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Engineering Academy

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ESE- 2018 (Prelims) - Offline Test Series **Test - 19**

MECHANICAL ENGINEERING

SUBJECT: ENGINEERING MATERIALS + MANUFACTURING, INDUSTRIAL AND MAINTENANCE ENGINEERING + MECHATRONICS AND ROBOTICS – SOLUTIONS

01. Ans: (d)

Sol: The shear angle relationship according to Stabler's criteria is given as :

$$\phi+\beta-\frac{\alpha}{2}=45^{o}$$

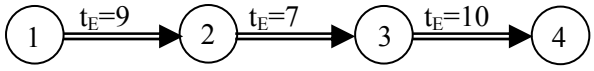
$$\Rightarrow\phi=\frac{\pi}{4}+\frac{\alpha}{2}-\beta$$

02. Ans: (b) **03. Ans: (a)**

04. Ans: (d)

Sol:

Activity	$t_E=\frac{t_o+4t_m+t_p}{6}$
$1-2$	$\frac{3+4(8)+19}{6}=9$
$2-3$	$\frac{2+4(6)+16}{6}=7$
$3-4$	$\frac{4+4(9)+20}{6}=10$



$\therefore$ Expected Project duration = 9 + 7 + 10

= 26 days

05. Ans: (a)

Sol: Relationship between lattice parameter (a) and atomic radius (R) is $3R=\sqrt{3}a$

Bond length = $2R=\frac{\sqrt{3}a}{4}$

06. Ans: (b)

Sol: Interpolator is a device used to control the feed motions provided to the axes.

The interpolator coordinates the motion along the machine axes, which are separately driven, by providing reference positions instant by instant for the position- and velocity-control loops, to generate the required machining path. Typical interpolators are capable of generating linear and circular paths.

07. Ans: (d)

Sol: Laser beam technique is used for deeper penetration welds even with dissimilar metals and multilayer materials.

08. Ans: (d)

Sol: Surface decarburization process reduces the surface hardness and strength so fatigue limit also reduce.

09. Ans: (b)

Sol: $T(\text{min cost}) = T_1 = \left(\frac{1-n}{n}\right)T_c$

$T(\text{max cost}) = T_2 = \left(\frac{1-n}{n}\right)\left(T_c + \frac{c_t}{c_m}\right)$

[Where, c_t = tool change cost ,

c_m = machining cost]

$\therefore T_1 < T_2$

T(max.profit), T_3 lies in the middle of 'T_1' and 'T_2'

$\therefore T_1 < T_3 < T_2$

10. Ans: (d)

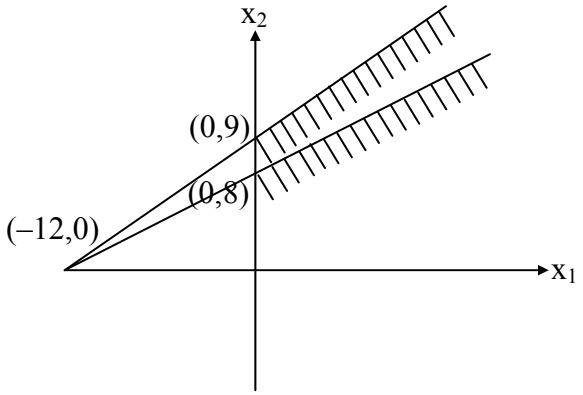
Sol: $-2x_1 + 3x_2 \le 24$

$\frac{x_1}{-12} + \frac{x_2}{8} \le 1$

$3x_1 - 4x_2 \ge -36$

$\Rightarrow -3x_1 + 4x_2 \le 36$

$\frac{x_1}{-12} + \frac{x_2}{9} \le 1,\ x \ge 0\ ,\ x_2 \ge 0$



11. Ans: (a)

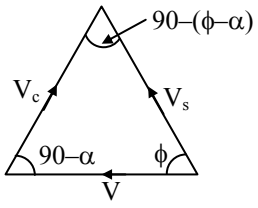
12. Ans: (b)

Sol: In FCC structure 8 atoms are arranged at 8 corners of a cube and 6 atoms of 6 face centres

13. Ans: (d)

14. Ans: (d)

Sol:



From the velocity diagram

$$\frac{V_c}{\sin\phi} = \frac{V}{\cos(\phi-\alpha)}$$

$$\frac{V}{V_c} = \frac{\cos(\phi-\alpha)}{\sin\phi}$$

15. Ans: (c)

Sol: Interference float = Slack at head event

$= 24 - 21 = 3$

Total Float = $(24 - 15) - 4 = 5$

Free Float = Total Float – Slack at head event

$= 5 - 3 = 2$

$\therefore$ Free Float – Interference Float – Total Float

16. Ans: (b)

Sol: Statement (I) is wrong because in α-Fe, maximum percentage of carbon is 0.025 %, α-Ferrite is a BCC structure with small percentage of carbon (0.025) and above 910°C it converts into FCC structure.

