where NC machines can be used profitably
(a) For jobs requiring many set-ups and/or the setups very expensive
(b) For jobs requiring very high accuracy and repeatability.
(c) For the parts having complex contours, that cannot be manufactured by conventional machine tools.
(d) All of the above

17.2 Advantage of numerical control machining is
(a) Faster manufacturing
(b) Parts requiring frequent design changes can be done
(c) One-off production can be produced accurately
(d) All of the above

17.3 Disadvantage of numerical control machining is
(a) Skill of the required is high
(b) Higher investment in equipment costs
(c) Special training required for the operator and maintenance personnel
(d) All of the above

17.4 For which application a point-to-point numerical control system can be used
(a) A lathe machine
(b) A milling machine
(c) A punching press
(d) None of the above

17.5 Numerical control manufacturing can be useful for
(a) Only for mass production
(b) Only for small batch production
(c) Only for single piece production
(d) None of the above

17.6 While specifying the axes of CNC machine tool (as per the ISO standards), the spindle axis is considered as
(a) X-axis (b) Y-axis
(c) Z-axis (d) A-axis

17.7 "The need for Jigs and fixtures is completely eliminated when using numerical control." This statement is
(a) True
(b) False
(c) True when dealing with really complex parts
(d) True when dealing with hard materials

17.8 Preparatory functions in a CNC program (in word address format) are identified by the letter
(a) A (b) G
(c) P (d) F

17.9 Using word address format, the centre of an arc in XY plane using circular interpolation is programmed using the letters
(a) I and J (b) I and K
(c) J and K (d) C and R

17.10 Using word address format, the centre of an arc in XZ plane using circular interpolation is programmed using the letters
(a) I and J (b) I and K
(c) J and K (d) C and R

17.11 Using word address format, the centre of an arc in YZ plane using circular interpolation is programmed using the letters
(a) I and J (b) I and K
(c) J and K (d) C and R

Answers to MCQs

17.1 (d)	17.2 (d)	17.3 (d)	17.4 (c)	17.5 (d)
17.6 (c)	17.7 (b)	17.8 (b)	17.9 (a)	17.10 (b)
17.11 (c)				

GATE Previous Years' Questions

CHAPTER 2

2.1 In an orthogonal cutting process the tool used has rake angle of zero degree. The measured cutting force and thrust force are 500 N and 250 N, respectively. The coefficient of friction between the tool and the chip is ____________.

(GATE-2016-ME-SET-1, 1-Mark)

2.2 The tool life equation for HSS tool is $VT^{0.14} f^{0.7} d^{0.4}$ = Constant. The tool life (T) of 30 min is obtained using the following cutting conditions:
V = 45 m/min, f = 0.35 mm, d = 2.0 mm
If speed (V), feed (f) and depth of cut (d) are increased individually by 25%, the tool life (in min) is

(a) 0.15 (b) 1.06
(c) 22.50 (d) 30.0

(GATE-2016-ME-SET-1, 2-Marks)

2.3 The following data is applicable for a turning operation. The length of job is 900 mm, diameter of job is 200 mm, feed rate is 0.25 mm/rev and optimum cutting speed is 300 m/min. The machining time (in min) is ____________.

(GATE-2016-ME-SET-2, 1-Mark)

2.4 For an orthogonal cutting operation, tool material is HSS, rake angle is 22°, chip thickness is 0.8 mm, speed is 48 m/min and feed is 0.4 mm/rev. The shear plane angle (in degrees) is

(a) 19.24 (b) 29.70
(c) 56.00 (d) 68.75

(GATE-2016-ME-SET-3, 2-Marks)

2.5 In a single point turning operation with cemented carbide tool and steel work piece, it is found that the Taylor's exponent is 0.25. If the cutting speed is reduced by 50%, then the tool life changes by ____________ times.

(GATE-2016-ME-SET-3, 2-Marks)

2.6 Under certain cutting conditions, doubling the cutting speed reduces the tool life to $(1/16)^{th}$ of the original. Taylor's tool life index (n) for this tool-work piece combination will be ____________.

(GATE-2015-ME-SET-1, 1-Mark)

2.7 An orthogonal turning operation is carried out under the following conditions: rake angle = 5°, spindle rotational speed = 400 rpm; axial feed = 0.4 m/min and radial depth of cut = 5 mm. The chip thickness t_c, is found to be 3 mm. The shear angle (in degrees) in this turning process is ____________.

(GATE-2015-ME-SET-1, 2-Marks)

2.8 A single point cutting tool with 0° rake angle is used in an orthogonal machining process. At a cutting speed of 180 m/min, the thrust fore is 490 N. If the coefficient of friction between the tool and the chip is 0.7, then the power consumption (in kW) for the machining operation is ____________.

