CHAPTER 10

MANUFACTURING ENGINEERING

YEAR 2012 **ONE MARK**

MCQ 10.1 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.

MCQ 10.2 Match the following metal forming processes with their associated stresses in the workpiece.

	Metal forming process		**Types of stress**
1.	Coining	**P.**	Tensile
2.	Wire Drawing	**Q.**	Shear
3.	Blanking	**R.**	Tensile and compressive
4.	Deep Drawing	**S.**	Compressive

(A) 1-S, 2-P, 3-Q, 4-R (B) 1-S, 2-P, 3-R, 4-Q

(C) 1-P, 2-Q, 3-S, 4-R (D) 1-P, 2-R, 3-Q, 4-S

MCQ 10.3 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

MCQ 10.4 During normalizing process of steel, the specimen is heated

(A) between the upper and lower critical temperature and cooled in still air.

(B) above the upper critical temperature and cooled in furnace.

(C) above the upper critical temperature and cooled in still air.

(D) between the upper and lower critical temperature and cooled in furnace

MCQ 10.5 A CNC vertical milling machine has to cut a straight slot of 10 mm width and 2 mm depth by a cutter of 10 mm 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

MCQ 10.6 A solid cylinder of diameter 100 mm and height 50 mm is forged between two frictionless flat dies to a height of 25 mm. The percentage change in diameter is

(A) 0 (B) 2.07

(C) 20.7 (D) 41.4

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MCQ 10.7 Detail pertaining to an orthogonal metal cutting process are given below

Chip thickness ratio	0.4
Undeformed thickness	0.6 mm
Rake angle	$+10°$
Cutting speed	2.5 m/s
Mean thickness of primary shear zone	25 microns

The shear strain rate in s^{-1} during the process is

(A) 0.1781×10^5 (B) 0.7754×10^5

(C) 1.0104×10^5 (D) 4.397×10^5

MCQ 10.8 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

MCQ 10.9 Calculate the punch size in mm, for a circular blanking operation for which details are given below.

Size of the blank	25 mm
Thickness of the sheet	2 mm
Radial clearance between punch and die	0.06 mm
Die allowance	0.05 mm

(A) 24.83 (B) 24.89

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(C) 25.01 (D) 25.17

MCQ 10.10 In a single pass rolling process using 410 mm diameter steel rollers, a strip of width 140 mm and thickness 8 mm undergoes 10% reduction of thickness. The angle of bite in radians is

(A) 0.006 (B) 0.031

(C) 0.062 (D) 0.600

MCQ 10.11 In a DC are welding operation, the voltage-arc length characteristic was obtained as $V_{arc} = 20 + 5l$ where the arc length l was varied between 5 mm and 7 mm. Here V_{arc} denotes the arc voltage in Volts. The arc current was varied from 400 A to 500 A. Assuming linear power source characteristic, the open circuit voltage and short circuit current for the welding operation are

(A) 45 V, 450 A (B) 75 V, 750 A

(C) 95 V, 950 A (D) 150 V, 1500 A

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MCQ 10.12 The maximum possible draft in cold rolling of sheet increases with the

(A) increase in coefficient of friction

(B) decrease in coefficient of friction

(C) decrease in roll radius

(D) increase in roll velocity

MCQ 10.13 The operation in which oil is permeated into the pores of a powder metallurgy product is known as

(A) mixing (B) sintering

(C) impregnation (D) infiltration

MCQ 10.14 A hole is of 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

MCQ 10.15 Green sand mould indicates that

(A) polymeric mould has been cured

(B) mould has been totally dried

(C) mould is green in color

(D) mould contains moisture

MCQ 10.16 Which one among the following welding processes uses non-consumable

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electrode ?

(A) Gas metal arc welding
(B) Submerged arc welding
(C) Gas tungsten arc welding
(D) Flux coated arc welding

MCQ 10.17 The crystal structure of austenite is

(A) body centered cubic
(B) face centered cubic
(C) hexagonal closed packed
(D) body centered tetragonal

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MCQ 10.18 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°

MCQ 10.19 Match the following non-traditional machining processes with the corresponding material removal mechanisms :

	Machining process		Mechanism of material removal
P.	Chemical machining	**1.**	Erosion
Q.	Electro-chemical machining	**2.**	Corrosive reaction
R.	Electro-discharge machining	**3.**	Ion displacement
S.	Ultrasonic machining	**4.**	Fusion and vaporization

(A) P-2, Q-3, R-4, S-1
(B) P-2, Q-4, R-3, S-1
(C) P-3, Q-2, R-4, S-1
(D) P-2, Q-3, R-1, S-4

MCQ 10.20 A cubic casting of 50 mm side undergoes volumetric solidification shrinkage and volumetric solid contraction of 4% and 6% respectively. No riser is used. Assume uniform cooling in all directions. The side of the cube after solidification and contraction is

(A) 48.32 mm
(B) 49.90 mm
(C) 49.94 mm
(D) 49.96 mm

MCQ 10.21 The shear strength of a sheet metal is 300 MPa. The blanking force required to produce a blank of 100 mm diameter from a 1.5 mm thick sheet is close to

(A) 45 kN
(B) 70 kN
(C) 141 kN
(D) 3500 kN

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MCQ 10.22 The material property which depends only on the basic crystal structure is

(A) fatigue strength (B) work hardening

(C) fracture strength (D) elastic constant

MCQ 10.23 In a gating system, the ratio 1 : 2 : 4 represents

(A)	sprue base area	: runner area	: ingate area
(B)	pouring basin area	: ingate area	: runner area
(C)	sprue base area	: ingate area	: casting area
(D)	runner area	: ingate area	: casting area

MCQ 10.24 A shaft has a dimension, $\phi 35^{-0.009}_{-0.025}$. The respective values of fundamental deviation and tolerance are

(A) $-0.025, \pm 0.008$ (B) $-0.025, 0.016$

(C) $-0.009, \pm 0.008$ (D) $-0.009, 0.016$

MCQ 10.25 In a CNC program block, N002 GO2 G91 X40 Z40......,GO2 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

YEAR 2010 TWO MARKS

MCQ 10.26 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

MCQ 10.27 Two pipes of inner diameter 100 mm and outer diameter 110 mm each are joined by flash-butt welding using 30 V power supply. At the interference, 1 mm of material melts from each pipe which has a resistance of 42.4 Ω. If the unit melt energy is 64.4 MJm^{-3}, then time required for welding (in s) is

(A) 1 (B) 5

(C) 10 (D) 20

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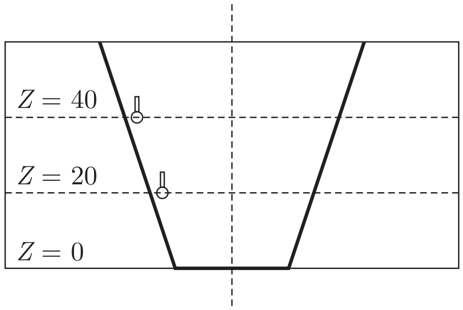
MCQ 10.28 A taper hole is inspected using a CMM, with a probe of 2 mm diameter. At a height, $Z = 10$ mm from the bottom, 5 points are touched and a diameter of circle (not compensated for probe size) is obtained as 20 mm. Similarly, a 40 mm diameter is obtained at a height $Z = 40$ mm. The smaller diameter (in mm) of hole at $Z = 0$ is

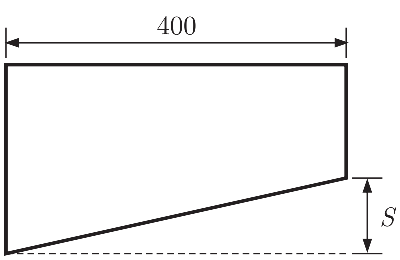


(A) 13.334 (B) 15.334

(C) 15.442 (D) 15.542

• Common Data For Q.28 and Q.29

In shear cutting operation, a sheet of 5 mm thickness is cut along a length of 200 mm. The cutting blade is 400 mm long (see fig.) and zero-shear ($S = 0$) is provided on the edge. The ultimate shear strength of the sheet is 100 MPa and penetration to thickness ratio is 0.2. Neglect friction.



MCQ 10.29 Assuming force vs displacement curve to be rectangular, the work done (in J) is

(A) 100 (B) 200

(C) 250 (D) 300

MCQ 10.30 A shear of 20 mm ($S = 0$ mm) is now provided on the blade. Assuming force vs displacement curve to be trapezoidal, the maximum force (in kN) exerted is

(A) 5 (B) 10

(C) 20 (D) 40

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MCQ 10.31 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

MCQ 10.32 Two streams of liquid metal which are not hot enough to fuse properly result into a casting defect known as

(A) cold shut
(B) swell
(C) sand wash
(D) scab

MCQ 10.33 The effective number of lattice points in the unit cell of simple cubic, body centered cubic, and face centered cubic space lattices, respectively, are

(A) 1, 2, 2
(B) 1, 2, 4
(C) 2, 3, 4
(D) 2, 4, 4

MCQ 10.34 Which of the following is the correct data structure for solid models ?

(A) solid part $\rightarrow$ faces $\rightarrow$ edges $\rightarrow$ vertices
(B) solid part $\rightarrow$ edges $\rightarrow$ faces $\rightarrow$ vertices
(C) vertices $\rightarrow$ edges $\rightarrow$ faces $\rightarrow$ solid parts
(D) vertices $\rightarrow$ faces $\rightarrow$ edges $\rightarrow$ solid parts

YEAR 2009 TWO MARKS

MCQ 10.35 Minimum shear strain in orthogonal turning with a cutting tool of zero rake angle is

(A) 0.0
(B) 0.5
(C) 1.0
(D) 2.0

MCQ 10.36 Electrochemical machining is performed to remove material from an iron surface of 20 mm $\times$ 20 mm under the following conditions :

$$\text{Inter electrode gap} = 0.2 \text{ mm}$$
$$\text{Supply voltage (DC)} = 12 \text{ V}$$
$$\text{Specific resistance of electrolyte} = 2\,\Omega \text{ cm}$$
$$\text{Atomic weight of Iron} = 55.85$$
$$\text{Valency of Iron} = 2$$
$$\text{Faraday's constant} = 96540 \text{ Coulombs}$$

The material removal rate (in g/s) is

(A) 0.3471
(B) 3.471
(C) 34.71
(D) 347.1

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MCQ 10.37 Match the following:

	NC code		Definition
P.	M05	1.	Absolute coordinate system
Q.	G01	2.	Dwell
R.	G04	3.	Spindle stop
S.	G09	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

MCQ 10.38 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 $\mu\text{m} = 0.45D^{1/3} + 0.001D$
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

MCQ 10.39 Match the items in Column I and Column II.

	Column I		Column II
P.	Metallic Chills	**1.**	Support for the core
Q.	Metallic Chaplets	**2.**	Reservoir of the molten metal
R.	Riser	**3.**	Control cooling of critical sections
S.	Exothermic Padding	**4.**	Progressive solidification

(A) P-1, Q-3, R-2, S-4
(B) P-1, Q-4, R-2, S-3
(C) P-3, Q-4, R-2, S-1
(D) P-4, Q-1, R-2, S-3

MCQ 10.40 The exponent (n) and constant (K) of the Taylor's tool life equation are
(A) $n = 0.5$ and K = 540
(B) $n = 1$ and K = 4860
(C) $n = -1$ and K = 0.74
(D) $n = -0.5$ and K = 1.155

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MCQ 10.41 What is the percentage increase in tool life when the cutting speed is halved ?

(A) 50% (B) 200%

(C) 300% (D) 400%

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MCQ 10.42 For generating a Coon's surface we require

(A) a set of grid points on the surface

(B) a set of grid control points

(C) four bounding curves defining the surface

(D) two bounding curves and a set of grid control points

MCQ 10.43 Internal gear cutting operation can be performed by

(A) milling (B) shaping with rack cutter

(C) shaping with pinion cutter (D) hobbing

YEAR 2008 TWO MARKS

MCQ 10.44 While cooling, a cubical casting of side 40 mm undergoes 3%, 4% and 5% volume shrinkage during the liquid state, phase transition and solid state, respectively. The volume of metal compensated from the riser is

(A) 2% (B) 7%

(C) 8% (D) 9%

MCQ 10.45 In a single point turning tool, the side rake angle and orthogonal rake angle are equal. φ is the principal cutting edge angle and its range is $0^\circ \le \varphi \le 90^\circ$. The chip flows in the orthogonal plane. The value of φ is closest to

(A) 0° (B) 45°

(C) 60° (D) 90°

MCQ 10.46 A researcher conducts electrochemical machining (ECM) on a binary alloy (density 6000 kg/m^3) of iron (atomic weight 56, valency 2) and metal (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

MCQ 10.47 In a single pass rolling operation, a 20 mm thick plate with plate width of 100 mm, is reduced to 18 mm. The roller radius is 250 mm and rotational speed is 10 rpm. The average flow stress for the plate material is 300 MPa.

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The power required for the rolling operation in kW is closest to

(A) 15.2 (B) 18.2

(C) 30.4 (D) 45.6

MCQ 10.48 In arc welding of a butt joint, the welding speed is to be selected such that highest cooling rate is achieved. Melting efficiency and heat transfer efficiency are 0.5 and 0.7, respectively. The area of the weld cross section is $5\,\text{mm}^2$ and the unit energy required to melt the metal is $10\,\text{J/mm}^3$. If the welding power is $2\,\text{kW}$, the welding speed in mm/s is closest to

(A) 4 (B) 14

(C) 24 (D) 34

MCQ 10.49 In the deep drawing of cups, blanks show a tendency to wrinkle up around the periphery (flange). The most likely cause and remedy of the phenomenon are, respectively,

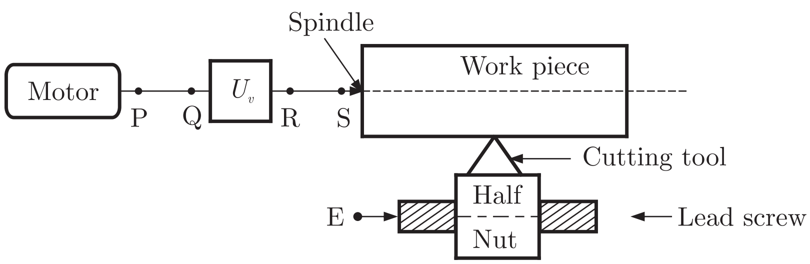
(A) Buckling due to circumferential compression; Increase blank holder pressure

(B) High blank holder pressure and high friction; Reduce blank holder pressure and apply lubricant

(C) High temperature causing increase in circumferential length; Apply coolant to blank

(D) Buckling due to circumferential compression; decrease blank holder pressure

MCQ 10.50 The figure shows an incomplete schematic of a conventional lathe to be used for cutting threads with different pitches. The speed gear box U_v is shown and the feed gear box U_s is to be placed. P, Q, R and S denote locations and have no other significance. Changes in U_v should NOT affect the pitch of the thread being cut and changes in U_s should NOT affect the cutting speed.



The correct connections and the correct placement of U_s are given by

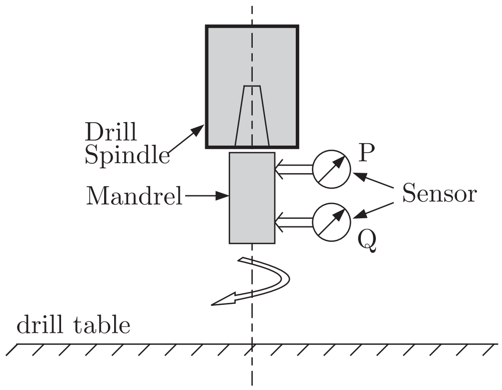
(A) Q and E are connected. U_s is placed between P and Q.

(B) S and E are connected. U_s is placed between R and S

(C) Q and E are connected. U_s is placed between Q and E

(D) S and E are connected. U_s is placed between S and E

MCQ 10.51 A displacement sensor (a dial indicator) measure the lateral displacement of a mandrel mounted on the taper hole inside a drill spindle. The mandrel axis is an extension of the drill spindle taper hole axis and the protruding portion of the mandrel surface is perfectly cylindrical measurements are taken with the sensor placed at two positions P and Q as shown in the figure. The reading are recorded as $R_x =$ maximum deflection minus minimum deflection, corresponding to sensor position at X, over one rotation.



If $R_P = R_Q > 0$, which one of the following would be consistent with the observation ?

(A) The drill spindle rotational axis is coincident with the drill spindle taper hole axis

(B) The drill spindle rotational axis intersects the drill spindle taper hole axis at point P

(C) The drill spindle rotational axis is parallel to the drill spindle taper hole axis

(D) The drill spindle rotational axis intersects the drill spindle taper hole axis at point Q

• Common Data For Q.52 and Q.53

Orthogonal turning is performed on a cylindrical workpiece with the shear strength of 250 MPa. The following conditions are used: cutting velocity is 180 m/min, feed is 0.20 mm/rev, depth of cut is 3 mm, chip thickness ratio $= 0.5$. The orthogonal rake angle is $7°$. Apply Merchant's theory for analysis.

MCQ 10.52 The shear plane angle (in degree) and the shear force respectively are

(A) 52, 320 N (B) 52, 400 N

(C) 28, 400 N (D) 28, 320 N

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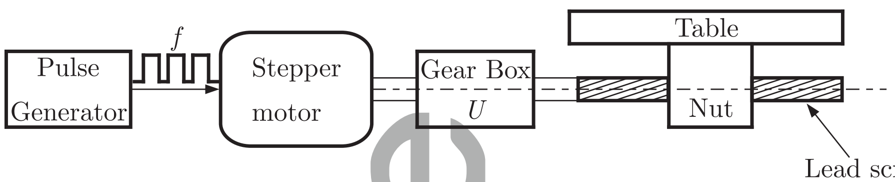
MCQ 10.53 The cutting and frictional forces, respectively, are

(A) 568 N, 387 N (B) 565 N, 381 N

(C) 440 N, 342 N (D) 480 N, 356 N

• Common Data For Q.54 and Q.55

In the feed drive of a Point-to-Point open loop CNC drive, a stepper motor rotating at 200 steps/rev drives a table through a gear box and lead screw-nut mechanism (pitch=4 mm, number of starts=1). The gear ratio $=\left(\dfrac{\text{Output rotational speed}}{\text{Input rotational speed}}\right)$ is given by $U=\dfrac{1}{4}$. The stepper motor (driven by voltage pulses from a pulse generator) executes 1 step/pulse of the pulse generator. The frequency of the pulse train from the pulse generator is $f=10{,}000$ pulses per minute.



MCQ 10.54 The basic Length Unit (BLU), i.e, the table movement corresponding to 1 pulse of the pulse generator, is

(A) 0.5 microns (B) 5 microns

(C) 50 microns (D) 500 microns

MCQ 10.55 A customer insists on a modification to change the BLU of the CNC drive to 10 microns without changing the table speed. The modification can be accomplished by

(A) changing U to $\frac{1}{2}$ and reducing f to $\frac{f}{2}$

(B) changing U to $\frac{1}{8}$ and increasing f to $2f$

(C) changing U to $\frac{1}{2}$ and keeping f unchanged

(D) keeping U unchanged and increasing f to $2f$

YEAR 2007 **ONE MARK**

MCQ 10.56 If a particular Fe-C alloy contains less than 0.83% carbon, it is called

(A) high speed steel (B) hypoeutectoid steel

(C) hypereutectoid steel (D) cast iron

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MCQ 10.57 Which of the following engineering materials is the most suitable candidate for hot chamber die casting ?

(A) low carbon steel (B) titanium

(C) copper (D) tin

MCQ 10.58 Which one of the following is a solid state joining process ?

(A) gas tungsten arc welding (B) resistance spot welding

(C) friction welding (D) submerged arc welding

MCQ 10.59 In orthogonal turning of a low carbon steel bar of diameter 150 mm with uncoated carbide tool, the cutting velocity is 90 m/min. The feed is 0.24 mm/rev and the depth of cut is 2 mm. The chip thickness obtained is 0.48 mm. If the orthogonal rake angle is zero and the principle cutting edge angle is 90°, the shear angle in degree is

(A) 20.56 (B) 26.56

(C) 30.56 (D) 36.56

MCQ 10.60 Which type of motor is NOT used in axis or spindle drives of CNC machine tools ?