17. Ans: (a)

Sol: In a cold chamber die casting process, molten metal is poured into injection cylinder from where metal is forced into the die cavity.

18. Ans: (c)

Sol: $\varepsilon_T = 2\ell n\left(\frac{d_i}{d_f}\right) = 2\ell n\left(\frac{10}{8}\right) = 0.446$

19. Ans: (d)

20. Ans: (b)

Sol: Low carbon stainless steel requires high percentage of chromium because low carbon steels are more corrodable.

21. Ans: (b) **22. Ans: (a)**

23. Ans: (b)

Sol: The extra-distance moved by the cutter in order to complete the material removal is known as compulsory approach, CA and is given by

$$CA = \frac{D - \sqrt{D^2 - W^2}}{2}$$

24. Ans: (c)

25. Ans: (c)

Sol: Given,

Length , L = 500 mm

Width, W = 100 mm

Cutting speed, V = 10 m/min

Feed rate, f = 0.5 mm/min

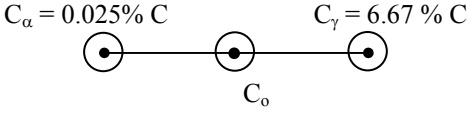
Quick return ratio, m = 0.5

Shaping time, $T = \frac{L\,W(1+m)}{f\,V}$

$$= \frac{500 \times 0.1 \times 1.5}{0.5 \times 10} = 15 \text{ min}$$

26. Ans: (d)

Sol:



$$\alpha = 0.091 = \frac{6.67 - C_o}{6.67 - 0.025}$$

C_o = 6.06 % C

27. Ans: (d)

Sol: The shortest average flow time is possible with SPT rule.

Job	Processing time	Flow time (F_j)
E	4	4
B	5	9
D	6	15
C	7	22
A	12	34
		$\Sigma F_j = 84$

$$\overline{F} = \frac{\Sigma F_j}{n} = \frac{84}{5} = 16.8$$

28. Ans: (a)

29. Ans (a)

Sol: G02 – Clockwise circular interpolation

30. Ans: (a)

Sol: Given,

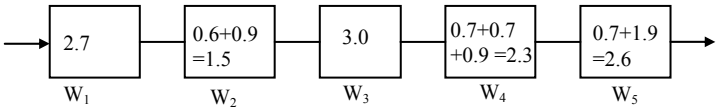
Minimum hole, d_{min} = t (thickness)

$$\sigma_{cp} = \frac{4\,t\,\tau_u}{d_{min}}$$

$$= \frac{4 \times t \times \tau_u}{t} = 4\,\tau_u$$

31. Ans: (a)

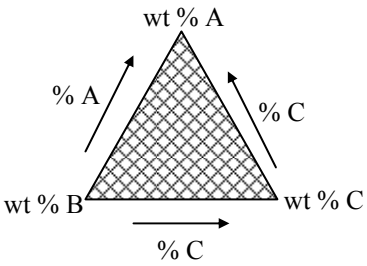
Sol:



Cycle time = Maximum of [2.7, 1.5, 3.0, 2.3, 2.6] = 3.0

32. Ans: (a)

Sol:



Tertiary phase diagram consist of 3 components. So it is drawn with three component axis and one temperature axis. The vertices represent components and sides represent binary compositions.

33. Ans: (a)

Sol:

- Hot rolling occurs at elevated temperatures, so scaling tendency is high. So, (1) is correct.
- Due to the increase in ductility, heavy reductions are possible. So, (2) is correct.
- No strain-hardening occurs. So, (3) is incorrect.
- Friction coefficient of the surface is high. So, (4) is incorrect.

34. Ans: (b)

Sol: Number of containers

$$= \frac{\text{demand during lead time} + \text{safety stock}}{\text{size of a container}}$$

Demand during lead time

$$= 2000 \times (0.08 + 0.02) = 200 \text{ units}$$

Safety stock = 10 % of demand during LT

$$= 0.1 \times 200 = 20 \text{ units}$$

No. of containers = $\frac{220}{22} = 10$

35. Ans: (b)

Sol: Pitting corrosion is a localized form of corrosion by which cavities or holes are produced in the material. Pitting is considered to be more dangerous than uniform corrosion because it is more difficult to defect predict.

36. Ans: (a)

37. Ans: (c)

Sol:

- Planimeter → Instrument to determine the area of an arbitrary 2-D shape.
- Autocollimator → Optical instrument for non-contact measurement of angles
- Clinometer → Instrument for measuring angle of slope, elevation or depression of an object with respect to gravity.
- Diffraction grating → For measuring small displacements

38. Ans: (a)

Sol: At EOQ, Annual inventory holding cost = Annual inventory ordering cost

$$= \frac{10000}{1000} \times 500 = \text{Rs. } 5000$$

39. Ans: (d)

40. Ans: (d)

41. Ans: (c)

42. Ans: (b)

Sol: Maximum value of incident angle can be 90° for which sine is 1.