(GATE-2015-ME-SET-2, 2-Marks)

2.9 In a machining operation, if the generatrix and directix both are straight lines, the surface obtained.

(a) Cylindrical
(b) Helical

(c) Plane
(d) Surface of revolution

(GATE-2015-ME-SET-3, 1-Mark)

2.10 Orthogonal turning of a mild steel tube with a tool of rake angle 10° carried out at a feed of 0.14 mm/rev. If the thickness of the chip produced is 0.28 mm, the values of shear angle and shear strain will be respectively

(a) 28° 20' and 2.19
(b) 22° 20' and 3.53
(c) 24° 30' and 3.53
(d) 37° 20' and 5.19

(GATE-2015-ME-SET-3, 2-Marks)

2.11 During pure orthogonal turning operation of a hollow cylindrical pipe, it is found that the thickness of the chip produced is 0.5 mm. The feed given to the zero degree rake angle tool is 0.2 mm/rev. The shear strain produced during the operation is ________.

(GATE-2014-ME-SET-1, 2-Marks)

2.12 If the Taylor's tool life exponent n is 0.2, and the tool changing time is 1.5 min, then the tool life (in min) for maximum production rate is ________.

(GATE-2014-SET-1, 2-Marks)

2.13 Which pair of following statements is correct for orthogonal cutting using a single-point cutting tool?

P. Reduction in friction angle increases cutting force
Q. Reduction in friction angle decreases cutting force
R. Reduction in friction angle increases chip thickness
S. Reduction in friction angle decreases chip thickness

(a) P and R (b) P and S
(c) Q and R (d) Q and S

(GATE-2014-SET-3, 2-Marks)

2.14 The normal force acting at the chip-tool interface in N is

(a) 1000 (b) 1500
(c) 2000 (d) 2500

(GATE-2013-ME-2-Marks)

2.15 A single-point cutting tool with 12° rake angle is used to machine a steel work-piece. The depth of cut, i.e. uncut thickness is 0.81 mm. The chip thickness under orthogonal machining condition is 1.8 mm. The shear angle is approximately

(a) 22° (b) 26°
(c) 56° (d) 76°

(GATE-2011-ME-2-Marks)

2.16 For tool A, Taylor's tool life exponent (n) is 0.45 and constant (K) is 90. Similarly for tool B, n = 0.3 and K = 60. The cutting speed (in m/min) above which tool A will have a higher tool life than tool B is

(a) 26.7 (b) 42.5
(c) 80.7 (d) 142.9

(GATE-2010-ME-2-Marks)

2.17 Friction at the tool-chip interface can be reduced by

(a) Decreasing the rake angle
(b) Increasing the depth of cut
(c) Decreasing the cutting speed
(d) Increasing the cutting speed

(GATE-2009-ME-1-Mark)

2.18 The values of shear angle and shear strain, respectively, are

(a) 30.3° and 1.98 (b) 30.3° and 4.23
(c) 40.2° and 2.97 (d) 40.2° and 1.65

(GATE-2006-ME-2-Marks)

2.19 The coefficient of friction at the tool-chip interface is

(a) 0.23 (b) 0.46
(c) 0.85 (d) 0.95

(GATE-2006-ME-2-Marks)

2.20 The percentage of total energy dissipated due to friction at the tool-chip interface is

(a) 30% (b) 42%
(c) 58% (d) 70%

(GATE-2006-ME-2-Marks)

2.21 In an orthogonal cutting test on mild steel, the following data were obtained

Cutting speed	:	40 m/min
Depth of cut	:	0.3 mm
Tool rake angle	:	+ 5°

Chip thickness	:	1.5 mm
Cutting force	:	900 N
Thrust force	:	450 N

Using Merchant's analysis, the Friction angle during the machining will be

(a) 26.6° (b) 31.5°
(c) 45° (d) 63.4°

(GATE-2004-ME-2-Marks)

2.22 In a machining operation, doubling the cutting speed reduces the tool life to 1/8th of the original value. The exponent n in Taylor's tool life equation $VT^n = C$, is

(a) $\frac{1}{8}$ (b) $\frac{1}{4}$
(c) $\frac{1}{3}$ (d) $\frac{1}{2}$

(GATE-2004-ME-2-Marks)

2.23 A built-up-edge is formed while machining
(a) Ductile materials at high speed
(b) Ductile materials at low speed
(c) Brittle materials at high speed
(d) Brittle materials at low speed

(GATE-2002-ME-2-Marks)

2.24 During orthogonal cutting of mild steel with a 10° rake angle tool the chip thickness ratio was obtained as 0.4, the shear angle (in degrees) evaluated from this data is

(a) 6.53 (b) 20.22
(c) 22.94 (d) 50.00

(GATE-2001-ME-2-Marks)

2.25 Tool life testing on a lathe under dry cutting conditions gave 'n' and 'C' of Taylor tool life equation as 012 and 130 m/min, respectively. When a coolant was used, C increased by 10%. Find the percent increase in tool life with the use of coolant at a cutting speed of 90 m/min. **(GATE-2001-ME-5-Marks)**

2.26 In an orthogonal cutting experiment with a tool of rake angle $\gamma = 7°$, the chip thickness was found to be 2.5 mm when the uncut chip thickness was set to 1 mm.
(a) Find the shear angle ϕ
(b) Find the friction angle β assuming that Merchant's formula holds good.