(A) induction motor (B) dc servo motor

(C) stepper motor (D) linear servo motor

MCQ 10.61 Volume of a cube of side 'l' and volume of a sphere of radius 'r' are equal. Both the cube and the sphere are solid and of same material. They are being cast. The ratio of the solidification time of the cube to the same of the sphere is

(A) $\left(\frac{4\pi}{6}\right)^3\left(\frac{r}{l}\right)^6$ (B) $\left(\frac{4\pi}{6}\right)\left(\frac{r}{l}\right)^2$

(C) $\left(\frac{4\pi}{6}\right)^2\left(\frac{r}{l}\right)^3$ (D) $\left(\frac{4\pi}{6}\right)^2\left(\frac{r}{l}\right)^4$

YEAR 2007 TWO MARKS

MCQ 10.62 In electrodischarge 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) low and low

(C) high and low (D) low and high

MCQ 10.63 In orthogonal turning of medium carbon steel, the specific machining energy is $2.0\ \text{J/mm}^3$. The cutting velocity, feed and depth of cut are 120 m/min, 0.2 mm/rev. and 2 mm respectively. The main cutting force in N is

(A) 40 (B) 80

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(C) 400 (D) 800

MCQ 10.64 A direct current welding machine with a linear power source characteristic provides open circuit voltage of 80 V and short circuit current of 800 A . During welding with the machine, the measured arc current is 500 A corresponding to an arc length of 5.0 mm and the measured arc current is 460 A corresponding to an arc length of 7.0 mm. The linear voltage (E) arc length (L) characteristic of the welding arc can be given as (where E is in volt and L in in mm)

(A) $E = 20 + 2L$ (B) $E = 20 + 8L$

(C) $E = 80 + 2L$ (D) $E = 80 + 8L$

MCQ 10.65 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

MCQ 10.66 In orthogonal turning of low carbon steel pipe with principal cutting edge angle of 90°, the main cutting force is 1000 N and the feed force is 800 N. The shear angle is 25° and orthogonal rake angle is zero. Employing Merchant's theory, the ratio of friction force to normal force acting on the cutting tool is

(A) 1.56 (B) 1.25

(C) 0.80 (D) 0.64

MCQ 10.67 Two metallic sheets, each of 2.0 mm thickness, are welded in a lap joint configuration by resistance spot welding at a welding current of 10 kA and welding time of 10 millisecond. A spherical fusion zone extending up to full thickness of each sheet is formed. The properties of the metallic sheets are given as :

Ambient temperature	= 293 K
Melting temperature	= 1793 K
Density	= 7000 kg/m^3
Latent heat of fusion	= 300 kJ/kg
Specific heat	= 800 J/kgK

Assume :

(i) contact resistance along sheet interface is 500 micro-ohm and along electrode-sheet interface is zero;

(ii) no conductive heat loss through the bulk sheet materials ; and

(iii) the complete weld fusion zone is at the melting temperature.

The melting efficiency (in %) of the process is

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(A) 50.37 (B) 60.37
(C) 70.37 (D) 80.37

MCQ 10.68 In open-die forging, disc of diameter 200 mm and height 60 mm is compressed without any barreling effect. The final diameter of the disc is 400 mm. The true strain is
(A) 1.986 (B) 1.686
(C) 1.386 (D) 0.602

MCQ 10.69 The thickness of a metallic sheet is reduced from an initial value of 16 mm to a final value of 10 mm in one single pass rolling with a pair of cylindrical rollers each of diameter of 400 mm. The bite angle in degree will be.
(A) 5.936 (B) 7.936
(C) 8.936 (D) 9.936

MCQ 10.70 Match the correct combination for following metal working processes.

	Processes		Associated state of stress
P:	Blanking	**1.**	Tension
Q:	Stretch Forming	**2.**	Compression
R:	Coining	**3.**	Shear
S:	Deep Drawing	**4.**	Tension and Compression
		5.	Tension and Shear

(A) P - 2, Q - 1, R - 3, S - 4
(B) P - 3, Q - 4, R - 1, S - 5
(C) P - 5, Q - 4, R - 3, S - 1
(D) P - 3, Q - 1, R - 2, S - 4

MCQ 10.71 The force requirement in a blanking operation of low carbon steel sheet is 5.0 kN. The thickness of the sheet is 't' and diameter of the blanked part is 'd'. For the same work material, if the diameter of the blanked part is increased to $1.5d$ and thickness is reduced to $0.4t$, the new blanking force in kN is
(A) 3.0 (B) 4.5
(C) 5.0 (D) 8.0

MCQ 10.72 A 200 mm long down sprue has an area of cross-section of 650 mm^2 where the pouring basin meets the down sprue (i.e at the beginning of the down sprue). A constant head of molten metal is maintained by the pouring basin. The molten metal flow rate is $6.5 \times 10^5\ mm^3/s$. Considering the end of down sprue to be open to atmosphere and an acceleration due to gravity

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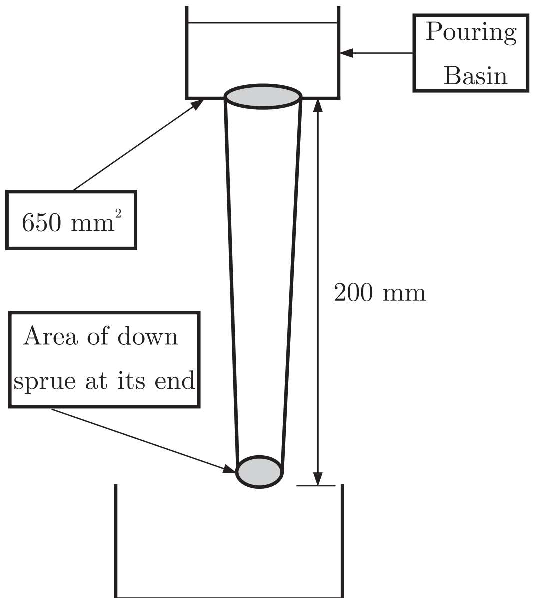
of 10^4 mm/s^2, the area of the down sprue in mm^2 at its end (avoiding aspiration effect) should be



(A) 650.0
(B) 350.0
(C) 290.7
(D) 190.0

MCQ 10.73 Match the most suitable manufacturing processes for the following parts.

	Parts		**Manufacturing Process**
P.	Computer chip	**1.**	Electrochemical Machining
Q.	Metal forming dies and molds	**2.**	Ultrasonic Machining
R.	Turbine blade	**3.**	Electrodischarge Machining
S.	Glass	**4.**	Photochemical Machining

(A) P - 4, Q - 3, R - 1, S - 2
(B) P - 4, Q - 3, R - 2, S - 1
(C) P - 3, Q - 1, R - 4, S - 2
(D) P - 1, Q - 2, R - 4, S - 3

• Common Data For Q. 74 and Q.75

A low carbon steel bar of 147 mm diameter with a length of 630 mm is being turned with uncoated carbide insert. The observed tool lives are 24 min and 12 min for cutting velocities of 90 m/min and 120 m/ min. respectively. The feed and depth of cut are 0.2 mm/rev and 2 mm respectively. Use the unmachined diameter to calculate the cutting velocity.

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MCQ 10.74 When tool life is 20 min, the cutting velocity in m/min is

(A) 87 (B) 97

(C) 107 (D) 114

MCQ 10.75 Neglect over-travel or approach of the tool. When tool life is 20 min., the machining time in min for a single pass is

(A) 5 (B) 10

(C) 15 (D) 20

YEAR 2006 ONE MARK

MCQ 10.76 An expendable pattern is used in

(A) slush casting (B) squeeze casting

(C) centrifugal casting (D) investment casting

MCQ 10.77 The main purpose of spheroidising treatment is to improve

(A) hardenability of low carbon steels

(B) machinability of low carbon steels

(C) hardenability of high carbon steels

(D) machinability of high carbon steels

MCQ 10.78 NC contouring is an example of

(A) continuous path positioning (B) point-to-point positioning

(C) absolute positioning (D) incremental positioning

MCQ 10.79 A ring gauge 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

YEAR 2006 TWO MARKS

MCQ 10.80 The ultimate tensile strength of a material is 400 MPa and the elongation up to maximum load is 35%. If the material obeys power law of hardening, then the true stress-true strain relation (stress in MPa) in the plastic deformation range is

(A) $\sigma = 540\varepsilon^{0.30}$ (B) $\sigma = 775\varepsilon^{0.30}$

(C) $\sigma = 540\varepsilon^{0.35}$ (D) $\sigma = 775\varepsilon^{0.35}$

MCQ 10.81 In a sand casting operation, the total liquid head is maintained constant such that it is equal to the mould height. The time taken to fill the mould with a top gate is t_A. If the same mould is filled with a bottom gate, then the time taken is t_B. Ignore the time required to fill the runner and frictional effects. Assume atmospheric pressure at the top molten metal surfaces. The relation between t_A and t_B is

(A) $t_B = \sqrt{2}\, t_A$ (B) $t_B = 2t_A$

(C) $t_B = \frac{t_A}{\sqrt{2}}$ (D) $t_B = 2\sqrt{2}\, t_A$

MCQ 10.82 A 4 mm thick sheet is rolled with 300 mm diameter roll to reduce thickness without any change in its width. The friction coefficient at the work-roll interface is 0.1. The minimum possible thickness of the sheet that can be produced in a single pass is

(A) 1.0 mm (B) 1.5 mm

(C) 2.5 mm (D) 3.7 mm

MCQ 10.83 In a wire drawing operation, diameter of a steel wire is reduced from 10 mm to 8 mm. The mean flow stress of the material is 400 MPa. The ideal force required for drawing (ignoring friction and redundant work) is

(A) 4.48 kN (B) 8.97 kN

(C) 20.11 kN (D) 31.41 kN

MCQ 10.84 Match the item in columns I and II

	Column I		Column II
P.	Wrinkling	**1.**	Yield point elongation
Q.	Orange peel	**2.**	Anisotropy
R.	Stretcher strains	**3.**	Large grain size
S.	Earing	**4.**	Insufficient blank holding force
		5.	Fine grain size
		6.	Excessive blank holding force

(A) P-6, Q-3, R-1, S-2

(B) P-4, Q-5, R-6, S-1

(C) P-2, Q-5, R-3, S-1

(D) P-4, Q-3, R-1, S-2

MCQ 10.85 In an arc welding process, the voltage and current are 25 V and 300 A respectively. The arc heat transfer efficiency is 0.85 and welding speed is 8 mm/sec. The net heat input (in J/mm) is

(A) 64 (B) 797

(C) 1103 (D) 79700

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MCQ 10.86 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

MCQ 10.87 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

MCQ 10.88 Match the items in columns I and II.

	Column I		Column II
P.	Charpy test	**1.**	Fluidity
Q.	Knoop test	**2.**	Microhardness
R.	Spiral test	**3.**	Formability
S.	Cupping test	**4.**	Toughness
		5.	Permeability

(A) P-4, Q-5, R-3, S-2

(B) P-3, Q-5, R-1, S-4

(C) P-2, Q-4, R-3, S-5

(D) P-4, Q-2, R-1, S-3

• Common Data For Q.89, 90 and Q.91

In an orthogonal machining operation :

Uncut thickness = 0.5 mm

Cutting speed = 20 m/min

Rake angel = 15°

Width of cut = 5 mm Chip thickness = 0.7 mm

Thrust force = 200 N Cutting force = 1200 N
Assume Merchant's theory.

MCQ 10.89 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

MCQ 10.90 The coefficient of friction at the tool-chip interface is
(A) 0.23
(B) 0.46
(C) 0.85
(D) 0.95

MCQ 10.91 The percentage of total energy dissipated due to friction at the tool-chip interface is
(A) 30%
(B) 42%
(C) 58%
(D) 70%

YEAR 2005 ONE MARK

MCQ 10.92 Match the items of List-I (Equipment) with the items of List-II (Process) and select the correct answer using the given codes.

	List-I (Equipment)		List-II (Process)
P.	Hot Chamber Machine	**1.**	Cleaning
Q.	Muller	**2.**	Core making
R.	Dielectric Baker	**3.**	Die casting
S.	Sand Blaster	**4.**	Annealing
		5.	Sand mixing

(A) P-2, Q-1, R-4, S-5
(B) P-4, Q-2, R-3, S-5
(C) P-4, Q-5, R-1, S-2
(D) P-3, Q-5, R-2, S-1

MCQ 10.93 When the temperature of a solid metal increases,
(A) strength of the metal decreases but ductility increases
(B) both strength and ductility of the metal decreases
(C) both strength and ductility of the metal increases
(D) strength of the metal increases but ductility decreases

MCQ 10.94 The strength of a brazed joint
(A) decreases with increase in gap between the two joining surfaces
(B) increases with increase in gap between the two joining surfaces

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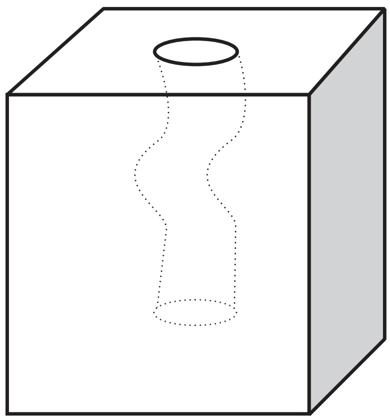
(C) decreases up to certain gap between the two joining surfaces beyond which it increases

(D) increases up to certain gap between the two joining surfaces beyond which it decreases

MCQ 10.95 A zigzag cavity in a block of high strength alloy is to be finish machined. This can be carried out by using.



(A) electric discharge machining (B) electric-chemical machining

(C) laser beam machining (D) abrasive flow machining

MCQ 10.96 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

MCQ 10.97 When 3-2-1 principle is used to support and locate a three dimensional work-piece during machining, the number of degrees of freedom that are restricted is

(A) 7 (B) 8

(C) 9 (D) 10

MCQ 10.98 Which among the NC operations given below are continuous path operations ?

Arc Welding (AW)

Drilling (D)

Laser Cutting of Sheet Metal (LC)

Milling (M)

Punching in Sheet Metal (P)

Spot Welding (SW)

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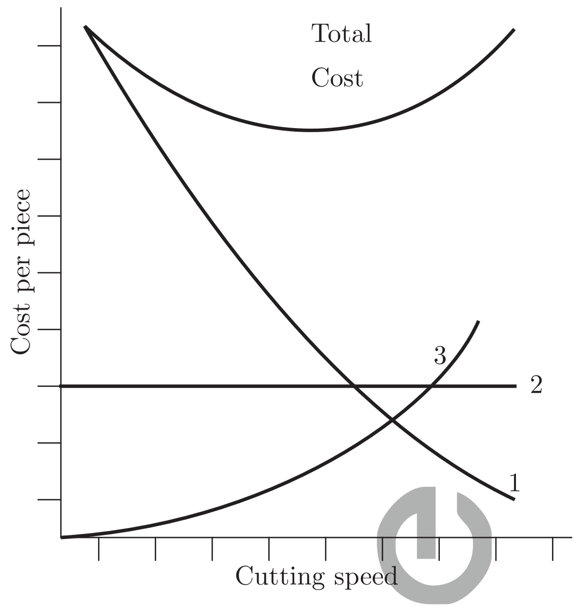
(A) AW, LC and M
(B) AW, D, LC and M
(C) D, LC, P and SW
(D) D, LC, and SW

MCQ 10.99 The figure below shows a graph which qualitatively relates cutting speed and cost per piece produced.



The three curves 1, 2 and 3 respectively represent

(A) machining cost, non-productive cost, tool changing cost
(B) non-productive cost, machining cost, tool changing cost
(C) tool changing cost, machining cost, non-productive cost
(D) tool changing cost, non-productive cost, machining cost

YEAR 2005 **TWO MARKS**

MCQ 10.100 A mould has a downsprue whose length is 20 cm and the cross sectional area at the base of the downsprue is 1 cm^2. The downsprue feeds a horizontal runner leading into the mould cavity of volume 1000 cm^3. The time required to fill the mould cavity will be

(A) 4.05 s
(B) 5.05 s
(C) 6.05 s
(D) 7.25 s

MCQ 10.101 Spot welding of two 1 mm thick sheets of steel (density $= 8000$ kg/m^3) is carried out successfully by passing a certain amount of current for 0.1 second through the electrodes. The resultant weld nugget formed is 5 mm in diameter and 1.5 mm thick. If the latent heat of fusion of steel is 1400 kJ/kg and the effective resistance in the welding operation is 200 $\mu\Omega$, the current passing through the electrodes is approximately

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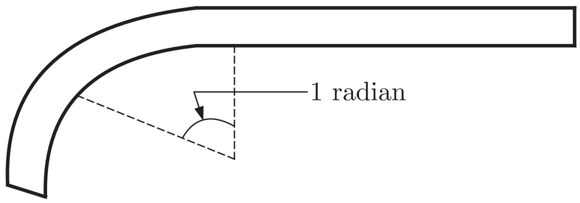
(A) 1480 A (B) 3300 A

(C) 4060 A (D) 9400 A

MCQ 10.102 A 2 mm thick metal sheet is to be bent at an angle of one radian with a bend radius of 100 mm. If the stretch factor is 0.5, the bend allowance is



(A) 99 mm (B) 100 mm

(C) 101 mm (D) 102 mm

MCQ 10.103 A $600\,\text{mm} \times 30\,\text{mm}$ flat surface of a plate is to be finish machined on a shaper. The plate has been fixed with the $600\,\text{mm}$ side along the tool travel direction. If the tool over-travel at each end of the plate is $20\,\text{mm}$, average cutting speed is $8\,\text{m/min.}$, feed rate is $0.3\,\text{mm}/$ 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

MCQ 10.104 The tool of an NC machine has to move along a circular arc from (5, 5) to (10, 10) while performing an operation. The centre of the arc is at (10, 5). Which one of the following NC tool path command performs the above mentioned operation ?