(GATE-1999-ME-5-Marks)

2.27 In an orthogonal machining operation, the chip thickness and the uncut thickness are equal to 0.45 mm. If the tool rake angle is 0°, the shear plane angle is

(a) 45° (b) 30°
(c) 18° (d) 60°

(GATE-1998-ME-2-Marks)

2.28 In a typical metal cutting operation, using a cutting tool of positive rake $\gamma = 10°$, it was observed that the shear angle was 20°. The friction angle is

(a) 45° (b) 30°
(c) 60° (d) 40°

(GATE-1997-ME-2-Marks)

2.29 A cutting tool has a radius of 1.8 mm. The feed rate for a theoretical surface roughness of $R_a = 5$ μm is

(a) 0.36 mm/rev (b) 0.187 mm/rev
(c) 0.036 mm/rev (d) 0.0187 mm/rev

(GATE-1997-ME-2-Marks)

2.30 To get good surface finish on a turned job, one should use a sharp tool with a ____________ feed and ____________ speed of rotation of the job.

(GATE-1994-ME-2-Marks)

2.31 Tool life of 10 hours is obtained when cutting with single point tool at 63 m/min.

If Taylor's constant C = 257.35, tool life on doubling the velocity will be

(a) 5 hours (b) 25.7 min
(c) 38.3 min (d) unchanged

(GATE-1996-ME-2-Marks)

Chapter 4

4.1 A shaft of length 90 mm has a tapered portion of length 55 mm. The diameter of the taper is 80 mm at one end and 65 mm at the other. If the taper is made by tailstock set over method, the taper angle and the set over respectively are

(a) 15°32′ and 12.16 mm
(b) 15°32′ and 15.66 mm

(c) $11°22'$ and 10.26 mm
(d) $10°32'$ and 14.46 mm

(GATE-2015-ME-SET-3, 2-Marks)

4.2 Match the Machine Tools (Group A) with the probable Operations (Group B):

Group A	Group B
(P) Centre lathe	(1) Slotting
(Q) Milling	(2) Counter-boring
(R) Grinding	(3) Knurling
(S) Drilling	(4) Dressing

(a) P-1, Q-2, R-4, S-3
(b) P-2, Q-1, R-4, S-3
(c) P-3, Q-1, R-4, S-2
(d) P-3, Q-4, R-2, S-1

(GATE-2014-ME-SET-2, 1-Mark)

4.3 A steel bar 200 mm in diameter is turned at a feed of 0.25 mm/rev with a depth of cut of 4 mm. The rotational speed of the workpiece is 160 rpm. The material removal rate in mm^3/s is

(a) 160 (b) 167.6
(c) 1600 (d) 1675.5

(GATE-2013-ME-1-Mark)

4.4 Cutting power consumption in turning can be significantly reduced by

(a) Increasing rake angle of the tool
(b) Increasing the cutting angles of the tool
(c) Widening the nose radius of the tool
(d) Increasing the clearance angle

(GATE-1995-ME-1-Mark)

CHAPTER 6

6.1 A cast iron block of 200 mm length is being shaped in a shaping machine with a depth of cut of 4 mm, feed of 0.25 mm/stroke and the tool principal cutting edge angle of 30°. Number of cutting strokes per minute is 60. Using specific energy for cutting as 1.49 J/mm^3, the average power consumption (in watt) is ______________.

(GATE-2014-ME-SET-4, 2-Marks)

6.2 A 600 mm × 300 mm flat surface of a plate is to be finish machined on a shaper. The plate has been fixed with the 600 mm side along the tool travel direction. If the tool over-travel at each end of the plate is 20 mm, average cutting speed is 8 m/min, feed rate is 0.3 mm/stroke and the ratio of return time to cutting time of the tool is 1:2, the time required for machining will be

(a) 8 minutes (b) 12 minutes
(c) 16 minutes (d) 20 minutes

(GATE-2005-ME-2-Marks)

CHAPTER 7

7.1 A milling cutter having 8 teeth is rotating at 150 rpm. If the feed per tooth is 0.1, the table speed in mm per minute is

(a) 120 (b) 187
(c) 125 (d) 70

(GATE-1993-ME-2-Marks)

7.2 In horizontal milling process ______________ (up/down) milling provides better surface finish and ______________ (up/down) milling provides longer tool life.

(GATE-1992-ME-2-Marks)

CHAPTER 8

8.1 In a single pass drilling operation, a through hole of 15 mm diameter is to be drilled in a steel plate of 50 mm thickness. Drill spindle speed is 500 rpm, feed is 0.2 mm/rev and drill point angle is 118°. Assuming 2 mm clearance at approach and exit, the total drill time in seconds is

(a) 35.1 (b) 32.4
(c) 31.2 (d) 30.1

(GATE-2012-ME-2-Marks)

8.2 Trepanning is performed for

(a) Finishing a drilled hole
(b) Producing a large hole without drilling

(c) Truing a hole for alignment
(d) Enlarging a drilled hole

(GATE-2002-ME-1-Mark)

8.3 The time taken to drill a hole though a 25 mm thick plate with the drill rotating at 300 rpm and moving at a feed rate of 0.25 mm/revolution is

(a) 10 sec (b) 20 sec
(c) 60 sec (d) 100 sec

(GATE-2002-ME-2-Marks)

8.4 The rake angle in a drill

(a) Increases from centre to periphery
(b) Decreases from centre to periphery
(c) Remains constant
(d) is irrelevant to the drilling operation

(GATE-1996-ME-1-Mark)

8.5 A hole of 20 mm diameter is to be drilled in a steel block of 40 mm thickness. The drilling is performed at rotational speed of 400 rpm and feed rate of 0.1 mm/rev. The required approach and over run of the drill together is equal to the radius of drill. The drilling time (in minute) is

(a) 1.00 (b) 1.25
(c) 1.50 (d) 1.75

(GATE-2014-ME-SET-2, 2-Marks)

CHAPTER 9

9.1 Diamond wheels should not be used for grinding steel components. State True or False.

(GATE-1996-ME-2-Marks)

9.2 If each abrasive grain is viewed as a cutting tool, then which of the following represents the cutting parameters in common grinding operations?

(a) Large negative rake angle, low shear angle and high cutting speed
(b) Large positive rake angle, low shear angle and high cutting speed
(c) Large negative rake angle, high shear angle and low cutting speed
(d) Zero rake angle, high shear angle and high cutting speed

(GATE-2006-ME-2-Marks)

9.3 The hardness of a grinding wheel is determined by the

(a) Hardness of abrasive grains
(b) Ability of the bond to retain abrasives
(c) Hardness of the bond
(d) Ability of the grinding wheel to penetrate the work piece

(GATE-2002-ME-1-Mark)

9.4 Abrasive material used in grinding wheel selected for grinding ferrous alloys is:

(a) silicon carbide
(b) diamond
(c) aluminium oxide
(d) boron carbide

(GATE-2000-ME-1-Mark)

9.5 Ideal surface roughness, as measured by the maximum height of unevenness, is best achieved when the material is removed by

(a) an end mill
(b) a grinding wheel
(c) a tool with zero nose radius
(d) a ball mill

(GATE-1998-ME-1-Mark)

9.6 In machining using abrasive material, increasing abrasive grain size

(a) increases the material removal rate
(b) decreases the material removal rate
(c) first decreases and then increases the material removal rate
(d) first increases and then decreases the material removal rate

(GATE-1998-ME-1-Mark)

9.7 Among the conventional machining processes, maximum specific energy is consumed in

(a) Turning (b) Drilling
(c) Planning (d) Grinding

(GATE-1995-ME-1-Mark)

Chapter 10

10.1 Internal gears are manufactured by
(a) Hobbing
(b) Shaping with pinion cutter
(c) Shaping with rack cutter
(d) Milling
(GATE-2016-ME-SET-3, 1-Mark)

10.2 Internal gear cutting operation can be performed by
(a) Milling
(b) Shaping with rack cutter
(c) Shaping with pinion cutter
(d) Hobbing
(GATE-2008-ME-1-Mark)

Chapter 11

11.1 The principle of material removal in electrochemical machining is
(a) Fick's law
(b) Faraday's laws
(c) Kirchhoff's laws
(d) Ohm's law
(GATE-2014-SET-4, 1-Mark)

11.2 During the electrochemical machining (ECM) of iron (atomic weight = 56, valency = 2) at current of 1000 A with 90% current efficiency, the material removal rate was observed to be 0.26 gm/s. If Titanium (atomic weight = 48, valency = 3) is machined by the ECM process at the current of 2000 A with 90% current efficiency, the expected material removal rate in gm/s will be
(a) 0.11 (b) 0.23
(c) 0.30 (d) 0.52
(GATE-2013-ME-2-Marks)