(A) N010 GO2 X10 Y10 X5 Y5 R5

(B) N010 GO3 X10 Y10 X5 Y5 R5

(C) N010 GO1 X5 Y5 X10 Y10 R5

(D) N010 GO2 X5 Y5 X10 Y10 R5

MCQ 10.105 Two tools P and Q have signatures 5°-5°-6°-6°-8°-30°-0 and 5°-5°-7°-7°-8°-15°-0 (both ASA) respectively. They are used to turn components under the same machining conditions. If h_P and h_Q denote the peak-to-valley heights of surfaces produced by the tools P and Q, the ratio h_P/h_Q will be

(A) $\dfrac{\tan 8^\circ + \cot 15^\circ}{\tan 8^\circ + \cot 30^\circ}$ (B) $\dfrac{\tan 15^\circ + \cot 8^\circ}{\tan 30^\circ + \cot 8^\circ}$

(C) $\dfrac{\tan 15^\circ + \cot 7^\circ}{\tan 30^\circ + \cot 7^\circ}$ (D) $\dfrac{\tan 7^\circ + \cot 15^\circ}{\tan 7^\circ + \cot 30^\circ}$

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YEAR 2004 ONE MARK

MCQ 10.106 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

MCQ 10.107 During the execution of a CNC part program block

$NO20\ GO2\ X45.0\ Y25.0\ R5.0$ the type of tool motion will be

(A) circular Interpolation – clockwise

(B) circular Interpolation – counterclockwise

(C) linear Interpolation

(D) rapid feed

MCQ 10.108 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

MCQ 10.109 Two 1 mm thick steel sheets are to be spot welded at a current of 5000 A. Assuming effective resistance to be 200 μm and current flow time of 0.2 second, heat generated during the process will be

(A) 0.2 Joule (B) 1 Joule

(C) 5 Joule (D) 1000 Joule

MCQ 10.110 Misrun is a casting defect which occurs due to

(A) very high pouring temperature of the metal

(B) insufficient fluidity of the molten metal

(C) absorption of gases by the liquid metal

(D) improper alignment of the mould flasks

MCQ 10.111 The percentage of carbon in gray cast iron is in the range of

(A) 0.25 to 0.75 percent (B) 1.25 to 1.75 percent

(C) 3 to 4 percent (D) 8 to 10 percent

YEAR 2004 TWO MARKS

MCQ 10.112 GO and NO-GO plug gauges are to be designed for a hole $20.000^{+0.050}_{+0.010}$ mm. Gauge tolerances can be taken as 10% of the hole tolerance. Following ISO system of gauge design, sizes of GO and NO-GO gauge 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

MCQ 10.113 10 mm diameter holes are to be punched in a steel sheet of 3 mm thickness. Shear strength of the material is 400 N/mm^2 and penetration is 40%. Shear provided on the punch is 2 mm. The blanking force during the operation will be

(A) 22.6 kN (B) 37.7 kN

(C) 61.6 kN (D) 94. 3 kN

MCQ 10.114 Through holes of 10 mm diameter are to be drilled in a steel plate of 20 mm thickness. Drill spindle speed is 300 rpm, feed 0.2 mm/rev and drill point angle is 120°. Assuming drill overtravel of 2 mm, the time for producing a hole will be

(A) 4 seconds (B) 25 seconds

(C) 100 seconds (D) 110 seconds

MCQ 10.115 Gray cast iron blocks $200 \times 100 \times 10$ mm are to be cast in sand moulds. Shrinkage allowance for pattern making is 1%. The ratio of the volume of pattern to that of the casting will be

(A) 0.97 (B) 0.99

(C) 1.01 (D) 1.03

MCQ 10.116 In a 2-D CAD package, clockwise circular arc of radius 5, specified from $P_1(15,10)$ to $P_2(10,15)$ will have its centre at

(A) (10, 10) (B) (15, 10)

(C) (15, 15) (D) (10, 15)

MCQ 10.117 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°

MCQ 10.118 In a rolling process, sheet of 25 mm thickness is rolled to 20 mm thickness. Roll is of diameter 600 mm and it rotates at 100 rpm. The roll strip contact length will be

(A) 5 mm (B) 39 mm

(C) 78 mm (D) 120 mm

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MCQ 10.119 In a machining operation, doubling the cutting speed reduces the tool life to $\frac{1}{8}$th 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) $\frac{1}{2}$

MCQ 10.120 Match the following

	Feature to be inspected		Instrument
P.	Pitch and Angle errors of screw thread	**1.**	Auto Collimator
Q.	Flatness error of a surface	**2.**	Optical Interferometer
R.	Alignment error of a machine slideway	**3.**	Dividing Head and Dial Gauge
S.	Profile of a cam	**4.**	Spirit Level
		5.	Sine bar
		6.	Tool maker's Microscope

(A) P-6 Q-2 R-4 S-6
(B) P-5 Q-2 R-1 S-6
(C) P-6 Q-4 R-1 S-3
(D) P-1 Q-4 R-5 S-2

MCQ 10.121 Match the following

	Product		Process
P.	Molded luggage	**1.**	Injection molding
Q.	Packaging containers for Liquid	**2.**	Hot rolling
R.	Long structural shapes	**3.**	Impact extrusion
S.	Collapsible tubes	**4.**	Transfer molding
		5.	Blow molding
		6.	Coining

(A) P-1 Q-4 R-6 S-3
(B) P-4 Q-5 R-2 S-3
(C) P-1 Q-5 R-3 S-2
(D) P-5 Q-1 R-2 S-4

MCQ 10.122 Typical machining operations are to be performed on hard-to-machine materials by using the processes listed below. Choose the best set of Operation-Process combinations

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	Operation		Process
P.	Deburring (internal surface)	**1.**	Plasma Arc Machining
Q.	Die sinking	**2.**	Abrasive Flow Machining
R.	Fine hole drilling in thin sheets	**3.**	Electric Discharge Machining
S.	Tool sharpening	**4.**	Ultrasonic Machining
		5.	Laser beam Machining
		6.	Electrochemical Grinding

(A) P-1 Q-5 R-3 S-4
(B) P-1 Q-4 R-1 S-2
(C) P-5 Q-1 R-2 S-6
(D) P-2 Q-3 R-5 S-6

MCQ 10.123 From the lists given below choose the most appropriate set of heat treatment process and the corresponding process characteristics

	Process		Characteristics
P.	Tempering	**1.**	Austenite is converted into bainite
Q.	Austempering	**2.**	Austenite is converted into martensite
R.	Martempering	**3.**	Cementite is converted into globular structure
		4.	Both hardness and brittleness are reduced
		5.	Carbon is absorbed into the metal

(A) P-3 Q-1 R-5 (B) P-4 Q-3 R-2
(C) P-4 Q-1 R-2 (D) P-1 Q-5 R-4

YEAR 2003 ONE MARK

MCQ 10.124 During heat treatment of steel, the hardness of various structures in increasing order is
(A) martensite, fine pearlite, coarse pearlite, spherodite
(B) fine pearlite, Martensite, spherodite, coarse pearlite
(C) martensite, coarse pearlite, fine pearlite, spherodite
(D) spherodite, coarse pearlite, fine pearlite, martensite

MCQ 10.125 Hardness of green sand mould increases with
(A) increase in moisture content beyond 6 percent
(B) increase in permeability
(C) decrease in permeability
(D) increase in both moisture content and permeability

MCQ 10.126 In Oxyacetylene gas welding, temperature at the inner cone of the flame is around

(A) 3500° C (B) 3200° C

(C) 2900° C (D) 2550° C

MCQ 10.127 Cold working of steel is defined as working

(A) at its recrystallisation temperature

(B) above its recrystallisation temperature

(C) below its recrystallisation temperature

(D) at two thirds of the melting temperature of the metal

MCQ 10.128 Quality screw threads are produced by

(A) thread milling

(B) thread chasing

(C) thread cutting with single point tool

(D) thread casting

MCQ 10.129 As tool and work are not in contact in EDM process

(A) no relative motion occurs between them

(B) no wear of tool occurs

(C) no power is consumed during metal cutting

(D) no force between tool and work occurs

MCQ 10.130 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

YEAR 2003 TWO MARKS

MCQ 10.131 Hardness of steel greatly improves with

(A) annealing (B) cyaniding

(C) normalizing (D) tempering

MCQ 10.132 With a solidification factor of $0.97 \times 10^6\ \text{s/m}^2$, the solidification time (in seconds) for a spherical casting of 200 mm diameter is

(A) 539 (B) 1078

(C) 4311 (D) 3233

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MCQ 10.133 A shell of 100 mm diameter and 100 mm height with the corner radius of 0.4 mm is to be produced by cup drawing. The required blank diameter is

(A) 118 mm (B) 161 mm

(C) 224 mm (D) 312 mm

MCQ 10.134 A brass billet is to be extruded from its initial diameter of 100 mm to a final diameter of 50 mm. The working temperature of 700°C and the extrusion constant is 250 MPa. The force required for extrusion is

(A) 5.44 MN (B) 2.72 MN

(C) 1.36 MN (D) 0.36 MN

MCQ 10.135 A metal disc of 20 mm diameter is to be punched from a sheet of 2 mm thickness. The punch and the die clearance is 3%. The required punch diameter is

(A) 19.88 mm (B) 19.84 mm

(C) 20.06 mm (D) 20.12 mm

MCQ 10.136 A batch of 10 cutting tools could produce 500 components while working at 50 rpm with a tool feed of 0.25 mm/rev and depth of cut of 1mm. A similar batch of 10 tools of the same specification could produce 122 components while working at 80 rpm with a feed of 0.25 mm/rev and 1 mm depth of cut. How many components can be produced with one cutting tool at 60 rpm ?

(A) 29 (B) 31

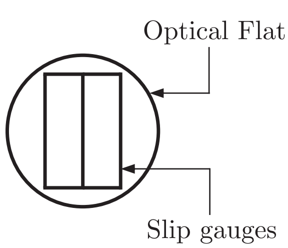
(C) 37 (D) 42

MCQ 10.137 A thread nut of $M16$ ISO metric type, having 2 mm pitch with a pitch diameter of 14.701 mm is to be checked for its pitch diameter using two or three number of balls or rollers of the following sizes

(A) Rollers of 2 mm φ (B) Rollers of 1.155 mm φ

(C) Balls of 2 mm φ (D) Balls of 1.155 mm φ

MCQ 10.138 Two slip gauges of 10 mm width measuring 1.000 mm and 1.002 mm are kept side by side in contact with each other lengthwise. An optical flat is kept resting on the slip gauges as shown in the figure. Monochromatic light of wavelength 0.0058928 mm is used in the inspection. The total number of straight fringes that can be observed on both slip gauges is



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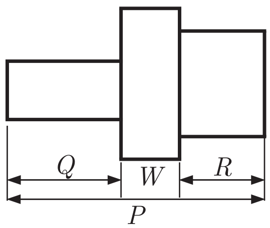
(A) 2 (B) 6

(C) 8 (D) 13

MCQ 10.139 A part shown in the figure is machined to the sizes given below



$P = 35.00 \pm 0.08$ mm, $Q = 12.00 \pm 0.02$ 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

MCQ 10.140 Match the following

	Working material		Type of Joining
P.	Aluminium	**1.**	Submerged Arc Welding
Q.	Die steel	**2.**	Soldering
R.	Copper wire	**3.**	Thermit Welding
S.	Titanium sheet	**4.**	Atomic Hydrogen Welding
		5.	Gas Tungsten Arc Welding
		6.	Laser Beam Welding

(A)	P-2	Q-5	R-1	S-3
(B)	P-6	Q-3	R-4	S-1
(C)	P-4	Q-1	R-6	S-2
(D)	P-5	Q-4	R-2	S-6

• Common Data For Q.141 and Q.142

A cylinder is turned on a lathe with orthogonal machining principle. Spindle rotates at 200 rpm. The axial feed rate is 0.25 mm per revolution. Depth of cut is 0.4 mm. The rake angle is $10°$. In the analysis it is found that the shear angle is $27.75°$.

MCQ 10.141 The thickness of the produced chip is

(A) 0.511 mm (B) 0.528 mm

(C) 0.818 mm (D) 0.846 mm

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MCQ 10.142 In the above problem, the coefficient of friction at the chip tool interface obtained using Earnest and Merchant theory is

(A) 0.18 (B) 0.36

(C) 0.71 (D) 0.98

YEAR 2002 **ONE MARK**

MCQ 10.143 A lead-screw with half nuts in a lathe, free to rotate in both directions has

(A) V-threads (B) Whitworth threads

(C) Buttress threads (D) Acme threads

MCQ 10.144 The primary purpose of a sprue in a casting mould is to

(A) feed the casting at a rate consistent with the rate of solidification.

(B) act as a reservoir for molten metal

(C) feed molten metal from the pouring basin to the gate

(D) help feed the casting until all solidification takes place

MCQ 10.145 Hot rolling of mild steel is carried out

(A) at re-crystallization temperature

(B) between 100° C to 150° C

(C) between re-crystallization temperature

(D) above re-crystallization temperature

MCQ 10.146 Which of the following arc welding processes does not use consumable electrodes ?

(A) GMAW (B) GTAW

(C) Submerged Arc Welding (D) None of these

MCQ 10.147 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

MCQ 10.148 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

YEAR 2002 **TWO MARKS**

MCQ 10.149 In centrifugal casting, the impurities are
(A) uniformly distributed
(B) forced towards the outer surface
(C) trapped near the mean radius of the casting
(D) collected at the centre of the casting

MCQ 10.150 The ductility of a material with work hardening
(A) increases
(B) decreases
(C) remains unaffected
(D) unpredictable

MCQ 10.151 The temperature of a carburising flame in gas welding is ......that of a neutral or an oxidising flame.
(A) lower than
(B) higher than
(C) equal to
(D) unrelated to

MCQ 10.152 In a blanking operation, the clearance is provided on
(A) the die
(B) both the die and the punch equally
(C) the punch
(D) neither the punch nor the die

MCQ 10.153 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

MCQ 10.154 The time taken to drill a hole through a 25 mm thick plate with the drill rotating at 300 rpm and moving at a feed rate of 0.25 mm/rev is
(A) 10 s
(B) 20 s
(C) 60 s
(D) 100 s

YEAR 2001 **ONE MARK**

MCQ 10.155 Shrinkage allowance on pattern is provided to compensate for shrinkage when
(A) the temperature of liquid metal drops from pouring to freezing temperature.
(B) the metal changes from liquid to solid state at freezing temperature
(C) the temperature of solid phase drops from freezing to room temperature
(D) the temperature of metal drops from pouring to room temperature

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MCQ 10.156 The cutting force in punching and blanking operations mainly depends on

(A) the modulus of elasticity of metal (B) the shear strength of metal

(C) the bulk modulus of metal (D) the yield strength of metal

MCQ 10.157 In ECM, the material removal is due to

(A) corrosion (B) erosion

(C) fusion (D) ion displacement

MCQ 10.158 Two plates of the same metal having equal thickness are to be butt welded with electric arc. When the plate thickness changes, welding is achieved by

(A) adjusting the current

(B) adjusting the duration of current

(C) changing the electrode size

(D) changing the electrode coating

MCQ 10.159 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 sizes of hole

(D) difference between maximum and minimum sizes of shaft.

YEAR 2001 **TWO MARKS**

MCQ 10.160 The height of the downsprue is 175 mm and its cross-sectional area at the base is 200 mm^2. The cross-sectional area of the horizontal runner is also 200 mm^2, assuming no losses, indicate the correct choice for the time (in sec) required to fill a mold cavity of volume 10^6 mm^3. (Use $g = 10\text{ m/s}^2$).

(A) 2.67 (B) 8.45

(C) 26.72 (D) 84.50

MCQ 10.161 For rigid perfectly plastic work material, negligible interface friction and no redundant work, the theoretically maximum possible reduction in the wire drawing operation is

(A) 0.36 (B) 0.63

(C) 1.00 (D) 2.72

MCQ 10.162 During orthogonal cutting of mild steel with a 10° rake angle, the chip thickness ratio was obtained as 0.4. The shear angle (in degree) evaluated from this data is

(A) 6.53 (B) 20.22

(C) 22.94 (D) 50.00

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MCQ 10.163 Resistance spot welding is performed on two plates of 1.5 mm thickness with 6 mm diameter electrode, using 15000 A current for a time duration of 0.25 s. Assuming the interface resistance to be $0.0001\,\Omega$, the heat generated to form the weld is

(A) 5625 W-s (B) 8437 W-s

(C) 22500 W-s (D) 33750 W-s

MCQ 10.164 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

MCQ 10.165 In an NC machining operation, the tool has to be moved from point (5, 4) to point (7, 2) along a circular path with centre at (5, 2). Before starting the operation, the tool is at (5, 4). The correct G and N codes for this motion are

(A) $N010$ $GO3$ $X7.0$ $Y2.0$ $I5.0$ $J2.0$

(B) $N010$ $GO2$ $X7.0$ $Y2.0$ $I5.0$ $J2.0$

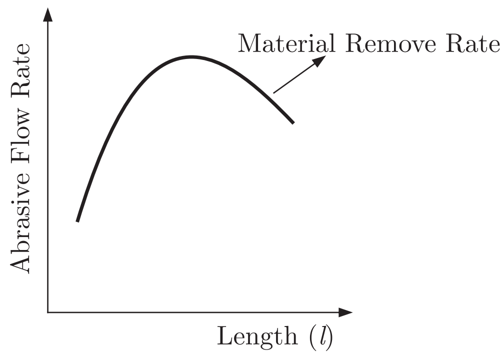
(C) $N010$ $GO1$ $X7.0$ $Y2.0$ $I5.0$ $J2.0$

(D) $N010$ GOO $X7.0$ $Y2.0$ $I5.0$ $J2.0$

****

SOLUTION

SOL 10.1 Option (D) is correct.



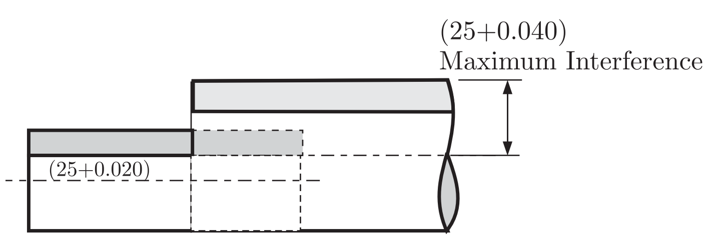
Graph for abrasive jet machining for the distance between the nozzle tip and work surface (l) and abrasive flow rate is given in figure.
It is clear from the graph that the material removal rate is first increases because of area of jet increase than becomes stable and then decreases due to decrease in jet velocity.

SOL 10.2 Option (A) is correct.

	Metal forming process		Types of stress
1.	Coining	**S.**	Compressive
2.	Wire Drawing	**P.**	Tensile
3.	Blanking	**Q.**	Shear
4.	Deep Drawing	**R.**	Tensile and compressive

Hence, correct match list is, 1-S, 2-P, 3-Q, 4-R

SOL 10.3 Option (C) is correct.
An interference fit for shaft and hole is as given in figure below.



Maximum Interference

$$= \text{Maximum limit of shat} - \text{Minimum limit of hole}$$

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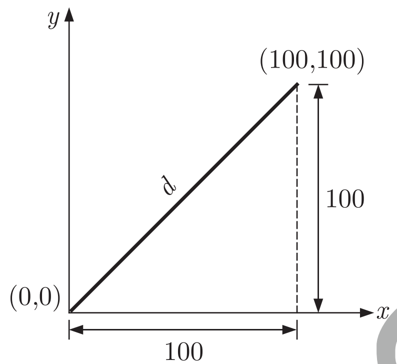
$$= (25 + 0.040) - (25 + 0.020)$$
$$= 0.02 \text{ mm} = 20 \text{ microns}$$

SOL 10.4 Option (C) is correct

Normalising involves prolonged heating just above the critical temperature to produce globular form of carbine and then cooling in air.

SOL 10.5 Option (B) is correct.

Given : width $(b) = 10$ mm, depth $= 2$ mm



Distance travelled for cut between points (0,0) and (100,100)

By Pythagoras theorem

$$d = \sqrt{100^2 + 100^2} = 141.42 \text{ mm}$$

$$\text{Feed rate } f = 50 \text{ mm/min}$$
$$= \frac{50}{60} = 0.833 \text{ mm/sec.}$$

Time required to cut distance (d)

$$t = \frac{d}{f} = \frac{141.42}{0.833} = 169.7 \simeq 170 \text{ sec.}$$

SOL 10.6 Option (D) is correct.

Since volume of cylinder remains same. Therefore

$$\text{Volume before forging} = \text{Volume after forging}$$
$$\pi\frac{d_1^2}{4} \times h_1 = \pi\frac{d_2^2}{4} \times h_2$$
$$\pi \times \frac{100^2}{4} \times 50 = \pi \times \frac{d_2^2}{4} \times 25$$
$$d_2^2 = (100)^2 \times 2$$
$$d_2 = 100 \times \sqrt{2} = 141.42$$

Percentage change in diameter

$$= \frac{d_2 - d_1}{d_1} \times 100 = \frac{141.42 - 100}{100} \times 100$$

$$\% \text{ change in } (d) = 41.42\%$$

SOL 10.7 Option (C) is correct.

$$\text{Shear strain rate} = \frac{\cos\alpha}{\cos(\phi - \alpha)} \times \frac{V}{\Delta y}$$

Where

$$\alpha = \text{Rake angle} = 10^\circ$$

$$V = \text{cutting speed} = 2.5 \text{ m/s}$$

$$\Delta y = \text{Mean thickness of primary shear zone}$$

$$= 25 \text{ microns} = 25 \times 10^{-6} \text{ m}$$

$$\phi = \text{shear angle}$$

Shear angle,

$$\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha}$$

where $r =$ chip thickness ratio $= 0.4$

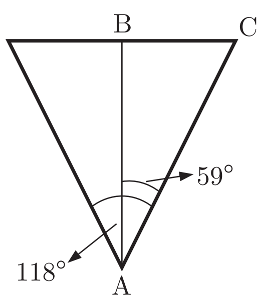
$$\tan\phi = \frac{0.4 \times \cos 10^\circ}{1 - 0.4\sin 10^\circ} = 0.4233$$

$$\phi = \tan^{-1}(0.4233) \cong 23^\circ$$

$$\text{Shear Strain rate} = \frac{\cos 10^\circ}{\cos(23 - 10)} \times \frac{2.5}{25 \times 10^{-6}} = 1.0104 \times 10^5 \, s^{-1}$$

SOL 10.8 Option (A) is correct.

Drill bit tip is shown as below.



$$BC = \text{radius of hole or drill bit } (R) = \frac{15}{2} = 7.5 \text{ mm}$$

From ΔABC

$$\tan 59^\circ = \frac{BC}{AB} = \frac{7.5}{AB}$$

$$AB = \frac{7.5}{\tan 59^\circ} = 4.506 \text{ mm}$$

Travel distance of drill bit

$l =$ thickness of steel plate (t) + clearance at approach + clearance at exit + AB

$$= 50 \text{ mm} + 2 + 2 + 4.506 = 58.506 \text{ mm}$$

$$\text{Total drill time} = \frac{\text{distan ce}}{\text{feed rate}}$$

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$$f = 0.2\,\text{mm/rev} = \frac{0.2 \times \text{rpm}}{60} = \frac{0.2 \times 500}{60} = 1.66\,\text{mm/s}$$

Hence drill time, $t = \frac{58.506}{1.60} = 35.1\,\text{sec.}$

SOL 10.9 Option (A) is correct.

Punch diameter, $d = D - 2c - a$

where D = Blank diameter = 25 mm

c = Clearance = 0.06 mm

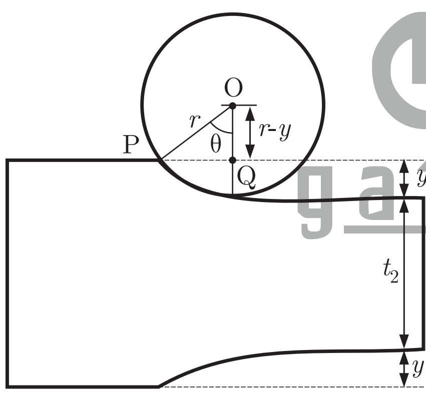
a = Die allowance = 0.05 mm

Hence, $d = 25 - 2 \times 0.06 - 0.05 = 24.83\,\text{mm}$

SOL 10.10 Option (C) is correct.

Given : $t_1 = 8\,\text{mm},\ d = 410\,\text{mm},\ r = 205\,\text{mm}$

Reduction of thickness, $\Delta t = 10\%\text{ of } t_1 = \frac{10}{100} \times 8 = 0.8\,\text{mm}$



$$y = \frac{\Delta t}{2} = 0.4\,\text{mm}$$

From ΔOPQ, $\cos\theta = \left(\frac{r - y}{r}\right)$

$$= \left[\frac{205 - 0.4}{205}\right] = 0.99804$$

$$\theta = \cos^{-1}(0.99804) = 3.58^\circ$$

Angle of bite in radians is

$$\theta = 3.58 \times \frac{\pi}{180}\,\text{rad} = 0.062\,\text{rad.}$$

Alternate Method :

Angle of bite, $\theta = \tan^{-1}\left[\sqrt{\frac{t_i - t_f}{r}}\right]$

Where, t_i = Initial thickness = 8 mm

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$$t_f = \text{Final reduced thickness} = 8 - 8 \times \frac{10}{100} = 7.2 \text{ mm}$$

$$r = \text{radius of roller} = \frac{410}{2} = 205 \text{ mm}$$

$$\theta = \tan^{-1}\left[\sqrt{\frac{8-7.2}{205}}\right] = 3.5798^\circ$$

And in radians, $\theta = 3.5798 \times \frac{\pi}{180} = 0.0624$ rad.

SOL 10.11 Option (C) is correct.

From power source characteristic,

$$\frac{V}{OCV} + \frac{I}{SCC} = 1 \qquad \text{...(i)}$$

where, V = Voltage

OCV = Open circuit voltage

SCC = Short circuit current

I = Current.

From voltage arc length characteristic

$$V_{arc} = 20 + 5l$$

For $l_1 = 5$ mm, $V_1 = 20 + 5 \times 5 = 45$ V

For $l_2 = 7$ mm, $V_2 = 20 + 5 \times 7 = 55$ V

and $I_1 = 500$ Amp. and $I_2 = 400$ Amp.

Substituting these value in Eq. (i)

$$\frac{V_1}{OCV} + \frac{I_1}{SCC} = 1$$

$$\frac{45}{OCV} + \frac{500}{SCC} = 1 \qquad \text{...(ii)}$$

$$\frac{V_2}{OCV} + \frac{I_2}{SCC} = 1 \quad \Rightarrow \quad \frac{55}{OCV} + \frac{400}{SCC} = 1 \qquad \text{...(iii)}$$

Solving Eq. (ii) and (iii), we get

$$OCV = 95 \text{ V}$$

$$SCC = 950 \text{ Amp.}$$

SOL 10.12 Option (A) is correct.

The main objective in rolling is to decrease the thickness of the metal.

The relation for the rolling is given by

$$F = \mu P_r$$

Where ; F = tangential frictional force

μ = Coefficient of friction

P_r = Normal force between the roll and work piece

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Now, from the increase in μ, the draft in cold rolling of sheet increases.

SOL 10.13 Option (C) is correct.
If the pores in a sintered compact are filled with an oil, the operation is called as impregnation. The lubricants are added to the porous bearings, gears and pump rotors etc.

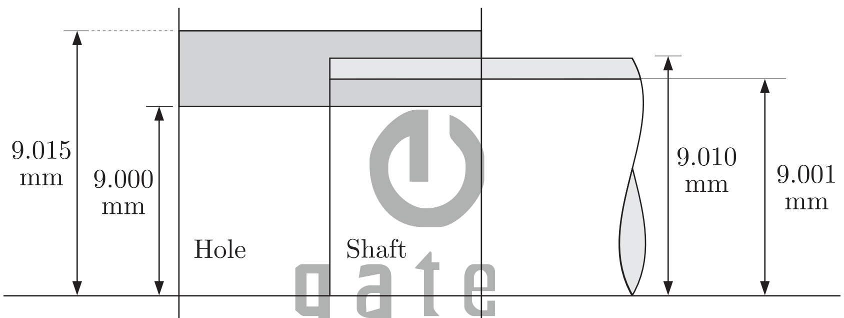
SOL 10.14 Option (C) is correct.
In transition fit, the tolerance zones of holes and shaft overlap.

Upper limit of hole $= 9 + 0.015 = 9.015\,\text{mm}$

Lower limit of hole $= 9 + 0.000 = 9.000\,\text{mm}$

Upper limit of shaft $= 9 + 0.010 = 9.010\,\text{mm}$

Lower limit of shaft $= 9 + 0.001 = 9.001\,\text{mm}$



Now, we can easily see from figure dimensions that it is a transition fit.

SOL 10.15 Option (D) is correct.
A green sand mould is composed of a mixture of sand (silica sand, SiO_2), clay (which acts as binder) and water.
The word green is associated with the condition of wetness or freshness and because the mould is left in the damp condition, hence the name " green sand mould".

SOL 10.16 Option (C) is correct.
GTAW is also called as Tungsten Inert Gas Welding (TIG). The arc is maintained between the work piece and a tungsten electrode by an inert gas. The electrode is non-consumable since its melting point is about 3400°C.

SOL 10.17 Option (B) is correct.
Austenite is a solid solution of carbon in γ-iron. It has F.C.C structure. It has a solid solubility of upto 2% C at 1130°C.

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SOL 10.18 Option (B) is correct.

Given : $\alpha = 12^\circ$, $t = 0.81\text{ mm}$, $t_c = 1.8\text{ mm}$

Shear angle, $$\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha} \qquad ...(i)$$

Chip thickness ratio, $$r = \frac{t}{t_c} = \frac{0.81}{1.8} = 0.45$$

From equation (i), $$\tan\phi = \frac{0.45\cos 12^\circ}{1 - 0.45\sin 12^\circ}$$

$$\phi = \tan^{-1}(0.486) = 25.91^\circ \simeq 26^\circ$$

SOL 10.19 Option (A) is correct.

	Machining process		**Mechanism of material removal**
P.	Chemical machining	**2.**	Corrosive reaction
Q.	Electro-chemical machining	**3.**	Ion displacement
R.	Electro-discharge machining	**4.**	Fusion and vaporization
S.	Ultrasonic machining	**1.**	Erosion

So, correct pairs are, P-2, Q-3, R-4, S-1

SOL 10.20 Option (A) is correct.

Given : $a = 50\text{ mm}$, $V = a^3 = (50)^3 = 125000\text{ mm}^3$

Firstly side undergoes volumetric solidification shrinkage of 4%.

So, Volume after shrinkage,

$$V_1 = 125000 - 125000 \times \frac{4}{100} = 120000\text{ mm}^3$$

After this, side undergoes a volumetric solid contraction of 6%.

So, volume after contraction,

$$V_2 = 120000 - 120000 \times \frac{6}{100} = 112800\text{ mm}^3$$

Here V_2 is the combined volume after shrinkage and contraction.

Let at volume V_2, side of cube is b.

So, $$b^3 = 112800 = \sqrt[3]{112800} = 48.32\text{ mm}$$

SOL 10.21 Option (C) is correct.

Given : $\tau = 300\text{ MPa}$, $D = 100\text{ mm}$, $t = 1.5\text{ mm}$

Blanking force $$F_b = \tau \times \text{Area} = \tau \times \pi D t$$

$$F_b = 300 \times 10^6 \times 3.14 \times 100 \times 1.5 \times 10^{-6}$$

$$= 141300\text{ N} = 141.3\text{ kN} \simeq 141\text{ kN}$$

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SOL 10.22 Option (C) is correct.
Fracture strength be a material property which depends on the basic crystal structure. Fracture strength depends on the strength of the material.

SOL 10.23 Option (A) is correct.
Gate Ratio is defined as the ratio of sprue base area, followed by the total runner area and the total ingate area. The sprue base area is taken is unity.
So, $1:2:4 = \text{Sprue base area : Runner area : Total ingate area}$

SOL 10.24 Option (D) is correct.
We know that, shaft tolerance

$$= \text{Upper limit of shaft} - \text{Lower limit of shaft}$$
$$= (35 - 0.009) - (35 - 0.025) = 34.991 - 34.975 = 0.016$$

Fundamental deviation for basic shaft is lower deviation.

$$= -0.009$$

SOL 10.25 Option (C) is correct.
GO2 represent circular interpolation in clockwise direction.
G91 represent incremental dimension.

SOL 10.26 Option (A) is correct.
For Tool A, $n = 0.45$, $K = 90$
For Tool B, $n = 0.3$, $K = 60$
Now, From the Taylor's tool life equation ($VT^n = K$)
For Tool A, $V_A T_A^{0.45} = 90$ ...(i)
For Tool B, $V_B T_B^{0.3} = 60$ ...(ii)
Dividing equation (i) by equation (ii), we get

$$\left(\frac{V_A}{V_B}\right) \times \frac{T_A^{0.45}}{T_B^{0.3}} = \frac{90}{60} \quad \text{...(iii)}$$

Let V is the speed above which tool A will have a higher life than B. But at V, $T_A = T_B$

Then $V_A = V_B = V(\text{let})$
$T_A = T_B = T(\text{let})$

So, from equation(iii) $\frac{T^{0.45}}{T^{0.3}} = \frac{3}{2} \Rightarrow T^{0.45-0.3} = \frac{3}{2}$

$$T = \left(\frac{3}{2}\right)^{\frac{1}{0.15}} = 14.92 \text{ min}.$$

From equation (i), $V \times T^{0.45} = 90$

$$V \times (14.92)^{0.45} = 90$$

$$V = 26.67 \text{ m/min} \simeq 26.7 \text{ m/min}$$

SOL 10.27 Option (C) is correct.

Given: $d_i = 100$ mm, $d_o = 110$ mm, $V = 30$ Volt, $R = 42.4\,\Omega$, $E_u = 64.4$ MJ/m^3

Each pipe melts 1 mm of material. So, thickness of material melt, $t = 2 \times 1 = 2$ mm

Melting energy in whole volume is given by

$$Q = \text{Area} \times \text{thickness} \times E_u = \frac{\pi}{4}(d_o^2 - d_i^2) \times t \times E_u$$

$$Q = \frac{\pi}{4}[(110)^2 - (100)^2] \times 10^{-6} \times 2 \times 10^{-3} \times 64.4 \times 10^6$$

$$= 212.32 \text{ J} \qquad \text{...(i)}$$

The amount of heat generated at the contacting area of the element to be weld is,

$$Q = I^2 Rt = \frac{V^2}{R}t \qquad I = \frac{V}{R}$$

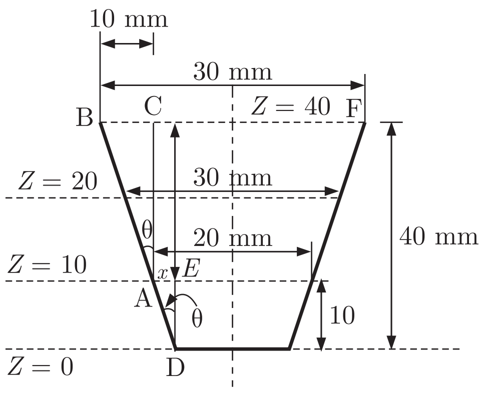
$$t = \frac{Q \times R}{V^2}$$

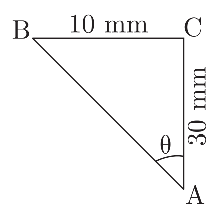
Substitute the values, we get

$$t = \frac{212.32 \times 42.4}{(30)^2} = 10 \text{ sec}$$

SOL 10.28 Option (A) is correct

Draw a perpendicular from the point A on the line BF, which intersect at point C.





Let Angle $\angle BAC = \theta$

$$AE = x$$

Now, take the right angle triangle ΔABC,

$$\tan\theta = \frac{BC}{AC} = \frac{10}{30} = \frac{1}{3} \qquad \text{...(i)}$$

From the same triangle ΔADE,

$$\tan\theta = \frac{x}{DE} = \frac{x}{10}$$

Put the value of $\tan\theta$, from the equation (i),

So, $$\frac{1}{3} = \frac{x}{10} \Rightarrow x = \frac{10}{3}\,\text{mm} = 3.333\,\text{mm}$$

Now, diameter at $Z = 0$ is,

$$d = 20 - 2x = 20 - 2 \times 3.333 = 13.334\,\text{mm}$$

SOL 10.29 Option (B) is correct.

Given : $t = 5\,\text{mm}$, $L = 200\,\text{mm}$, $\tau_s = 100\,\text{MPa}$

Penetration to thickness ratio $\frac{p}{t} = 0.2 = k$

Force vs displacement curve to be rectangle,

So, Shear area, $A = (200 + 200) \times 5 = 2000\,\text{mm}^2$

Work done, $W = \tau \times A \times k \times t$

Substitute the values, we get

$$W = 100 \times 10^6 \times 2000 \times 10^{-6} \times 0.2 \times 5 \times 10^{-3}$$
$$= 100 \times 2 \times 0.2 \times 5 = 200\,\text{Joule}$$

SOL 10.30 Option (B) is correct.

Given : Shear $S = 20\,\text{mm}$

Now force vs displacement curve to be trapezoidal.

So, maximum force is given by,

$$F_{max} = \frac{W}{(kt + \text{Shear})} = \frac{200}{(0.2 \times 5 + 20) \times 10^{-3}}$$
$$= \frac{200}{21} \times 10^{-3} = 9.52 \times 10^3 \simeq 10\,\text{kN}$$

SOL 10.31 Option (D) is correct.

The cutting forces decrease with an increase in cutting speed, but it is substantially smaller than the increase in speed. With the increase in speed, friction decreases at the tool chip interface. The thickness of chip reduces by increasing the speed.

SOL 10.32 Option (A) is correct.

Two streams of liquid metal which are not hot enough to fuse properly result into a casting defect known as cold shut. This defect is same as in sand mould casting. The reasons are :-

(i) Cooling of die or loss of plasticity of the metal.

(ii) Shot speed less.

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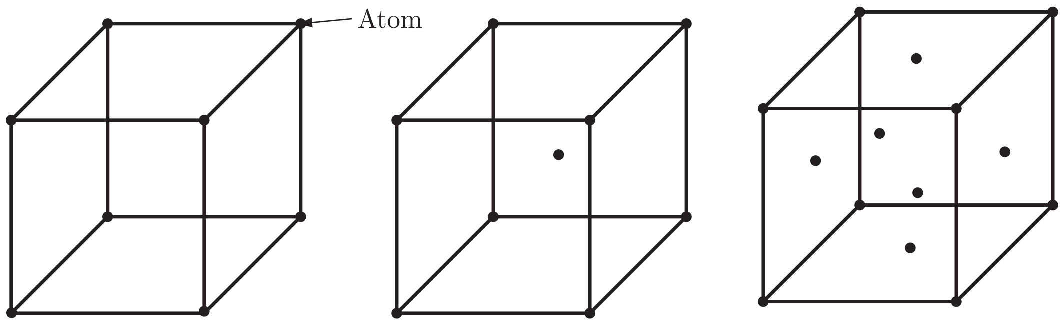
(iii) Air-vent or overflow is closed.

SOL 10.33 Option (B) is correct.



(i) Simple Cubic

Effective no. of Lattice

$\frac{1}{8}\times 8 = 1$

(ii) BCC

Effective no. of Lattice

$\frac{1}{8}\times 8 + 1 = 2$

(iii) FCC

Effective no. of Lattice

$\frac{1}{8}\times 8 + \frac{1}{2}\times 6 = 4$

SOL 10.34 Option (C) is correct.

Correct data structure for solid models is given by,

Vertices $\rightarrow$ edges $\rightarrow$ faces $\rightarrow$ solid parts

SOL 10.35 Option (D) is correct.

Given : $\alpha = 0^\circ$

We know that, shear strain

$$s = \cot\phi + \tan(\phi - \alpha) \qquad \alpha = 0^\circ$$

So,
$$s = \cot\phi + \tan\phi \qquad \text{...(i)}$$

For minimum value of shear strain differentiate equation (i) w.r.t. ϕ

$$\frac{ds}{d\phi} = \frac{d}{d\phi}(\cot\phi + \tan\phi) = -\operatorname{cosec}^2\phi + \sec^2\phi \qquad \text{...(ii)}$$

Again differentiate w.r.t. to ϕ,

$$\frac{d^2 s}{d\phi^2} = -2\operatorname{cosec}\phi \times (-\operatorname{cosec}\phi\cot\phi) + 2\sec\phi \times (\sec\phi\tan\phi)$$

$$= +2\operatorname{cosec}^2\phi\cot\phi + 2\sec^2\phi\tan\phi \qquad \text{.....(iii)}$$

Using the principle of minima - maxima and put $\frac{ds}{d\phi} = 0$ in equation(ii)

$$-\operatorname{cosec}^2 + \sec^2\phi = 0$$

$$-\frac{1}{\sin^2\phi} + \frac{1}{\cos^2\phi} = 0$$

$$\frac{\cos^2\phi - \sin^2\phi}{\sin^2\phi \times \cos^2\phi} = 0$$

$$\cos^2\phi - \sin^2\phi = 0$$

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$$\cos 2\phi = 0$$

$$2\phi = \cos^{-1}(0) = \frac{\pi}{2}$$

$$\phi = \frac{\pi}{4}$$

From equation (iii), at $\phi = \frac{\pi}{4}$

$$\left(\frac{d^2 s}{d\phi^2}\right)_{\phi=\frac{\pi}{4}} = 2\,\mathrm{cosec}^2\frac{\pi}{4} \times \cot\frac{\pi}{4} + 2\sec^2\frac{\pi}{4}\tan\frac{\pi}{4}$$

$$\left(\frac{d^2 s}{d\phi^2}\right)_{\phi=\frac{\pi}{4}} = 2 \times 2 \times 1 + 2 \times 2 \times 1 = 8$$

$$\left(\frac{d^2 s}{d\phi^2}\right)_{\phi=\frac{\pi}{4}} > 0$$

Therefore it is minimum at $\phi = \frac{\pi}{4}$, so from equation (i),

$$(s)_{\min} = \cot\frac{\pi}{4} + \tan\frac{\pi}{4} = 1 + 1 = 2$$

SOL 10.36 Option (A) is correct.