11.3 The non-traditional machining process that essentially requires vacuum is
(a) electron beam machining
(b) electro chemical machining
(c) electro chemical discharge machining
(d) elecro discharge machining
(GATE-2016-ME-SET-1, 1-Mark)

11.4 In an ultrasonic machining (USM) process, the material removal rate (MRR) is plotted as a function of the feed force of the USM tool. With increasing feed force, the MRR exhibits the following behaviour:
(a) Increases linearly
(b) Decreases linearly
(c) Does not change
(d) First increases and then decreases
(GATE-2016-ME-SET-2, 1-Mark)

11.5 In a wire-cut EDM process the necessary conditions that have to be met for making a successful cut are that
(a) Wire and sample are electrically non-conducting
(b) Wire and sample are electrically conducting
(c) Wire is electrically conducting and sample is electrically non-conducting
(d) Sample is electrically conducting and wire is electrically non-conducting
(GATE-2016-ME-SET-3, 1-Mark)

11.6 The primary mechanism of material removal in electrochemical machining (ECM) is
(a) Chemical corrosion
(b) Etching
(c) Ionic dissolution
(d) Spark erosion
(GATE-2015-ME-SET-2, 1-Mark)

11.7 The following four unconventional machining processes are available in a shop floor. The most appropriate one to drill a hole of square cross section of 6 mm × 6 mm and 25 mm deep
(a) Is abrasive Jet Machining
(b) Is Plasma Arc Machining
(c) Is Laser Beam Machining
(d) Is Electro Discharge Machining
(GATE-2014-SET-2, 1-Mark)

11.8 The process utilizing mainly thermal energy for removing material is
(a) Ultrasonic Machining
(b) Electrochemical Machining
(c) Abrasive Jet Machining
(d) Laser Beam Machining
(GATE-2014-SET-3, 1-Mark)

11.9 In abrasive jet machining, as the distance between the nozzle tip and the work surface increases, the material removal rate
(a) Increases continuously
(b) Decreases continuously
(c) Decreases, becomes stable and then increases
(d) Increases, becomes stable and then decreases

(GATE-2012-ME-1-Mark)

11.10 A researcher conducts electrochemical machining (ECM) on a binary alloy (density 6000 kg/m^3) of iron (atomic weight 56, valency 2) and metal P (atomic weight 24, valency 4). Faraday's constant = 96500 coulomb/mole. Volumetric material removal rate of the alloy is 50 mm^3/s at a current of 2000 A. The percentage of the metal P in the alloy is closest to
(a) 40 (b) 25
(c) 15 (d) 79

(GATE-2008-ME-2-Marks)

11.11 In electrodes charge machining (EDM), if the thermal conductivity of tool is high and the specific heat of work piece is low, then the tool wear rate and material removal rate are expected to be respectively
(a) High and high (b) High and low
(c) Low and low (d) Low and high

(GATE-2007-ME-2-Marks)

11.12 Arrange the processes in the increasing order of their maximum material removal rate.
Electrochemical Machining (ECM)
Ultrasonic Machining (USM)
Electron Beam Machining (EBM)
Laser Beam Machining (LBM) and
Electric Discharge Machining (EDM)
(a) USM, LBM, EBM, EDM, ECM
(b) EBM, LBM, USM, ECM, EDM
(c) LBM, EBM, USM, ECM, EDM
(d) LBM, EBM, USM, EDM, ECM

(GATE-2006-ME-2-Marks)

11.13 The mechanism of material removal in EDM process is
(a) Melting and Evaporation
(b) Melting and Corrosion
(c) Erosion and Cavitation
(d) Cavitation and Evaporation

(GATE-2004-ME-1-Mark)

11.14 As tool and work are not in contact in EDM process
(a) No relative motion occurs between them
(b) No water of tool occurs
(c) No power is consumed during metal cutting
(d) No force between tool and work occurs

(GATE-2003-ME-1-Mark)

11.15 In ECM, the material removal is due to
(a) Corrosion (b) Erosion
(c) Fusion (d) Ion displacement

(GATE-2001-ME-1-Mark)

11.16 In Electro-Discharge Machining (EDM), the tool is made of:
(a) Copper
(b) High Speed Steel
(c) Cast Iron
(d) Plain Carbon Steel

(GATE-1999-ME-1-Mark)

11.17 Selection electrolyte for ECM is as follows:
(a) non-passivating electrolyte for stock removal and passivating electrolyte for finish control
(b) passivating electrolyte for stock removal and non-passivating electrolyte for finish control
(c) selection of electrolyte is dependent on current density
(d) electrolyte selection is based on tool-work electrodes

(GATE-1997-ME-1-Mark)