Given : $L = 0.2\,\text{mm},\ A = 20\,\text{mm} \times 20\,\text{mm} = 400\,\text{mm}^2,\ V = 12\,\text{Volt}$

$\rho = 2\,\Omega\text{cm} = 2 \times 10\,\Omega\,\text{mm},\ Z = 55.85,\ v = 2,\ F = 96540$ Coulombs

We know that Resistance is given by the relation

$$R = \frac{\rho L}{A} = \frac{2 \times 10 \times 0.2}{20 \times 20} = 0.01\,\Omega$$

$$I = \frac{V}{R} = \frac{12}{0.01} = 1200\,\text{A}$$

Rate of mass removal $\dot{m} = \frac{I}{F} \times \frac{Z}{v} = \frac{1200}{96540} \times \frac{55.85}{2} = 0.3471\,\text{g/sec}$

SOL 10.37 Option (C) is correct.

	NC code		Definition
P.	M05	3.	Spindle stop
Q.	G01	4.	Linear interpolation
R.	G04	2.	Dwell
S.	G09	1.	Absolute coordinate system

So, correct pairs are, P-3, Q-4, R-2, S-1

SOL 10.38 Option (A) is correct.

Since diameter 60 lies in the diameter step of $50 - 80\,\text{mm}$, therefore the geometric mean diameter.

$$D = \sqrt{50 \times 80} = 63.246\,\text{mm}$$

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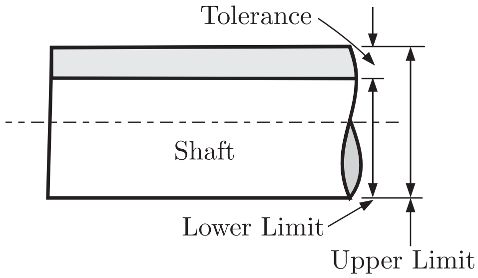

Fundamental tolerance unit.

$$i = 0.45D^{1/3} + 0.001D = 0.45(63.246)^{1/3} + 0.001 \times 63.246$$
$$= 1.856\,\mu\text{m} = 0.00186\text{ mm}$$

Standard tolerance for the hole of grades 8 (IT8)

$$= 25i = 25 \times 0.00186 = 0.0465\text{ mm}$$

Fundamental deviation for 'f' shaft

$$e_f = -5.5D^{0.41} = -5.5(63.246)^{0.41}$$
$$= -30.115\,\mu\text{m} = -0.030115\text{ mm}$$

Upper limit of shaft = Basic size + Fundamental deviation

$$= 60 - 0.030115 = 59.970\text{ mm}$$

Lower limit of shaft = Upper limit − Tolerance = 59.970 − 0.0465

$$= 59.924$$

SOL 10.39 Option (D) is correct.

	Column I		Column II
P.	Metallic Chills	**4.**	Progressive solidification
Q.	Metallic Chaplets	**1.**	Support for the core
R.	Riser	**2.**	Reservoir of the molten metal
S.	Exothermic Padding	**3.**	Control cooling of critical sections

So, correct pairs are P-4, Q-1, R-2, S-3

SOL 10.40 Option (A) is correct.

Given : $V_1 = 60\text{ m/min}$, $T_1 = 81\text{ min}$, $V_2 = 90\text{ m/min}$, $T_2 = 36\text{ min}$.

From the Taylor's tool life Equation

$$VT^n = \text{Constant (K)}$$

For case (I), $V_1 T_1^n = \text{K}$

$$60 \times (81)^n = \text{K} \quad \text{...(i)}$$

For case (II), $V_2 T_2^n = \text{K}$

$$90 \times (36)^n = \text{K} \quad \text{...(ii)}$$

By dividing equation (i) by equation (ii),

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$$\frac{60 \times (81)^n}{90 \times (36)^n} = \frac{K}{K} = 1$$

$$\left(\frac{81}{36}\right)^n = \frac{90}{60}$$

$$\left(\frac{9}{4}\right)^n = \left(\frac{3}{2}\right)$$

Taking (log) both the sides,

$$n\log\left(\frac{9}{4}\right) = \log\left(\frac{3}{2}\right)$$

$$n \times 0.3522 = 0.1760$$

$$n = 0.5$$

Substitute $n = 0.5$ in equation (i), we get

$$K = 60 \times (81)^{0.5} = 540$$

So, $n = 0.5$ and $K = 540$

SOL 10.41 Option (C) is correct.

Take, $n = 0.5$ {from previous part}

From Taylor's tool life equation

$$VT^n = C$$

$$VT^{0.5} = C$$

$$V = \frac{1}{\sqrt{T}} \qquad \text{...(i)}$$

Given that cutting speed is halved

$$V_2 = \frac{1}{2} V_1 \qquad \Rightarrow \frac{V_2}{V_1} = \frac{1}{2}$$

Now, from equation (i),

$$\frac{V_2}{V_1} = \sqrt{\frac{T_1}{T_2}}$$

$$\frac{1}{2} = \sqrt{\frac{T_1}{T_2}}$$

$$\frac{1}{4} = \frac{T_1}{T_2}$$

$$\frac{T_2}{T_1} = 4 \qquad \Rightarrow T_2 = 4T_1$$

Now, percentage increase in tool life is given by

$$= \frac{T_2 - T_1}{T_1} \times 100 = \frac{4T_1 - T_1}{T_1} \times 100$$

$$= \frac{3T_1}{T_1} \times 100 = 300\%$$

SOL 10.42 Option (C) is correct

Coon's surface is obtained by blending four boundary curves. The main advantage of Coon's surface is its ability to fit a smooth surface through digitized points in space such as those used in reverse engineering.

SOL 10.43 Option (C) is correct.

Internal gear cutting operation can be performed by shaping with pinion cutter. In the case of 'rotating pinion type cutter', such an indexing is not required, therefore, this type is more productive and so common.

SOL 10.44 Option (B) is correct.

Since metal shrinks on solidification and contracts further on cooling to room temperature, linear dimensions of patterns are increased in respect of those of the finished casting to be obtained. This is called the "Shrinkage allowance".

The riser can compensate for volume shrinkage only in the liquid or transition stage and not in the solid state.

So, Volume of metal that compensated from the riser $= 3\% + 4\% = 7\%$

SOL 10.45 Option (D) is correct.

Interconversion between ASA (American Standards Association) system and ORS (Orthogonal Rake System)

$$\tan\alpha_s = \sin\phi\tan\alpha - \cos\phi\tan i$$

where
$$\alpha_s = \text{Side rake angle}$$
$$\alpha = \text{orthogonal rake angle}$$
$$\phi = \text{principle cutting edge angle} = 0 \le \phi \le 90^\circ$$
$$i = \text{inclination angle } (i = 0 \text{ for ORS})$$
$$\alpha_s = \alpha \text{ (Given)}$$
$$\tan\alpha_s = \sin\phi\tan\alpha - \cos\phi\tan(0^\circ)$$
$$\tan\alpha_s = \sin\phi\tan\alpha$$
$$\frac{\tan\alpha_s}{\tan\alpha} = \sin\phi$$
$$1 = \sin\phi$$
$$\phi = \sin^{-1}(1) = 90^\circ$$

SOL 10.46 Option (B) is correct.

Given : $\rho = 6000\text{ kg/m}^3 = 6\text{ gm/cm}^3,\ F = 96500\text{ coulomb/mole}$

$MRR = 50\text{ mm}^3\text{/s} = 50\times10^{-3}\text{ cm}^3\text{/s},\ I = 2000\text{ A}$

For Iron : Atomic weight $= 56$

Valency $= 2$

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For Metal P:Atomic weight $= 24$

Valency $= 4$

The metal Removal rate

$$MRR = \frac{eI}{F\rho}$$

$$50 \times 10^{-3} = \frac{e \times 2000}{96500 \times 6}$$

$$e = \frac{50 \times 10^{-3} \times 96500 \times 6}{2000} = 14.475$$

Let the percentage of the metal P in the alloy is x.

So,
$$\frac{1}{e} = \frac{100 - x}{100} \times \frac{V_{Fe}}{A_{t_{Fe}}} + \frac{x}{100} \times \frac{V_P}{A_{tP}}$$

$$\frac{1}{14.475} = \frac{100 - x}{100} \times \frac{2}{56} + \frac{x}{100} \times \frac{4}{24}$$

$$\frac{1}{14.475} = \left(1 - \frac{x}{100}\right)\frac{1}{28} + \frac{x}{100} \times \frac{1}{6}$$

$$\frac{1}{14.475} = x\left[\frac{1}{600} - \frac{1}{2800}\right] + \frac{1}{28}$$

$$\frac{1}{14.475} - \frac{1}{28} = x \times \frac{11}{8400}$$

$$\frac{541}{16212} = \frac{11x}{8400}$$

$$x = \frac{541 \times 8400}{16212 \times 11} \simeq 25$$

SOL 10.47 Option None of these.

Given : $t_i = 20\,\text{mm}$, $t_f = 18\,\text{mm}$, $b = 100\,\text{mm}$,
$R = 250\,\text{mm}$, $N = 10\,\text{rpm}$, $\sigma_0 = 300\,\text{MPa}$

We know, Roll strip contact length is given by,

$$L = \theta \times R = \sqrt{\frac{t_i - t_f}{R}} \times R$$

$$= \sqrt{R(t_i - t_f)}$$

So,
$$L = \sqrt{250 \times 10^{-3}(20 - 18)10^{-3}}$$

$$= 22.36 \times 10^{-3}$$

Rolling load,
$$F = Lb\sigma_0$$

$$= 22.36 \times 10^{-3} \times 100 \times 10^{-3} \times 300 \times 10^6$$

$$= 670.8\,\text{kN}$$

Power
$$P = F \times v = 670.8 \times \left(\frac{\pi DN}{60}\right)$$

$$= 670.8 \times \left(\frac{3.14 \times 0.5 \times 10}{60}\right) = 175.5\,\text{kW}$$

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SOL 10.48 Option (B) is correct.

Given : $\eta_m = 0.5$, $\eta_h = 0.7$, $A = 5\,\text{mm}^2$, $E_u = 10\,\text{J/mm}^3$, $P = 2\,\text{kW}$, $V\,(\text{mm/s}) = ?$

Total energy required to melt,

$$E = E_u \times A \times V = 10 \times 5 \times v = 50\,\text{VJ/sec}$$

Power supplied for welding,

$$P_s = P \times \eta_h \times \eta_m = 2 \times 10^3 \times 0.5 \times 0.7 = 700\,\text{W}$$

From energy balance,

Energy required to melt = Power supplied for welding

$$50V = 700 \qquad \Rightarrow \qquad V = 14\,\text{mm/sec}$$

SOL 10.49 Option (A) is correct.

Seamless cylinders and tubes can be made by hot drawing or cupping.

The thickness of the cup is reduced and its length increased by drawing it through a series of dies having reduced clearance between the die and the punch. Due to reduction in its thickness, blanks shows a tendency to wrinkle up around the periphery because of buckling due to circumferential compression an due to this compression blank holder pressure increases.

SOL 10.50 Option (C) is correct.

The feed drive serves to transmit power from the spindle to the second operative unit of the lathe, that is, the carriage. It, thereby converts the rotary motion of the spindle into linear motion of the carriage.

So, Q and E are connected & U_s is placed between Q and E.

SOL 10.51 Option (C) is correct.

A dial indicator (gauge) or clock indicator is a very versatile and sensitive instrument. It is used for :

(i) determining errors in geometrical form, for example, ovality, out-of roundness, taper etc.

(ii) determining positional errors of surface

(iii) taking accurate measurements of deformation.

Here equal deflections are shown in both the sensor P and sensor Q. So drill spindle rotational axis is parallel to the drill spindle tape hole axis.

SOL 10.52 Option (D) is correct.

Given : $\tau_s = 250\,\text{MPa}$, $V = 180\,\text{m/min}$, $f = 0.20\,\text{mm/rev}$

$d = 3\,\text{mm}$, $r = 0.5$, $\alpha = 7^\circ$

We know from merchant's theory,

Shear plane angle $\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha} = \frac{0.5\cos 7^\circ}{1 - 0.7\sin 7^\circ} = \frac{0.496}{0.915} = 0.54$

$$\phi = \tan^{-1}(0.54) = 28.36 \simeq 28^\circ$$

Average stress on the shear plane area are

$$\tau_s = \frac{F_s}{A_s} \qquad \Rightarrow F_s = \tau_s \times A_s$$

where, A_s is the shear plane area $= \frac{bt}{\sin\phi}$

for orthogonal operation $b \cdot t = d \cdot f$

So, $F_s = \frac{\tau_s \times d \times f}{\sin\phi} = \frac{250 \times 3 \times 0.20}{\sin 28^\circ} = 319.50 \simeq 320\text{ N}$

SOL 10.53 Option (B) is correct.

Now we have to find cutting force (F_c) and frictional force (F_t).

From merchant's theory, $2\phi + \beta - \alpha = 90^\circ$

$$\beta = 90^\circ + \alpha - 2\phi = 90^\circ + 7 - 2 \times 28 = 41^\circ$$

We know that

$$\frac{F_c}{F_s} = \frac{\cos(\beta - \alpha)}{\cos(\phi + \beta - \alpha)} \qquad F_s = \text{Share force}$$

$$F_c = 320 \times \frac{\cos(41^\circ - 7^\circ)}{\cos(28^\circ + 41^\circ - 7^\circ)} = 320 \times 1.766 \simeq 565\text{ N}$$

And $F_s = F_c\cos\phi - F_t\sin\phi$

So, $F_t = \frac{F_c\cos\phi - F_s}{\sin\phi} = \frac{565 \times \cos 28^\circ - 320}{\sin 28^\circ} = \frac{178.865}{0.47}$

$$= 381.56\text{ N} \simeq 381\text{ N}$$

SOL 10.54 Option (B) is correct.

Given : $N = 200$ step/rev., $p = 4$ mm, $U = \frac{1}{4}$, $f = 10000$ Pulse/min.

In a CNC machine basic length unit (BLU) represents the smallest distance.

Revolution of motor in one step $= \frac{1}{200}$ rev./step

Movement of lead screw $= \frac{1}{200} \times \frac{1}{4} = \frac{1}{800}$ rev. of load screw

Movement from lead screw is transferred to table.

i.e. Movement of table $= \frac{1}{800} \times \text{Pitch} = \frac{1}{800} \times 4 = \frac{1}{200}$

$$= 0.005 = 5\text{ microns.}$$

SOL 10.55 Option (C) is correct.

We know BLU = Revolution of motor $\times$ Gear ratio $\times$ pitch

$$= \frac{1}{200} \times \frac{1}{2} \times 4 = \frac{1}{100} = 10 \text{ micros}$$

We see that f is unchanged and value of Gear ratio is changed by 1/2.

SOL 10.56 Option (B) is correct.

The carbon alloy having less than 2% carbon are called "steels" and those containing over 2% carbon are called cast irons.

Now, steel may further be classified into two groups.

(i) Steels having less than 0.83% carbon are called "hypo-eutectoid steels"

(ii) Those having more than 0.83% carbon called "hyper-eutectoid steels"

SOL 10.57 Option (D) is correct.

The hot chamber die casting process is used for low melting temperature alloys.

Tin is a low melting temperature alloy.

SOL 10.58 Option (C) is correct.

Friction welding is defined as " A solid state welding process wherein coalescence is produced by heat obtained from mechanically induced sliding motion between rubbing surfaces.

SOL 10.59 Option (B) is correct.

Given : $D = 150$ mm, $V = 90$ m/min, $f = 0.24$ mm/rev.

$d = 2$ mm, $t_c = 0.48$ mm, $\alpha = 0°$, $\lambda = 90°$

Uncut chip thickness, $t = f \sin\lambda = 0.24 \times \sin 90° = 0.24$ mm

Chip thickness ratio, $r = \dfrac{t}{t_c} = \dfrac{0.24}{0.48} = \dfrac{1}{2}$

From merchant's theory,

Shear angle, $\tan\phi = \dfrac{r\cos\alpha}{1 - r\sin\alpha} = \dfrac{0.5\cos 0°}{1 - 0.5 \times \sin 0°} = 0.5$

$$\phi = \tan^{-1}(0.5) = 26.56°$$

SOL 10.60 Option (C) is correct.

A spindle motor is a small, high precision, high reliability electric motor that is used to rotate the shaft or spindle used in machine tools for performing a wide rang of tasks like drilling, grinding, milling etc.

A stepper motor have not all these characteristic due to change of direction of rotation with time interval.

SOL 10.61 Option (D) is correct.

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According to Caine's relation

Solidification time, $(T) = q\left(\frac{V}{A}\right)^2$

Where : $V =$ Volume, $A =$ Surface area, $Q =$ Flow rate

q = constant of proportionality depends upon composition of cast metal

Using the subscript c for the cube and subscript s for the sphere.

Given : $V_c = V_s$ So, $T \propto \frac{1}{A^2}$

So, $$\frac{T_c}{T_s} = \left(\frac{A_s}{A_c}\right)^2 = \left(\frac{4\pi r^2}{6l^2}\right)^2 = \left(\frac{4\pi}{6}\right)^2\left(\frac{r}{l}\right)^4$$

SOL 10.62 Question (A) is correct.

Metal removel rate depends upon current density and it increases with current. The MRR increase with thermal conductivity also

$$\text{Wear ratio} = \frac{\text{Volume of metal removed work}}{\text{Volume of metal removed tool}}$$

The volume of metal removed from the tool is very less compare to the volume of metal removed from the work.

So, Wear ration $\propto$ volume of metal removed work.

Hence, both the wear rate and MRR are expected to be high.

SOL 10.63 Option (D) is correct.

Given : $E = 2\text{ J/mm}^3$, $V = 120\text{ m/min}$, $f = 0.2\text{ mm/rev.} = t$, $d = 2\text{ mm} = b$

The specific energy. $E = \frac{F_c}{b \cdot t}$

In orthogonal cutting $b \times t = d \times f$

$$F_c = E \times b \times t = E \times d \times f$$

$$= 2 \times 10^9 \times 2 \times 10^{-3} \times 0.2 \times 10^{-3} = 800\text{ N}$$

SOL 10.64 Option (A) is correct.

Given : OCV $= 80$ V, SCC $= 800$ A

In Case (I) : $I = 500$ A and $L = 5.0$ mm

And in, Case (II) : $I = 460$ A, and $L = 7.0$ mm

We know that, for welding arc,

$$E = a + bL \qquad \text{...(i)}$$

And For power source,

$$E = \text{OCV} - \left(\frac{\text{OCV}}{\text{SCC}}\right)I = 80 - \left(\frac{80}{800}\right)I \qquad \text{...(ii)}$$

Where : $I =$ Arc current, $E =$ Arc voltage

For stable arc,

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$$\text{Welding arc} = \text{Power source}$$

$$80 - \left(\frac{80}{800}\right)I = a + bL \qquad \text{...(iii)}$$

Find the value of a & b, from the case (I) & (II)

For case (I), $I = 500\text{ A},\ L = 5\text{ mm}$

So, $$80 - \left(\frac{80}{800}\right) \times 500 = a + 5b \qquad \text{From equation (iii)}$$

$$80 - 50 = a + 5b$$

$$a + 5b = 30 \qquad \text{...(iv)}$$

For case II, $I = 460\text{ A},\ L = 7\text{ mm}$

So, $$80 - \frac{80}{800} \times 460 = a + 7b \qquad \text{From equation(iii)}$$

$$80 - 46 = a + 7b$$

$$a + 7b = 34 \qquad \text{...(v)}$$

Subtracting equation (iv) from equation (v),

$$(a + 7b) - (a + 5b) = 34 - 30$$

$$2b = 4 \qquad \Rightarrow b = 2$$

From equation (iv), put $b = 2$

$$a + 5 \times 2 = 30 \qquad \Rightarrow a = 20$$

Substituting the value of a & b in equation (i), we get

$$E = 20 + 2L$$

SOL 10.65 Option (C) is correct.

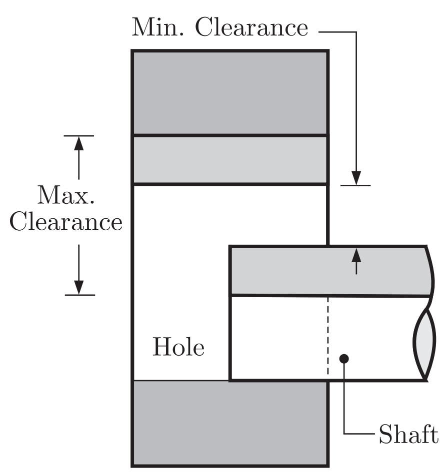
Given : Hole, $40^{+0.050}_{+0.000}$ mm

$$\text{Minimum hole size} = 40\text{ mm}$$

$$\text{Minimum clearance} = 0.01\text{ mm}$$

$$\text{Maximum size of hole} = 40 + 0.050 = 40.050\text{ mm}$$

$$\text{Tolerance of shaft} = 0.04\text{ mm}$$



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Given that the mating shaft has a clearance fit with minimum clearance of 0.01 mm.

So, Maximum size of shaft = Minimum hole size − Minimum clearance

$= 40 - 0.01 = 39.99$ mm

And Minimum size of shaft = Maximum shaft size − Tolerance of shaft

$= 39.99 - 0.04 = 39.95$

Maximum clearance,

c = Maximum size of hole − Minimum size of shaft

$= 40.050 - 39.95 = 0.1$ mm

SOL 10.66 Option (C) is correct

Given : $\lambda = 90^\circ$, $F_c = 1000$ N, $F_t = 800$ N, $\phi = 25^\circ$, $\alpha = 0^\circ$

We know that, from the merchant's theory,

$$\frac{\text{Friction force } (F)}{\text{Normal force } (N)} = \mu = \frac{F_c \tan\alpha + F_t}{F_c - F_t \tan\alpha}$$

Substitute the values, we get

$$\frac{F}{N} = \frac{1000 \tan 0^\circ + 800}{1000 - 800 \tan 0^\circ} = \frac{800}{1000} = 0.80$$

SOL 10.67 Option (C) is correct.

Given : $w = 2$ mm, $I = 10$ kA $= 10^4$ A, $t = 10$ milli second $= 10^{-2}$ sec.

$T_a = 293$ K, $T_m = 1793$ K, $\rho = 7000$ kg/m^3, $L_f = 300$ kJ/kg

$c = 800$ J/kg K, $R = 500$ micro - ohm $= 500 \times 10^{-6}$ ohm

Radius of sphere, $r = 2 \text{ mm} = 2 \times 10^{-3}$ m

Heat supplied at the contacting area of the element to be welded is

$$Q_s = I^2 Rt = (10^4)^2 \times 500 \times 10^{-6} \times 10^{-2} = 500 \text{ J}$$

As fusion zone is spherical in shape.

Mass, $m = \rho \times v = 7000 \times \frac{4}{3} \times 3.14 \times (2 \times 10^{-3})^3$

$= 2.344 \times 10^{-4}$ kg

Total heat for melting (heat input)

$$Q_i = mL_f + mc(T_m - T_a)$$

Where mL_f = Latent heat

Substitute the values, we get

$$Q_i = 2.344 \times 10^{-4}[300 \times 10^3 + 800(1793 - 293)]$$

$$= 2.344 \times 10^{-4}[300 \times 10^3 + 800 \times 1500] = 351.6 \text{ J}$$

$$\text{Efficiency } \eta = \frac{\text{Heat input } (Q_i)}{\text{Heat supplied} (Q_s)} \times 100$$

$$\eta = \frac{351.6}{500} \times 100 = 70.32\% \simeq 70.37\%$$

SOL 10.68 Option (C) is correct.

Given : $d_i = 200$ mm, $h_i = l_i = 60$ mm, $d_f = 400$ mm

Volume of disc remains unchanged during the whole compression process.

So, Initial volume = Final volume.

$$\frac{\pi}{4} d_i^2 \times l_i = \frac{\pi}{4} d_f^2 \times l_f$$

$$\frac{l_f}{l_i} = \frac{d_i^2}{d_f^2}$$

$$l_f = 60 \times \left(\frac{200}{400}\right)^2 = 60 \times \frac{1}{4} = 15 \text{ mm}$$

Strain, $$\varepsilon = \frac{\Delta l}{l} = \frac{l_i - l_f}{l_f} = \frac{60 - 15}{15} = 3$$

True strain, $$\varepsilon_0 = \ln(1+\varepsilon) = \ln(1+3) = 1.386$$

SOL 10.69 Option (D) is correct.

Let, Bite angle $= \theta$

$D = 400$ mm, $t_i = 16$ mm, $t_f = 10$ mm

Bite angle, $$\tan\theta = \sqrt{\frac{t_i - t_f}{R}} = \sqrt{\frac{16 - 10}{200}} = \sqrt{0.03}$$

$$\theta = \tan^{-1}(0.173) = 9.815^\circ \simeq 9.936^\circ$$

SOL 10.70 Option (D) is correct.

	Processes		Associated state of stress
P.	Blanking	**3.**	Shear
Q.	Stretch Forming	**1.**	Tension
R.	Coining	**2.**	Compression
S.	Deep Drawing	**4.**	Tension and Compression

So, correct pairs are, P-3, Q-1, R-2, S-4

SOL 10.71 Option (A) is correct.

Blanking force F_b is directly proportional to the thickness of the sheet 't' and diameter of the blanked part 'd'.

$$F_b \propto d \times t \qquad F_b = \tau \times d \times t \quad ...(i)$$

For case (I) : $F_{b1} = 5.0$ kN, $d_1 = d$, $t_1 = t$

For case (II) : $d_2 = 1.5d$, $t_2 = 0.4t$, $F_{b2} = ?$

From equation (i) $$\frac{F_{b2}}{F_{b1}} = \frac{d_2 t_2}{d_1 t_1}$$

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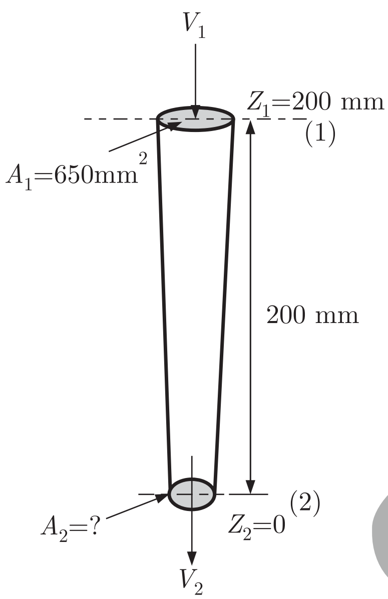
$$F_{b2} = 5 \times \frac{1.5d \times 0.4t}{d \times t} = 3\,\text{kN}$$

SOL 10.72 Option (C) is correct.

Let molten metal enters at section 1st and leaves the object at section 2nd



Given : $A_1 = 650\text{ mm}^2$, $Q = 6.5 \times 10^5\text{ mm}^3/\text{sec}$, $g = 10^4\text{ mm/sec}^2$

Now, for section 1st, flow rate

$$Q = A_1 V_1$$

$$V_1 = \frac{Q}{A_1} = \frac{6.5 \times 10^5}{650} = 1000\text{ mm/sec}$$

Applying Bernoulli's equation at section 1st and 2nd.

$$\frac{p_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{p_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$$

But $p_1 = p_2 = \text{atmosphere pressure}$

So, $$\frac{V_1^2}{2g} + Z_1 = \frac{V_2^2}{2g} + Z_2$$

$$\frac{(1000)^2}{2 \times 10^4} + 200 = \frac{V_2^2}{2 \times 10^4} + 0$$

$$(50 + 200) \times 2 \times 10^4 = V_2^2$$

$$V_2^2 = 500 \times 10^4 = 5 \times 10^6$$

$$V_2 = 2.236 \times 10^3\text{ mm/sec} = 2236\text{ mm/sec}$$

We know that, flow rate remains constant during the process (from continuity equation). So, for section 2nd

$$Q = A_2 V_2$$

$$A_2 = \frac{Q}{V_2} = \frac{6.5 \times 10^5}{2236} = 290.7 \text{ mm}^2$$

SOL 10.73 Option (A) is correct.

	Parts		**Manufacturing Process**
P.	Computer chip	**4.**	Photochemical Machining
Q.	Metal forming dies and molds	**3.**	Electrodischarge Machining
R.	Turbine blade	**1.**	Electrochemical Machining
S.	Glass	**2.**	Ultrasonic Machining

So, correct pairs are, P-4, Q-3, R-1, S-2

SOL 10.74 Option (B) is correct.

Given : $T_1 = 24$ min, $T_2 = 12$ min, $V_1 = 90$ m/min, $V_2 = 120$ m/min

We have calculate velocity, when tool life is 20 minute.

First of all we the calculate the values of n, From the Taylor's tool life equation.

$$VT^n = C$$

For case 1st and 2nd, we can write

$$V_1 T_1^n = V_2 T_2^n$$

$$\left(\frac{T_1}{T_2}\right)^n = \frac{V_2}{V_1}$$

$$\left(\frac{24}{12}\right)^n = \frac{120}{90}$$

$$(2)^n = 1.33$$

Taking log both the sides,

$$n \log 2 = \log 1.33$$

$$n \times 0.301 = 0.124$$

$$n = 0.412$$

For V_3, we can write from tool life equation,

$$V_1 T_1^n = V_3 T_3^n$$

$$90 \times (24)^{0.412} = V_3 (20)^{0.412}$$

$$333.34 = V_3 \times 3.435$$

$$V_3 = 97 \text{ m/min}$$

SOL 10.75 Option (C) is correct.

Given : $D = 147$ mm, $l = 630$ mm, $f = 0.2$ mm/rev.

$d = 2$ mm, $V_3 = 97$ m/min

$$\text{Machining time } t = \frac{l}{fN}$$

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$$V = \pi DN \text{ m/ min}$$

So,
$$t = \frac{l \times \pi \times D}{fV}$$

$$t = \frac{0.63 \times 3.14 \times 0.147}{0.2 \times 10^{-3} \times 97} \qquad V = V_3$$

$$t = 15 \text{ min}$$

SOL 10.76 Option (D) is correct.

Investment casting uses an expandable pattern, which is made of wax or of a plastic by molding or rapid prototyping techniques. This pattern is made by injecting molten wax or plastic into a metal die in the shape of the pattern.

SOL 10.77 Option (D) is correct.

Spheroidizing may be defined as any heat treatment process that produces a rounded or globular form of carbide. High carbon steels are spheroidized to improve machinability, especially in continuous cutting operations.

SOL 10.78 Option (A) is correct.

NC contouring is a continuous path positioning system. Its function is to synchronize the axes of motion to generate a predetermined path, generally a line or a circular arc.

SOL 10.79 Option (A) is correct.

Ring gauges are used for gauging the shaft and male components i.e. measure the outside diameter. It does not able to measure the roundness of the given shaft.

SOL 10.80 Option (B) is correct.

Given : $\sigma_u = 400$ MPa, $\frac{\Delta L}{L} = 35\% = 0.35 = \varepsilon_0$

Let, true stress is σ and true strain is ε.

True strain, $\varepsilon = \ln(1+\varepsilon_0) = \ln(1+0.35) = 0.30$

True stress, $\sigma = \sigma_u(1+\varepsilon_0) = 400(1+0.35) = 540$ MPa

We know, at Ultimate tensile strength,

$$n = \varepsilon = 0.3$$

Relation between true stress and true strain is given by,

$$\sigma = K\varepsilon^n \qquad \text{...(i)}$$

$$K = \frac{\sigma}{\varepsilon^n} = \frac{540}{(0.30)^{0.30}} = 774.92 \simeq 775$$

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So, From equation (i) $\sigma = 775\varepsilon^{0.3}$

SOL 10.81 Option (B) is correct.

We know that,Time taken to fill the mould with top gate is given by,

$$t_A = \frac{A_m H_m}{A_g\sqrt{2gH_g}}$$

Where A_m = Area of mould

H_m = Height of mould

A_g = Area of gate

H_g = Height of gate

Given that, total liquid head is maintained constant and it is equal to the mould height.

So, $H_m = H_g$

$$t_A = \frac{A_m\sqrt{H_m}}{A_g\sqrt{2g}} \qquad \text{...(i)}$$

Time taken to fill with the bottom gate is given by,

$$t_B = \frac{2A_m}{A_g\sqrt{2g}} \times (\sqrt{H_g} - \sqrt{H_g - H_m})$$

$$t_B = \frac{2A_m}{A_g\sqrt{2g}} \times \sqrt{H_m} \qquad H_m = H_g \text{ ...(ii)}$$

By Dividing equation (ii) by equation (i),

$$\frac{t_B}{t_A} = 2$$

$$t_B = 2t_A$$

SOL 10.82 Option (C) is correct.

Given : $t_i = 4$ mm, $D = 300$ mm, $\mu = 0.1$, $t_f = ?$

We know that,

For single pass without slipping, minimum possible thickness is given by the relation.

$$(t_i - t_f) = \mu^2 R$$

$$t_f = t_i - \mu^2 R = 4 - (0.1)^2 \times 150 = 2.5 \text{ mm}$$

SOL 10.83 Option (B) is correct.

Given, $d_i = 10$ mm, $d_f = 8$ mm, $\sigma_0 = 400$ MPa

The expression for the drawing force under frictionless condition is given by

$$F = \sigma_{mean} A_f \ln\left(\frac{A_i}{A_f}\right) = 400 \times 10^6 \times \frac{\pi}{4} \times (0.008)^2 \ln\left[\frac{\frac{\pi}{4}(0.001)^2}{\frac{\pi}{4}(0.008)^2}\right]$$

$$= 20096 \times \ln(1.5625) = 8.968\text{ kN} \simeq 8.97\text{ kN}$$

SOL 10.84 Option (D) is correct.

	Column I		Column II
P.	Wrinkling	**4.**	Insufficient blank holding force
Q.	Orange peel	**3.**	Large grain size
R.	Stretcher strains	**1.**	Yield point elongation
S.	Earing	**2.**	Anisotropy

So correct pairs are, P-4, Q-3, R-1, S-2

SOL 10.85 Option (B) is correct.

Given, $V = 25$ Volt, $I = 300$ A, $\eta = 0.85$, $V = 8$ mm/sec

We know that the power input by the heat source is given by,

$$\text{Voltage} = 25\text{ Volt}$$

$$P = \text{Voltage} \times I$$

Heat input into the work piece $= P \times$ efficiency of heat/transfer

$$H_i = \text{Voltage} \times I \times \eta = 25 \times 300 \times 0.85 = 6375\text{ J/sec}$$

$$\text{Heat energy input (J/mm)} = \frac{H_i}{V}$$

$$H_i(\text{J/mm}) = \frac{6375}{8} = 796.9 \simeq 797\text{ J/mm}$$

(D) Zero rake angle, high shear angle and high cutting speed

SOL 10.86 Option (A) is correct.

In common grinding operation, the average rake angle of the grains is highly negative, such as $-60°$ or even lower and smaller the shear angle. From this, grinding chips under go much larger deformation than they do in other cutting process. The cutting speeds are very high, typically 30 m/s

SOL 10.87 Option (D) is correct.

	Process	**Metal Removal Rate(MRR)** (in mm^3/sec)
1.	ECM	2700
2.	USM	14
3.	EBM	0.15
4.	LBM	0.10
5.	EDM	14.10

So the processes which has maximum MRR in increasing order is,

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LBM, EBM, USM, EDM, ECM

SOL 10.88 Option (D) is correct.

	Column I		Column II
P.	Charpy test	**4.**	Toughness
Q.	Knoop test	**2.**	Microhardness
R.	Spiral test	**1.**	Fluidity
S.	Cupping test	**3.**	Formability

So, correct pairs are, P-4, Q-2, R-1, S-3

SOL 10.89 Option (D) is correct.

Given : $t = 0.5\text{ mm}$, $V = 20\text{ m/min}$, $\alpha = 15^\circ$, $w = 5\text{ mm}$, $t_c = 0.7\text{ mm}$, $F_t = 200\text{ N}$, $F_c = 1200\text{ N}$

We know, from the merchant's theory

Chip thickness ratio, $r = \dfrac{t}{t_c} = \dfrac{0.5}{0.7} = 0.714$

For shear angle, $\tan\phi = \dfrac{r\cos\alpha}{1 - r\sin\alpha}$

Substitute the values, we get

$$\tan\phi = \frac{0.714\cos 15^\circ}{1 - 0.714\sin 15^\circ} = \frac{0.689}{0.815} = 0.845$$

$$\phi = \tan^{-1}(0.845) = 40.2^\circ$$

Shear strain, $s = \cot\phi + \tan(\phi - \alpha)$

$$s = \cot(40.2^\circ) + \tan(40.2^\circ - 15^\circ)$$

$$= \cot 40.2^\circ + \tan 25.2 = 1.183 + 0.470 = 1.65$$

SOL 10.90 Option (B) is correct.

From merchants, theory

$$\mu = \frac{F}{N} = \frac{F_c\sin\alpha + F_t\cos\alpha}{F_c\cos\alpha - F_t\sin\alpha} = \frac{F_c\tan\alpha + F_t}{F_c - F_t\tan\alpha}$$

$$= \frac{1200\tan 15^\circ + 200}{1200 - 200\times\tan 15^\circ} = \frac{521.539}{1146.41} = 0.455 \simeq 0.46$$

SOL 10.91 Option (A) is correct.

We know, from merchant's theory, frictional force of the tool acting on the tool-chip interface is

$$F = F_c\sin\alpha + F_t\cos\alpha$$

$$= 1200\sin 15^\circ + 200\cos 15^\circ = 503.77\text{ N}$$

Chip velocity, $V_c = \dfrac{\sin\phi}{\cos(\phi - \alpha)}\times V$

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$$= \frac{\sin(40.2^\circ)}{\cos(40.2^\circ - 15^\circ)} \times 20 = 14.27 \text{ m/min}$$

Total energy required per unit time during metal cutting is given by,

$$E = F_c \times V = 1200 \times \frac{20}{60} = 400 \text{ Nm/sec}$$

Energy consumption due to friction force F,

$$E_f = F \times V_c = 503.77 \times \frac{14.27}{60} \text{ Nm/sec}$$

$$= 119.81 \text{ Nm/sec}$$

Percentage of total energy dissipated due to friction at tool-chip interface is

$$E_d = \frac{E_f}{E} \times 100 = \frac{119.81}{400} \times 100 \simeq 30\%$$

SOL 10.92 Option (D) is correct.

	List-I (Equipment)		List-II (Process)
P.	Hot Chamber Machine	**3.**	Die casting
Q.	Muller	**5.**	Sand mixing
R.	Dielectric Baker	**2.**	Core making
S.	Sand Blaster	**1.**	Cleaning

So, correct pairs are, P-3, Q-5, R-2, S-1

SOL 10.93 Option (A) is correct.

When the temperature of a solid metal increases, its intramolecular bonds are brake and strength of solid metal decreases. Due to decrease its strength, the elongation of the metal increases, when we apply the load i.e. ductility increases.

SOL 10.94 Option (D) is correct.

We know that,

The strength of the brazed joint depend on (a) joint design and (b) the adhesion at the interfaces between the workpiece and the filler metal.

The strength of the brazed joint increases up to certain gap between the two joining surfaces beyond which it decreases.

SOL 10.95 Option (B) is correct.

In ECM, the principal of electrolysis is used to remove metal from the workpiece. The ECM method has also been developed for machining new hard and tough materials (for rocket and aircraft industry) and also hard refractory materials.