11.18 Inter electrode gap in ECG is controlled by
(a) controlling the pressure of electrolyte flow
(b) controlling the applied static load
(c) controlling the size of diamond particle in the wheel
(d) controlling the texture of the work piece

(GATE-1997-ME-1-Mark)

11.19 Ultrasonic machining is about the best process for making holes in glass which are comparable in size with the thickness of the sheet. **(GATE-1994-ME-2-Marks)**

11.20 In ultrasonic machining process, the material removal rate will be higher for materials with
(a) Higher toughness
(b) Higher ductility
(c) Lower toughness
(d) Higher fracture strain
(GATE-1993-ME-1-Mark)

11.21 In Ultrasonic Machining (USM) the material removal rate would _____ with increasing mean grain diameter of the abrasive material
(a) Increase
(b) Decrease
(c) Increase and then decrease
(d) Decrease and then increase
(GATE-1992-ME-1-Mark)

CHAPTER 15

15.1 3-2-1 method of location in a jig or fixture would collectively restrict the work piece in *n* degrees of freedom, where the value of *n* is
(a) 6 (b) 8
(c) 9 (d) 12
(GATE-2001-ME-2-Marks)

15.2 When a cylinder is located in a Vee-block, the number of degrees of freedom which area arrested is
(a) 2 (b) 4
(c) 7 (d) 8
(GATE-2003-ME-1-Mark)

CHAPTER 16

16.1 A hole is dimension $\phi 9^{+0.015}_{+0}$ mm. The corresponding shaft is of dimension $\phi 9^{+0.010}_{+0.001}$ mm. The resulting assembly has
(a) Loose running fit
(b) Close running fit
(c) Transition fit
(d) Interference fit
(GATE-2011-ME-1-Mark)

16.2 What are the upper and lower limits of the shaft represented by $60\,f_8$?
Use the following data:
Diameter 60 lies in the diameter step of 50–80 mm
Fundamental tolerance unit, i, in μm = $0.45D^{1/3} + 0.001\,D$, where D is the representative size in mm;
Tolerance value for IT8 = $25i$. Fundamental deviation for 'f' shaft = $-5.5D^{0.41}$
(a) Lower limit = 59.924 mm, Upper Limit = 59.970 mm
(b) Lower limit = 59.954 mm, Upper Limit = 60.000 mm
(c) Lower limit = 59.970 mm, Upper Limit = 60.016 mm
(d) Lower limit = 60.000 mm, Upper Limit = 60.046 mm
(GATE-2009-ME-2-Marks)

16.3 A hole is specified as $40^{0.050}_{0.000}$ mm. The mating shaft has a clearance fit with minimum clearance of 0.01 mm. The tolerance on the shaft is 0.04 mm. The maximum clearance in mm between the hole and the shaft is
(a) 0.04 (b) 0.05
(c) 0.10 (d) 0.11
(GATE-2007-ME-2-Marks)

16.4 In order to have interference fit, it is essential that the lower limit of the shaft should be
(a) Greater than the upper limit of the hole
(b) Lesser than the upper limit of the hole
(c) Greater than the lower limit of the hole
(d) Lesser than the lower limit of the hole
(GATE-2005-ME-1-Mark)

16.5 In an interchangeable assembly, shafts of size $25.000^{+0.040}_{-0.0100}$ mm mate with holes of size $25.000^{+0.020}_{-0.000}$ mm. The maximum possible clearance in the assembly will be

(a) 10 microns (b) 20 microns
(c) 30 microns (d) 60 microns
(GATE-2004-ME-1-Mark)

16.6 Allowance in limits and fits refers to
(a) Maximum clearance between shaft and hole
(b) Minimum clearance between shaft and hole
(c) Difference between maximum and minimum size of hole
(d) Difference between maximum and minimum size of shaft
(GATE-2001-ME-1-Mark)

16.7 Holes of diameter $25.0^{+0.040}_{+0.020}$ mm are assembled interchangeably with the pins of diameter $25.0^{+0.005}_{-0.008}$ mm. The minimum clearance in the assembly will be
(a) 0.048 mm (b) 0.015 mm
(c) 0.005 mm (d) 0.008 mm
(GATE-2015-ME-SET-1, 1-Mark)

16.8 Which one of the following statements is TRUE?
(a) The 'GO' guage controls the upper limit of a hole
(b) The 'NO' guage controls the lower limit of a shaft
(c) The 'GO' guage controls the lower limit of a hole
(d) The 'NO GO' guage controls the lower limit of a hole
(GATE-2015-ME-SET-2, 1-Mark)

16.9 For the given assembly: 25 *H7/g8*, match Group A with Group B.

Group A	Group B
(P) H	(I) Shaft Type
(Q) IT8	(II) Hole Type
(R) IT7	(III) Hole Tolerance Grade
(S) g	(IV) Shaft Tolerance Grade

(a) P-I, Q-III, R-IV, S-II
(b) P-I, Q-IV, R-III, S-II
(c) P-II, Q-III, R-IV, S-I
(d) P-II, Q-IV, R-III, S-I
(GATE-2014-ME-SET-1, 2-Marks)

16.10 A GO-No GO plug gauge is to be designed for measuring a hole of nominal diameter 25 mm with a hole tolerance of ±0.015 mm. Considering 10% of work tolerance to be the gauge tolerance and no wear condition, the dimension (in mm) of the GO plug gauge as per the unilateral tolerance system is
(a) $24.985^{+0.003}_{-0.003}$ (b) $25.015^{+0.000}_{-0.006}$
(c) $24.985^{+0.003}_{-0.003}$ (d) $24.985^{+0.003}_{-0.000}$
(GATE-2014-ME-SET-4, 2-Marks)

16.11 A metric thread of pitch 2 mm and thread angle 60° is inspected for its pitch diameter using 3-wire method. The diameter of the best size wire in mm is
(a) 0.866 (b) 1.000
(c) 1.154 (d) 2.000
(GATE-2013-ME-1-Mark)

16.12 Cylindrical pins of $25^{+0.020}_{+0.010}$ mm diameter are electroplated in a shop. Thickness of the plating is $30^{+2.0}$ micron. Neglecting guage tolerances, the size of the GO guage in mm to inspect the plated components is
(a) 25.042 (b) 25.052
(c) 25.074 (d) 25.084
(GATE-2013-ME-2-Marks)

16.13 In an interchangeable assembly, shafts of size $25.000^{+0.040}_{-0.010}$ mm mate with holes of size $25.000^{+0.030}_{+0.020}$ mm. The maximum interference (in microns) in the assembly is
(a) 40 (b) 30
(c) 20 (d) 10
(GATE-2012-ME-1-Mark)

16.14 A ring guage is used to measure
(a) Outside diameter but not roundness
(b) Roundness but not outside diameter
(c) Both outside diameter and roundness
(d) Only external threads
(GATE-2006-ME-1-Mark)

16.15 GO and No-GO plug guage are to be designed for a hole $20.000^{+0.050}_{+0.010}$ mm. Guage tolerances can be taken as 10% of the hole tolerance. Following ISO system of guage design, sizes of GO and NO-GO guage will be respectively

(a) 20.010 mm and 20.050 mm
(b) 20.014 mm and 20.046 mm
(c) 20.006 mm and 20.054 mm
(d) 20.014 mm and 20.054 mm

(GATE-2004-ME-2-Marks)

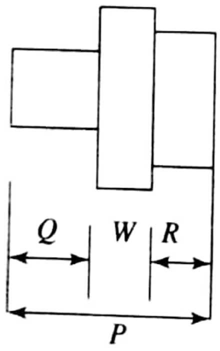
16.16 The dimensional limits on a shaft of $25h7$ are

(a) 25.000, 25.021 mm
(b) 25.000, 24.979 mm
(c) 25.000, 25.007 mm
(d) 25.000, 24.993 mm

(GATE-2003-ME-1-Mark)

16.17 A part shown in the figure is machined to the sizes given below

P = 35.00 ± 0.08 mm



Q = 12.00 ± 0.02 mm

R = $13.00^{+0.04}_{-0.02}$ mm

With 100% confidence, the resultant dimension W will have the specification

(a) 9.99 ± 0.03 mm
(b) 9.99 ± 0.13 mm
(c) 10.00 ± 0.03 mm
(d) 10.00 ± 0.13 mm

(GATE-2003-ME-2-Marks)

16.18 A shaft (diameter $20^{+0.05}_{-0.15}$) and a hole (diameter $20^{+0.20}_{+0.10}$ mm) when assembled would yield

(a) Transition fit
(b) Interference fit
(c) Clearance fit
(d) None of these

(GATE-1993-ME-2-Marks)

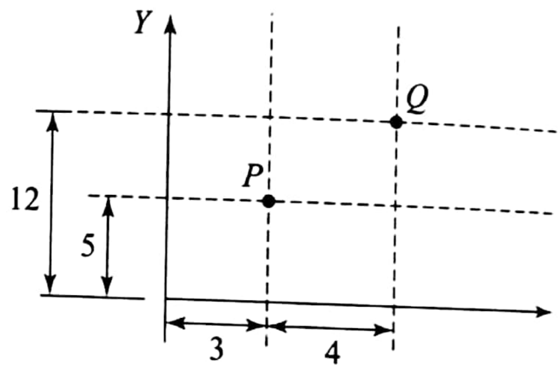
Chapter 17

17.1 The function of interpolator in a CNC machine controller is to

(a) Control spindle speed
(b) Coordinate feed rates of axes
(c) Control tool rapid approach speed
(d) Perform Miscellaneous (M) functions (tool change, coolant control etc.)