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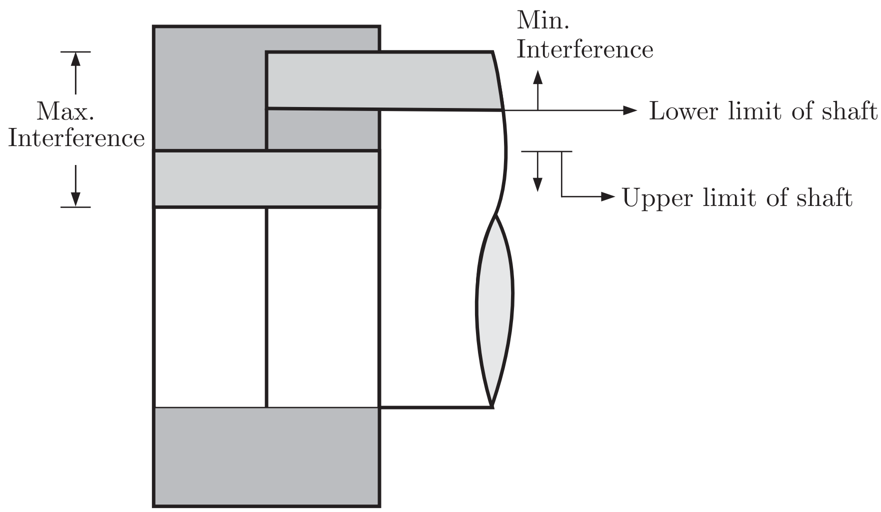
SOL 10.96 Option (A) is correct.



The interference is the amount by which the actual size of a shaft is larger than the actual finished size of the mating hole in an assembly.
For interference fit, lower limit of shaft should be greater than the upper limit of the hole (from figure).

SOL 10.97 Option (C) is correct.
According to 3-2-1 principle, only the minimum locating points should be used to secure location of the work piece in any one plane.

(A) The workpiece is resting on three pins A, B, C which are inserted in the base of fixed body.

The workpiece cannot rotate about the axis XX and YY and also it cannot move downward. In this case, the five degrees of freedom have been arrested.

(B) Two more pins D and E are inserted in the fixed body, in a plane perpendicular to the plane containing, the pins A, B and C. Now the workpiece cannot rotate about the Z-axis and also it cannot move towards the left. Hence the addition of pins D and E restrict three more degrees of freedom.

(C) Another pin F in the second vertical face of the fixed body, arrests degree of freedom 9.

SOL 10.98 Option (A) is correct.
Arc welding, Laser cutting of sheet and milling operations are the continuous path operations.

SOL 10.99 Option (A) is correct.

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We know,

Machining cost = Machining time × Direct labour cost.

If cutting speed increases then machining time decreases and machining cost also decreases and due to increase in cutting speed tool changing cost increases.

So, Curve 1 → Machining cost

Curve 2 → Non-productive cost

Curve 3 → Tool changing cost

SOL 10.100 Option (B) is correct.

Given : $l = 20\text{ cm} = 0.2\text{ m},\ A = 1\text{ cm}^2 = 10^{-4}\text{ m}^2$

$V = 1000\text{ cm}^3 = 1000\times10^{-6}\text{ m}^3 = 10^{-3}\text{ m}^3$

Velocity at the base of sprue is,

$$V = \sqrt{2gh} = \sqrt{2\times9.8\times0.2} = 1.98\text{ m/sec}$$

From the continuity equation flow rate to fill the mould cavity is,

Filling rate $$\dot{Q} = \text{Area}\times\text{Velocity} = AV$$

$$\frac{v}{t} = AV \qquad v = \text{Volume}$$

$$t = \frac{v}{AV} = \frac{10^{-3}}{10^{-4}\times1.98} = \frac{10}{1.98} = 5.05\text{ sec.}$$

SOL 10.101 Option (C) is correct.

Given :

$\rho = 8000\text{ kg/m}^3,\ t = 0.1\text{ sec.},\ d = 5\text{ mm},\ w = 1.5\text{ mm},\ L_f = 1400\text{ kJ/kg},\ R = 200\,\mu\Omega$

First of all calculate the mass,

$$\rho = \frac{m}{V}$$

$$m = \rho\times V = \rho\times\frac{\pi}{4}d^2\times t$$

$$= 8000\times\frac{\pi}{4}\times(5\times10^{-3})^2\times1.5\times10^{-3}$$

$$= 235.5\times10^{-6}\text{ kg} = 2.35\times10^{-4}\text{ kg}$$

Total heat for fusion,

$$Q = mL_f \qquad L = \text{Latent heat}$$

$$= 2.35\times10^{-4}\times1400\times10^3 = 329\text{ J} \qquad \text{...(i)}$$

We also know that, the amount of heat generated at the contacting area of the element to be welded is,

$$Q = I^2Rt$$

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$$329 = I^2 \times 200 \times 10^{-6} \times 0.1 \qquad \text{From equation (i)}$$

$$I^2 = \frac{329}{200 \times 10^{-7}} = 16.45 \times 10^6$$

$$I = \sqrt{16.45 \times 10^6} = 4056 \text{ A} \simeq 4060 \text{ A}$$

SOL 10.102 Option (C) is correct.

Given : $\alpha = 1 \text{ radian} \times \frac{180}{\pi} = \left(\frac{180}{\pi}\right)^\circ$, $r = 100 \text{ mm}$, $k = 0.5$, $t = 2 \text{ mm}$

Here, $r > 2t$

So, $k = 0.5t$

Bend allowance $B = \frac{\alpha}{360} \times 2\pi(r+k)$

$$= \frac{180}{\pi} \times \frac{2\pi}{360}(100 + 0.5 \times 2) = 101 \text{ mm}$$

SOL 10.103 Option (B) is correct.

Given : Side of the plate $= 600 \text{ mm}$, $V = 8 \text{ m/min}$, $f = 0.3 \text{ mm/stroke}$

$$\frac{\text{Return time}}{\text{Cutting time}} = \frac{1}{2}$$

The tool over travel at each end of the plate is 20 mm. So length travelled by the tool in forward stroke,

$$L = 600 + 20 + 20 = 640 \text{ mm}$$

$$\text{Number of stroke required} = \frac{\text{Thickness of flat plate}}{\text{Feed rate/stroke}}$$

$$= \frac{30}{0.3} = 100 \text{ strokes}$$

Distance travelled in 100 strokes is,

$$d = 640 \times 100$$

$$= 64000 \text{ mm} = 64 \text{ m}$$

So, Time required for forward stroke

$$t = \frac{d}{V} = \frac{64}{8} = 8 \text{ min}$$

$$\text{Return time} = \frac{1}{2} \times 8 = 4 \text{ min}$$

Machining time, $T_M = \text{Cutting time} + \text{Return time}$

$$= 8 + 4 = 12 \text{ min}$$

SOL 10.104 Option (A) is correct.

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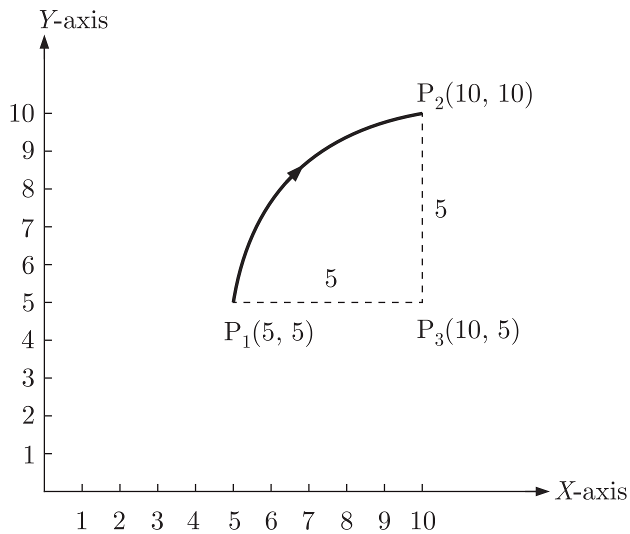

So, N010 →represent start the operation

GO2 →represent circular (clock wise) interpolation

X10Y10 →represent final coordinates

X5Y5 →represent starting coordinate

R5 →represent radius of the arc

So, NC tool path command is, N010 GO2 X10 Y10 X5 Y5 R5

SOL 10.105 Option (B) is correct.

Tool designation or tool signature under ASA, system is given in the order. Back rake, Side rake, End relief, Side relief, End cutting edge angle, Side cutting edge angle and nose radius that is

$$\alpha_b\text{-}\alpha_s\text{-}\theta_e\text{-}\theta_s\text{-}C_e\text{-}C_s\text{-}R$$

Given : For tool P, tool signature, $5°\text{-}5°\text{-}6°\text{-}6°\text{-}8°\text{-}30°\text{-}0$

For tool Q : $5°\text{-}5°\text{-}7°\text{-}7°\text{-}8°\text{-}15°\text{-}0$

We know that,

$$h = \frac{\text{feed}}{\tan(\text{SCEA}) + \cot(\text{ECEA})} = \frac{f}{\tan(C_s) + \cot(C_e)}$$

For tool P, $$h_P = \frac{f_P}{\tan 30° + \cot 8°}$$

For tool Q $$h_Q = \frac{f_Q}{\tan 15° + \cot 8°}$$

for same machining condition $f_P = f_Q$

Hence, $$\frac{h_P}{h_Q} = \frac{\tan 15° + \cot 8°}{\tan 30° + \cot 8°}$$

SOL 10.106 Option (C) is correct.

We know that maximum possible clearance occurs between minimum shaft size and maximum hole size.

$$\begin{aligned}
\text{Maximum size of shaft} &= 25 + 0.040 = 25.040\text{ mm}\\
\text{Minimum size of shaft} &= 25 - 0.100 = 24.99\text{ mm}\\
\text{Maximum size of hole} &= 25 + 0.020 = 25.020\text{ mm}\\
\text{Minimum size of hole} &= 25 - 0.000 = 25.00\text{ mm}\\
25.020 - 24.99 &= 0.03\text{ mm} = 30\text{ microns}
\end{aligned}$$

SOL 10.107 Option (A) is correct.

Given:-$NO20\ GO2\ X45.0\ Y25.0\ R5.0$

Here term $X45.0\ Y25.0\ R5.0$ will produce circular motion because radius is consider in this term and $GO2$ will produce clockwise motion of the tool.

SOL 10.108 Option (A) is correct

In EDM, the thermal energy is employed to melt and vaporize tiny particles of work material by concentrating the heat energy on a small area of the work-piece.

SOL 10.109 Option (D) is correct

Given : $I = 5000\text{ A}$, $R = 200\,\mu\Omega = 200 \times 10^{-6}\,\Omega$, $\Delta t = 0.2$ second

Heat generated, $$H_g = I^2(R \,\triangle\, t)$$

$$H_g = (5000)^2 \times 200 \times 10^{-6} \times 0.2$$

$$= 25 \times 10^6 \times 40 \times 10^{-6} = 1000\text{ Joule}$$

SOL 10.110 Option (B) is correct

Two streams of liquid metal which are not hot enough to fuse properly result into a casting defect, known as Misrun/cold shut.

It occurs due to insufficient fluidity of the molten metal.

SOL 10.111 Option (C) is correct.

Gray cast iron is the most widely used of all cast irons. In fact, it is common to speak of gray cast iron just as cast iron.

It contains 3 to 4% C and 2.5 % Si.

SOL 10.112 Option (B) is correct.

$$\begin{aligned}
\text{For hole size} &= 20.000^{+0.050}_{+0.010}\text{ mm}\\
\text{Maximum hole size} &= 20.000 + 0.050 = 20.050\text{ mm}\\
\text{Minimum hole size} &= 20.000 + 0.010 = 20.010
\end{aligned}$$

So, $$\begin{aligned}
\text{Hole tolerance} &= \text{Maximum hole size} - \text{Minimum hole size}\\
&= 20.050 - 20.010 = 0.040\text{ mm}
\end{aligned}$$

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Gauge tolerance can be 10% of the hole tolerance (Given).

So, Gauge tolerance $= 10\%$ of 0.040

$$= \frac{10}{100} \times 0.040 = 0.0040 \text{ mm}$$

$$\text{Size of Go Gauge} = \text{Minimum hole size} + \text{Gauge tolerance}$$

$$= 20.010 + 0.0040 = 20.014 \text{ mm}$$

$$\text{Size of NO-GO Gauge} = \text{Maximum hole size} - \text{Gauge tolerance}$$

$$= 20.050 - 0.004 = 20.046 \text{ mm}$$

SOL 10.113 Option (A) is correct.

Given : $d = 10\text{ mm},\ t = 3\text{ mm},\ \tau_s = 400\text{ N/mm}^2,\ t_1 = 2\text{ mm},\ p = 40\% = 0.4$

We know that, when shear is applied on the punch, the blanking force is given by,

$$F_B = \pi dt\left(\frac{t \times p}{t_1}\right) \times \tau_s \quad \text{Where } t \times p = \text{Punch travel}$$

Substitute the values, we get

$$F_B = 3.14 \times 10 \times 3\left(\frac{3 \times 0.4}{2}\right) \times 400$$

$$= 94.2 \times 0.6 \times 400 = 22.6 \text{ kN}$$

SOL 10.114 Option (B) is correct.

Given : $D = 10\text{ mm},\ t = 20\text{ mm},\ N = 300\text{ rpm},\ f = 0.2\text{ mm/rev.}$

Point angle of drill, $2\alpha_p = 120° \Rightarrow \alpha_p = 60°$

Drill over-travel $= 2$ mm

We know that, break through distance,

$$A = \frac{D}{2\tan\alpha_p} = \frac{10}{2\tan 60°} = 2.89 \text{ mm}$$

Total length travelled by the tool,

$$L = t + A + 2$$

$$= 20 + 2.89 + 2 = 24.89 \text{ mm}$$

So, time for drilling, $$t = \frac{L}{f \cdot N} = \frac{24.89}{0.2 \times 300} = 0.415 \text{ min}$$

$$= 0.415 \times 60 \text{ sec} = 24.9 \simeq 25 \text{ sec}$$

SOL 10.115 Option (D) is correct.

Given : Dimension of block $= 200 \times 100 \times 10$ mm

Shrinkage allowance, $X = 1\%$

We know that, since metal shrinks on solidification and contracts further on cooling to room temperature, linear dimensions of patterns are increased in

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respect of those of the finished casting to be obtained.

So, $$v_c = 200 \times 100 \times 10 = 2 \times 10^5 \text{ mm}^2$$

Shrinkage allowance along length,

$$S_L = LX = 200 \times 0.01 = 2 \text{ mm}$$

Shrinkage allowance along breadth,

$$S_B = 100 \times 0.01 = 1 \text{ mm}$$

or Shrinkage allowance along height,

$$S_H = 10 \times 0.01 = 0.1 \text{ mm}$$

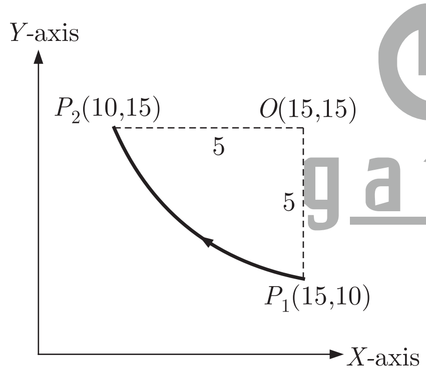
Volume of pattern will be

$$v_p = [(L + S_L)(B + S_B)(S + S_H)] \text{ mm}^3$$

$$= 202 \times 101 \times 10.01 \text{ mm}^3 = 2.06 \times 10^5 \text{ mm}^3$$

So, $$\frac{\text{Volume of Pattern } v_p}{\text{Volume of Casting } v_c} = \frac{2.06 \times 10^5}{2 \times 10^5} = 1.03$$

SOL 10.116 Option (C) is correct



From the figure, the centre of circular arc with radius 5 is

$$[15, (10 + 5)] = [15, 15] \qquad \text{From point } P_1$$

$$[(10 + 5), 15] = [15, 15] \qquad \text{From point } P_2$$

SOL 10.117 Option (B) is correct.

Given : $V = 40 \text{ m/min}$, $d = 0.3 \text{ mm}$, $\alpha = 5°$, $t = 1.5 \text{ mm}$, $F_c = 900 \text{ N}$, $F_t = 450 \text{ N}$

We know from the merchant's analysis

$$\mu = \frac{F}{N} = \frac{F_c \sin\alpha + F_t \cos\alpha}{F_c \cos\alpha - F_t \sin\alpha}$$

Where F = Frictional resistance of the tool acting on the chip.

N = Force at the tool chip interface acting normal to the cutting face of the tool.

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$$\mu = \frac{900\tan 5^\circ + 450}{900 - 450\tan 5^\circ}$$

$$= \frac{528.74}{860.63} = 0.614$$

Now, Frictional angle, $\beta = \tan^{-1}\mu = \tan^{-1}(0.614) = 31.5^\circ$

SOL 10.118 Option (B) is correct.

Given : $t_i = 25\text{ mm}$, $t_f = 20\text{ mm}$, $D = 600\text{ mm}$, $N = 100\text{ rpm}$

Let, Angle substended by the deformation zone at the roll centre is θ in radian and it is given by the relation.

$$\theta(\text{radian}) = \sqrt{\frac{t_i - t_f}{R}}$$

$$= \sqrt{\frac{25-20}{300}} = \sqrt{0.0166} = 0.129\text{ radian}$$

Roll strip contact length is

$$L = \theta \times R \qquad \text{Angle} = \frac{\text{Arc}}{R}$$

$$L = 0.129 \times 300 = 38.73\text{ mm} \simeq 39\text{ mm}$$

SOL 10.119 Option (C) is correct.

Given : $VT^n = C$

Let V and T are the initial cutting speed & tool life respectively.

Case (I) : The relation between cutting speed and tool life is,

$$VT^n = C \qquad ...(i)$$

Case (II) : In this case doubling the cutting speed and tool life reduces to $1/8^{\text{th}}$ of original values.

So, $$(2V) \times \left(\frac{T}{8}\right)^n = C \qquad ...(ii)$$

On dividing equation (i) by equation (ii),

$$\frac{VT^n}{2V\left(\frac{T}{8}\right)^n} = 1$$

$$T^n = 2\left(\frac{T}{8}\right)^n$$

$$\frac{1}{2} = \left(\frac{1}{8}\right)^n$$

$$\left(\frac{1}{2}\right)^1 = \left(\frac{1}{2}\right)^{3n}$$

Compare powers both the sides,

$$1 = 3n \qquad \Rightarrow n = \frac{1}{3}$$

SOL 10.120 Option (B) is correct.

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	Feature to be inspected		Instrument
P.	Pitch and Angle errors of screw thread	**5.**	Sine bar
Q.	Flatness error of a surface	**2.**	Optical Interferometer
R.	Alignment error of a machine slideway	**1.**	Auto collimator
S.	Profile of a cam	**6.**	Tool maker's Microscope

So, correct pairs are, P-5, Q-2, R-1, S-6

SOL 10.121 Option (B) is correct.

	Product		Process
P.	Molded luggage	**4.**	Transfer molding
Q.	Packaging containers for Liquid	**5.**	Blow molding
R.	Long structural shapes	**2.**	Hot rolling
S.	Collapsible tubes	**3.**	Impact extrusion

So, correct pairs are, P-4 Q-5 R-2 S-3

SOL 10.122 Option (D) is correct.

	Operation		Process
P.	Deburring (internal surface)	**2.**	Abrasive Flow Machining
Q.	Die sinking	**3.**	Electric Discharge Machining
R.	Fine hole drilling in thin sheets	**5.**	Laser beam Machining
S.	Tool sharpening	**6.**	Electrochemical Grinding

So, Correct pairs are, P-2, Q-3, R-5, S-6

SOL 10.123 Option (C) is correct.

	Process		Characteristics
P.	Tempering	**4.**	Both hardness and brittleness are reduced
Q.	Austempering	**1.**	Austenite is converted into bainite
R.	Martempering	**2.**	Austenite is converted into martensite

So, correct pairs are, P-4, Q-1, R-2

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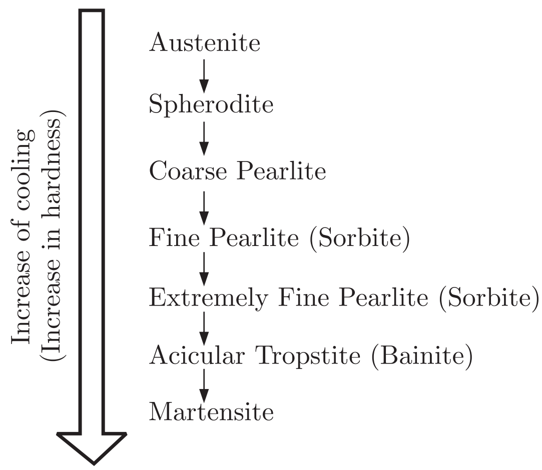
SOL 10.124 Option (D) is correct.