(GATE-2015-ME-SET-1, 1-Mark)

17.2 A drill is positioned at point P and its has to proceed to point Q. The coordinates of point Q in the incremental system of defining position of a point in CNC part program will be



(a) (3, 12)
(b) (5, 7)
(c) (7, 12)
(d) (4, 7)

(GATE-2015-ME-SET-3, 1-Mark)

17.3 In a CNC milling operation, the tool has to machine the circular arc from point (20, 20) to (10, 10) at sequence number 5 of the CNC part program. If the center of the arc is at (20, 10) and the machine has incremental mode of defining position coordinates, the correct tool path command is

(a) N 05 G90 G01 X–10 Y–10 R10
(b) N 05 G91 G03 X–10 Y–10 R10
(c) N 05 G90 G03 X–20 Y–20 R10
(d) N 05 G91 G02 X–20 Y–20 R10

(GATE-2015-ME-SET-3, 2-Marks)

17.4 For machining a rectangular island represented by coordinates $P(0, 0)$, $Q(100, 0)$, $R(100, 50)$ and (0, 50) on a casting using CNC milling machine, an end mill with a diameter of 16 mm is used. The trajectory of the cutter centre to machine the island PQRS is

(a) (–8, –8), (108, –8), (108, 58), (–8, 58), (–8, –8)
(b) (8, 8), (94, 8), (94, 44), (8, 44), (8, 8)
(c) (–8, 8), (94, 0), (94, 44), (8, 44), (–8, 8)
(d) (0, 0), (100, 0), (100, 50), (50, 0), (0, 0)

(GATE-2014-ME-SET-1, 1-Mark)

17.5 A CNC vertical milling machine has to cut a straight slot of 10 mm width and 2 mm depth by a cutter of 10mm diameter between points (0, 0) and (100, 100) on the XY plane (dimensions in mm). The feed rate used for milling is 50 mm/min. milling time for the slot (in seconds) is

(a) 120 (b) 170
(c) 180 (d) 240

(GATE-2012-ME-1-Mark)

17.6 In a CNC program block, N002 G02 G91 X40 Z40..., G02 and G91 refer to

(a) Circular interpolation in counterclockwise direction and incremental dimension
(b) Circular interpolation in counterclockwise direction and absolute dimension
(c) Circular interpolation in clockwise direction and incremental dimension
(d) Circular interpolation in clockwise direction and absolute dimension

(GATE-2010-ME-1-Mark)

17.7 Match the following:

NC Code	Definition
P. M05	1. Absolute coordinate system
Q. G01	2. Dwell
R. G04	3. Spindle stop
S. G90	4. Linear interpolation

(a) P-2, Q-3, R-4, S-1.
(b) P-3, Q-4, R-1, S-2.
(c) P-3, Q-4, R-2, S-1.
(d) P-4, Q-3, R-2, S-1.

(GATE-2009-ME-2-Marks)

17.8 NC contouring is an example of

(a) Continuous path positioning
(b) Point-to-point positioning
(c) Absolute positioning
(d) Incremental positioning

(GATE-2006-ME-1-Mark)

17.9 Which among the NC operations given below are continuous path operations?

Arc Welding (AW)	Milling (M)
Drilling (D)	Punching in Sheet Metal (P)
Laser Cutting of Sheet Metal (LC)	Spot Welding (SW)

(a) AW, LC and M
(b) AW, D, LC and M
(c) D, LC, P and SW
(d) D, LC and SW

(GATE-2005-ME-1-Mark)

17.10 The tool of an NC machine has to move along a circular arc from (5, 5) to (10, 10) while performing an operation. The center of the arc is at (10, 5). Which one of the following NC tool path commands performs the above mentioned operation?

(a) N010 G02 X10 Y10 X5 Y5 R5
(b) N010 G03 X10 Y10 X5 Y5 R5
(c) N010 G01 X5 Y5 X10 Y10 R5
(d) N010 G02 X5 Y5 X10 Y10 R5

(GATE-2005-ME-2-Marks)

17.11 During the execution of a CNC part program block N020 G02 X45.0 Y25.0 R5.0 the type of tool motion will be

(a) Circular Interpolation – clockwise
(b) Circular Interpolation – counterclockwise
(c) Linear Interpolation
(d) Rapid feed

(GATE-2004-ME-1-Mark)

17.12 CNC machines are more accurate than conventional machines because they have a high resolution encoder and digital read-outs for positioning.

(GATE-1994-ME-2-Marks)