Steel can be cooled from the high temperature region at a rate so high that the austenite does not have sufficient time to decompose into sorbite or troostite. In this case the austenite is transformed into martensite. Martensite is ferromagnetic, very hard & brittle.



So hardness is increasing in the order,

Spherodite $\rightarrow$ Coarse Pearlite $\rightarrow$ Fine Pearlite $\rightarrow$ Martensite

SOL 10.125 Option (C) is correct.

Permeability or porosity of the moulding sand is the measure of its ability to permit air to flow through it.

So, hardness of green sand mould increases by restricted the air permitted in the sand i.e. decrease its permeability.

SOL 10.126 Option (B) is correct.

In OAW, Acetylene (C_2H_2) produces higher temperature (in the range of 3200° C)than other gases, (which produce a flame temperature in the range of 2500° C) because it contains more available carbon and releases heat when its components (C & H) dissociate to combine with O_2 and burn.

SOL 10.127 Option (C) is correct.

Cold forming or cold working can be defined as the plastic deforming of metals and alloys under conditions of temperature and strain rate.

Theoretically, the working temperature for cold working is below the recrystallization temperature of the metal/alloy (which is about one-half the absolute melting temperature.)

SOL 10.128 Option (D) is correct.

Quality screw threads are produced by only thread casting.
Quality screw threads are made by die-casting and permanent mould casting are very accurate and of high finish, if properly made.

SOL 10.129 Option (D) is correct.
In EDM, the thermal energy is employed to melt and vaporize tiny particles of work-material by concentrating the heat energy on a small area of the work-piece.
A powerful spark, such as at the terminals of an automobile battery, will cause pitting or erosion of the metal at both anode & cathode. No force occurs between tool & work.

SOL 10.130 Option (B) is correct.
Since 25 mm lies in the diameter step 18 & 30 mm, therefore the geometric mean diameter,

$$D = \sqrt{18 \times 30} = 23.24\text{ mm}$$

We know that standard tolerance unit,

$$i(\text{microns}) = 0.45\sqrt[3]{D} + 0.001D$$

$$i = 0.45\sqrt[3]{23.24} + 0.001 \times 23.24 = 1.31 \text{ microns}$$

Standard tolerance for hole 'h' of grade $7(IT7)$,

$$IT7 = 16i = 16 \times 1.31 = 20.96 \text{ microns}$$

Hence, lower limit for shaft = Upper limit of shaft – Tolerance

$$= 25 - 20.96 \times 10^{-3}\text{ mm} = 24.979\text{ mm}$$

SOL 10.131 Option (B) is correct.
Hardness is greatly depend on the carbon content present in the steel.
Cyaniding is case-hardening with powered potassium cyanide or potassium ferrocyanide mixed with potassium bichromate, substituted for carbon. Cyaniding produces a thin but very hard case in a very short time.

SOL 10.132 Option (B) is correct.
Given : $q = 0.97 \times 10^6\text{ s/m}^2$, $D = 200\text{ mm} = 0.2\text{ m}$
From the caine's relation solidification time, $T = q\left(\frac{V}{A}\right)^2$

Volume $V = \frac{4}{3}\pi R^3$

Surface Area $A = 4\pi R^2$

So, $$T = 0.97 \times 10^6\left(\frac{\frac{4}{3}\pi R^3}{4\pi R^2}\right)^2 = 0.97 \times 10^6\left(\frac{R}{3}\right)^2$$

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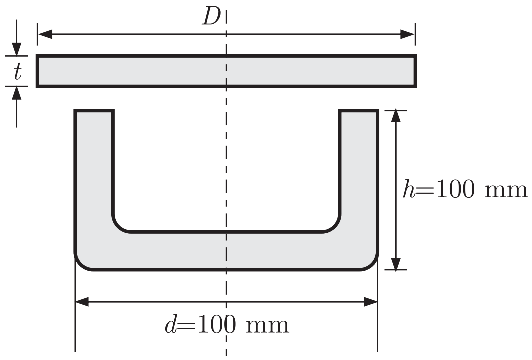
$$= \frac{0.97}{9} \times 10^6 \left(\frac{0.2}{2}\right)^2 = 1078 \text{ sec}$$

SOL 10.133 Option (C) is correct.

Given : $d = 100$ mm, $h = 100$ mm, $R = 0.4$ mm



Here we see that $d > 20r$

If $d \geq 20r$, blank diameter in cup drawing is given by,

$$D = \sqrt{d^2 + 4dh}$$

Where, D = diameter of flat blank

d = diameter of finished shell

h = height of finished shell

Substitute the values, we get

$$D = \sqrt{(100)^2 + 4 \times 100 \times 100} = \sqrt{50000}$$

$$= 223.61 \text{ mm} \simeq 224 \text{ mm}$$

SOL 10.134 Option (B) is correct.

Given : $d_i = 100$ mm, $d_f = 50$ mm, $T = 700^\circ$ C, $k = 250$ MPa

Extrusion force is given by,

$$F_e = kA_i \ln\left(\frac{A_i}{A_f}\right) = k\frac{\pi}{4}d_i^2 \ln\left(\frac{\frac{\pi}{4}d_i^2}{\frac{\pi}{4}d_f^2}\right) = k\frac{\pi}{4}d_i^2 \ln\left(\frac{d_i}{d_f}\right)^2$$

Substitute the values, we get

$$F_e = 250 \times \frac{\pi}{4}(0.1)^2 \ln\left(\frac{0.1}{0.05}\right)^2$$

$$= 1.96 \ln 4 = 2.717 \text{ MN} \simeq 2.72 \text{ MN}$$

SOL 10.135 Option (A) is correct.

Given : $D = 20$ mm, $t = 2$ mm, Punch or diameter clearance = 3%

Required punch diameter will be,

$$d = D - 2 \times (3\% \text{ of thickness})$$

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$$= 20 - 2 \times \frac{3}{100} \times 2 = 19.88 \text{ mm}$$

SOL 10.136 Option (A) is correct.

Given : For case (I) :

$N = 50$ rpm, $f = 0.25$ mm/rev., $d = 1$ mm

Number of cutting tools $= 10$

Number of components produce $= 500$

So, Velocity $\quad V_1 = N \times f = 50 \times 0.25 = 12.5 \text{ mm/min}$.

For case (II) :

$N = 80$ rpm, $f = 0.25$ mm/rev., $d = 1$ mm

Number of cutting tools, $= 10$

Number of components produce $= 122$

So, Velocity $\quad V_2 = N \times f = 80 \times 0.25 = 20 \text{ mm/min}$

From the tool life equation between cutting speed & tool life, $VT^n = C$,

$$V_1 T_1^n = V_2 T_2^n \qquad \text{where } C = \text{constant} \qquad ...(i)$$

Tool life = Number of components produce $\times$ Tool constant

For case (I), $\quad T_1 = 500k \qquad k =$ tool constant

For case (II), $\quad T_2 = 122k$

From equation (i),

$$12.5 \times (500k)^n = 20 \times (122k)^n$$

$$\left(\frac{500k}{122k}\right)^n = \frac{20}{12.5} = 1.6$$

Taking log both the sides,

$$n \ln\left(\frac{500}{122}\right) = \ln(1.6)$$

$$n(1.41) = 0.47$$

$$n = 0.333$$

Let the no. of components produced be n_1 by one cutting tool at 60 r.p.m.

So, tool life, $\quad T_3 = n_1 k$

Velocity, $V_3 = 60 \times 0.25 = 15 \text{ mm/min} \qquad$ feed remains same

Now, tool life T_1 if only 1 component is used,

$$T_1' = \frac{500k}{10}$$

So, $\quad V_1 (T_1')^n = V_3 (T_3)^n$

Substitute the values, we get

$$V_1 \left(\frac{500k}{10}\right)^n = 15 (n_1 k)^n$$

$$\left(\frac{50k}{n_1 k}\right)^n = \frac{15}{12.5}$$

$$\frac{50}{n_1} = (1.2)^{1/0.333} = 1.73$$

$$n_1 = \frac{50}{1.73} = 28.90 \simeq 29$$

SOL 10.137 Option (B) is correct.

Given : $p = 2\,\text{mm}$, $d = 14.701\,\text{mm}$

We know that, in case of ISO metric type threads,

$$2\theta = 60^\circ \qquad \Rightarrow \qquad \theta = 30^\circ$$

And in case of threads, always rollers are used.

For best size of rollers, $d = \frac{p}{2}\sec\theta = \frac{2}{2}\sec 30^\circ = 1.155\,\text{mm}$

Hence, rollers of $1.155\,\text{mm}$ diameter (1.155ϕ) is used.

SOL 10.138 Option (D) is correct.

The total number of straight fringes that can be observed on both slip gauges is 13.

SOL 10.139 Option (A) is correct.

Given : $P = 35.00 \pm 0.08\,\text{mm}$, $Q = 12.00 \pm 0.02\,\text{mm}$

$$R = 13.00^{+0.04}_{-0.02}\,\text{mm} = 13.01 \pm 0.03\,\text{mm}$$

From the given figure, we can say

$$P = Q + W + R$$

$$W = P - (Q + R)$$

$$= (35.00 \pm 0.08) - [(12.00 \pm 0.02) + (13.01 \pm 0.03)]$$

$$= (35 - 12 - 13.01)^{+0.08-0.02-0.03}_{-0.08+0.02+0.03}$$

$$= 9.99^{+0.03}_{-0.03} = 9.99 \pm 0.03\,\text{mm}$$

SOL 10.140 Option (D) is correct.

	Working material		Type of Joining
P.	Aluminium	**5.**	Gas Tungsten Arc Welding
Q.	Die steel	**4.**	Atomic Hydrogen Welding
R.	Copper Wire	**2.**	Soldering
S.	Titanium sheet	**6.**	Laser Beam Welding

So, correct pairs are, P - 5, Q - 4, R - 2, S - 6

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SOL 10.141 Option (A) is correct

Given : $N = 200\,\text{rpm}$, $f = 0.25\,\text{mm/revolution}$, $d = 0.4\,\text{mm}$, $\alpha = 10°$, $\phi = 27.75°$

Uncut chip thickness, $t = f(\text{feed, mm/rev.}) = 0.25\,\text{mm/rev.}$

Chip thickness ratio is given by,

$$r = \frac{t}{t_c} = \frac{\sin\phi}{\cos(\phi - \alpha)}$$

Where, t_c = thickness of the produced chip.

So,

$$t_c = \frac{t \times \cos(\phi - \alpha)}{\sin\phi}$$

$$= \frac{0.25 \times \cos(27.75 - 10)}{\sin(27.75)} = 0.511\,\text{mm}$$

Alternate :

We also find the value of t_c by the general relation,

$$\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha} \qquad \text{where } r = \frac{t}{t_c}$$

SOL 10.142 Option (D) is correct.

We know that angle of friction,

$$\beta = \tan^{-1}\mu$$

or,

$$\mu = \tan\beta \qquad ...(i)$$

For merchant and earnest circle, the relation between rake angle (α), shear angle (ϕ) and friction angle (β) is given by,

$$2\phi + \beta - \alpha = 90°$$

$$\beta = 90° + \alpha - 2\phi$$

$$= 90° + 10 - 2 \times 27.75 = 44.5°$$

Now, from equation (i),

$$\mu = \tan(44.5°) = 0.98$$

SOL 10.143 Option (D) is correct.

A lead-screw with half nuts in a lathe, free to rotate in both directions had Acme threads. When it is used in conjunction with a split nut, as on the lead screw of a lathe, the tapered sides of the threads facilitate ready to engagement and disengagement of the halves of the nut when required.

SOL 10.144 Option (C) is correct.

From the pouring basin, the molten metal is transported down into the mould cavity by means of the sprue or downgate. It is a vertical channel that connects the pouring basin with runners and gates.

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SOL 10.145 Option (D) is correct.

Hot rolling of metal means working of metals when heated sufficiently (above the recrystallizing temperature) to make them plastic and easily worked.

SOL 10.146 Option (B) is correct.

GTAW is also called as Tungsten Inert Gas welding (TIG). The electrode is non consumable since its melting point is about 3400° C.

SOL 10.147 Option (B) is correct.

In trepanning, the cutting tool produces a hole by removing a disk-shaped piece (core), usually from flat plates. A hole is produced without reducing all the material removed to chips, as is the case in drilling. Such drills are used in deep-hole drilling machines for making large hollow shafts, long machine tool spindles etc.

SOL 10.148 Option (B) is correct.

Because each abrasive grain usually removes only a very small amount of material at a time, high rates of material removal can be achieved only if a large number of these grains act together. This is done by using bonded abrasives, typically in the form of a grinding wheel. The abrasive grains are held together by a bonding material which acts as supporting posts or brace between the grains and also increases the hardness of the grinding wheel.

SOL 10.149 Option (D) is correct.

Centrifugal casting is the method of producing castings by pouring the molten metal into a rapidly rotating mould. Because of density differences, lighter elements such as dross, impurities and pieces of the refractory lining tend to collect at the centre of the casting. This results in better mould filling and a casting with a denser grain structure, which is virtually free of porosity.

SOL 10.150 Option (B) is correct.

Work hardening is when a metal is strained beyond the yield. An increasing stress is required to produce additional plastic deformation and the metal apparently becomes stronger and more difficult to deform.

Work hardening reduces ductility, which increases the chances of brittle failure.

SOL 10.151 Option (B) is correct.

A carburising flame is obtained when an excess of acetylene is supplied than

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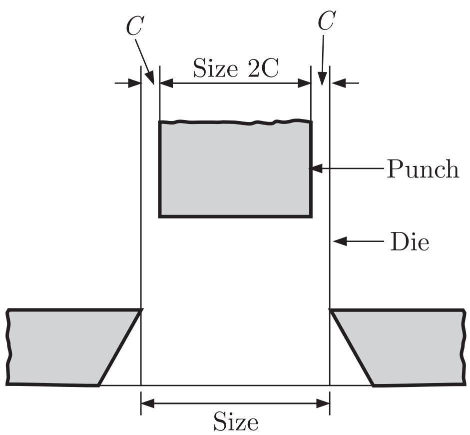
which is theoretically required. This excess amount of acetylene increases the temperature of the flame. So, the temperature of a carburising flame in gas welding is higher than that of a neutral or an oxidising flame.

SOL 10.152 Option (C) is correct.



The punch size is obtained by subtracting the clearance from the die-opening size. Clearance is the gap between the punch and the die. (From the figure)

SOL 10.153 Option (B) is correct.

When machining ductile materials, conditions of high local temperature and extreme pressure in the cutting zone and also high friction in the tool chip interface, may cause the work material to adhere or weld to the cutting edge of the tool forming the built-up edge. Low-cutting speed contributes to the formation of the built-up edge. Increasing the cutting speed, increasing the rake angle and using a cutting fluid contribute to the reduction or elimination of built-up edge.

SOL 10.154 Option (B) is correct.

Given : $t = 25\text{ mm}, \quad N = 300\text{ rpm}, \quad f = 0.25\text{ mm/rev}$

We know, time taken to drill a hole,

$$T = \frac{t}{fN} = \frac{25}{0.25 \times \frac{300}{60}} = \frac{25}{0.25 \times 5} = 20\text{ sec}$$

SOL 10.155 Option (C) is correct.

Since metal shrinks on solidification and contracts further on cooling to room temperature, linear dimensions of patterns are increased in respect of those of the finished casting to be obtained. This is called the "shrinkage allowance".

So, the temperature of solid phase drops from freezing to room temperature.

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SOL 10.156 Option (B) is correct.

The blanking force is given by the relation,

$$F_b = \tau \times d \times t$$

Where, $\tau =$ shear strength of material.

SOL 10.157 Option (D) is correct.

In ECM, the principal of electrolysis is used to remove metal from the workpiece. The material removal is due to ion displacement. The principal of electrolysis is based on Faraday's law of electrolysis.

SOL 10.158 Option (C) is correct.

Electric arc welding is "a welding process wherein coalescence is produced by heating with an arc, with or without the use of filler metals.

No filler metal is used in butt weld. So, when the plate thickness changes, welding is achieved by changing the electrode size.

SOL 10.159 Option (A) is correct.

Allowance is an intentional difference between the maximum material limits of mating parts. For shaft, the maximum material limit will be its high limit and for hole, it will be its low limit. So, allowance refers to maximum clearance between shaft and hole.

SOL 10.160 Option (A) is correct.

Given : $H_g = 175\text{ mm},\ A_g = 200\text{ mm}^2,\ v_m = 10^6\text{ mm}^3,$

$g = 10\text{ m/sec}^2 = 10^4\text{ mm/sec}^2$

Time required to fill the mould is given by,

$$t = \frac{v_m}{A_g\sqrt{2gH_g}} = \frac{10^6}{200 \times \sqrt{2 \times 10^4 \times 175}} = 2.67\text{ sec}$$

SOL 10.161 Option (B) is correct.

The maximum reduction taken per pass in wire drawing, is limited by the strength of the deformed product. The exit end of the drawn rod will fracture at the die exit, when

$$\frac{\sigma_d}{\sigma_o} = 1, \text{ if there is no strain hardening.}$$

For zero back stress, the condition will be,

$$\frac{1+B}{B}\left[1-(1-RA)^B\right] = 1 \qquad \text{...(i)}$$

In wire drawing, co-efficient of friction of the order 0.1 are usually obtained.

Now, $$B = \mu \cot\alpha$$

$$\mu = 0.1 \text{ and } \alpha = 6^\circ$$

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$$B = \mu \cot 6^\circ = 0.9515$$

From equation (i),

$$1 - (1 - RA)^B = \frac{B}{1 + B} = \frac{0.9515}{1 + 0.9515} = 0.49$$

$$(1 - RA)^B = 0.51$$

$$1 - RA = (0.51)^{\frac{1}{0.9515}} = 0.49$$

$$RA = 1 - 0.49 = 0.51$$

The approximate option is (B).

SOL 10.162 Option (C) is correct.

Given : $\alpha = 10^\circ$, $r = 0.4$

Shear angle $\tan \phi = \frac{r \cos \alpha}{1 - r \sin \alpha} = \frac{0.4 \cos 10^\circ}{1 - 0.4 \sin 10^\circ} = 0.4233$

$$\tan \phi = 0.4233$$

$$\phi = \tan^{-1}(0.4233) = 22.94^\circ$$

SOL 10.163 Option (A) is correct.

Given : $I = 15000\ \text{A}$, $t = 0.25\ \text{sec}$, $R = 0.0001\ \Omega$

The heat generated to form the weld is,

$$Q = I^2 Rt = (15000)^2 \times 0.0001 \times 0.25 = 5625\ \text{W-sec}$$

SOL 10.164 Option (C) is correct.

According to 3-2-1 principle, only the minimum locating points should be used to secure location of the work piece in any one plane.

(A) The workpiece is resting on three pins A, B, C which are inserted in the base of fixed body.

The workpiece cannot rotate about the axis XX and YY and also it cannot move downward. In this case, the five degrees of freedom have been arrested.

(B) Two more pins D and E are inserted in the fixed body, in a plane perpendicular to the plane containing, the pins A, B and C. Now the workpiece cannot rotate about the Z-axis and also it cannot move towards the left. Hence the addition of pins D and E restrict three more degrees of freedom.

(C) Another pin F in the second vertical face of the fixed body, arrests degree of freedom 9.

SOL 10.165 Option (B) is correct.

Given : Initial point (5, 4), Final point (7, 2), Centre (5, 4)

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So, the G, N codes for this motion are $N010$ $GO2$ $X7.0$ $Y2.0$ 15.0 $J2.0$

where, $GO2 \rightarrow$ Clockwise circular interpolation

$X7.0$ $Y2.0 \rightarrow$ Final point

$I5.0$ $J2.0 \rightarrow$ Centre point

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UNIT 10. Forming:

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UNIT 11. Joining:

Physics of welding, brazing and soldering; adhesive bonding; design considerations in welding.

UNIT 12. Machining and Machine Tool Operations:

Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures

UNIT 13. Metrology and Inspection:

Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

UNIT 14. Computer Integrated Manufacturing:

Basic concepts of CAD/CAM and their integration tools.

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