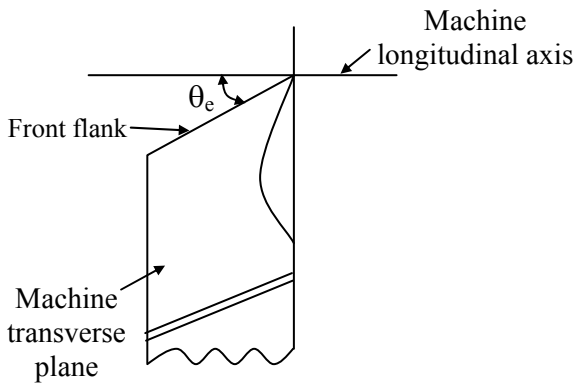
$n\lambda = 2d \sin\theta$

$\theta = 90°$

$d = \lambda/2$

43. Ans: (b)

Sol:



As clearly seen in the figure, end clearance angle (θ_e) is the angle between the front flank and machine longitudinal and it is measured in machine transverse plane.

44. Ans: (a)

45. Ans: (b)

Sol: $$R(z,-90^\circ) = \begin{bmatrix} \cos(-90) & -\sin(-90) & 0 \\ \sin(-90) & \cos(-90) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 3 \\ 2 \\ 7 \end{bmatrix}$$

$$= [\,2 \; -3 \; 7\,] = 2i - 3j + 7k$$

46. Ans: (a)

47. Ans: (b)

Sol: In blanking, die size is exact

$\therefore$ Die size = blank size = 20 mm

Punch size = die size – 2 × clearance

$= 20 - 2 \times 0.1 \times 5$

$= 19$ mm

48. Ans: (b)

49. Ans: (d)

Sol: δ-ferrite (B/C) exists over the temperature range of 1394°C to 1539°C. Maximum solubility of carbon it 0.09 %.

50. Ans: (b)

Sol: $\frac{A_1}{A_0} = 0.5$ (given)

Drawing stress, $\sigma_d = \sigma_y \times \ell n\left(\frac{A_0}{A_1}\right)$

$$\sigma_d = 100 \times \ell n(2) = 693 \text{ MPa}$$

51. Ans: (c)

Sol: Depending on the no.of dimensions, if all 3 dimensions are in 'nm' range it is termed as quantum dots (nano particles (or) clusters)

52. Ans: (c)

Sol:

- When back and front tensions are applied along the length of strip, the tensile stresses are induced in the length direction which induces compressive stresses. So, (1) is correct
- Yield strength reduction leads to higher possible draft. So, RSF is reduced. So, (2) is correct.
- RSF can be reduced by using smaller rolls and providing back-up rolls. So, (3) is correct.
- RSF decreases by decreasing friction coefficient. So, (4) is incorrect.

53. Ans: (a)

Sol: $V_{return} = \frac{Q}{A} = \frac{\text{discharging rate}}{A_c - A_r}$

$$Q = 100\,\text{LPM} = \frac{100 \times 10^{-3}\,\text{m}^3}{60\,\text{sec}} = \frac{1}{600}\,\text{m}^3/\text{sec}$$

$$V = \frac{\frac{1}{600}\,\text{m}^3/\text{sec}}{\frac{\pi}{4}\left[\left(8\times10^{-2}\right)^2 - \left(4\times10^{-2}\right)^2\right]}$$

$$= \frac{1}{600} \times \frac{4}{\pi(0.64 - 0.16)}$$

$$= \frac{4}{600 \times \pi(0.48)} = 4.42\,\frac{\text{mm}}{\text{sec}}$$

54. Ans: (a)

Sol: At the breakeven point, total revenue = total cost

Thus, breakeven point in units

$$Q^* = \frac{\text{Total fixed cost}}{\text{selling price} - \text{variable cost}}$$

$$= \frac{160000}{40 - 8} = 5000\,\text{units}$$

55. Ans: (b)

Sol: The nature of the bonding of a nanotube is described by applied quantum chemistry, specifically, orbit hybridization. Nanotubes are composed entirely of sp^2 bonds.

56. Ans: (b)

Sol:

- Pure metals and alloys behave differently on cooling and solidification. In pure metals solidification, crystal growth commences from the mold and extends towards the center. Alloys do not have a sharply defined freezing point temperature.
- When an alloy solidifies over a short range of temperature, it results into a wholly columnar structure. But over a wide range of temperature, then a dendritic structure results.
- The shrinkage allowance is provided in patterns to compensate the solid shrinkage of castings.
- Double shrinkage allowance is used for master pattern to take care of shrinkage of actual metal cast as well as the shrinkage of the pattern metal, which is called master pattern metal.

57. Ans: (d)

Sol: $\lambda = 6\,\text{hr}^{-1}$; $\mu = 10\,\text{hr}^{-1}$

Mean length of System

$$(L_S) = \frac{\lambda}{\mu - \lambda} = \frac{6}{10 - 6} = 1.5$$

58. Ans: (a)

59. Ans: (b)

Sol:

- Chaplets are used to support cores inside the mold cavity to take care of its own weight and overcome the metallic forces.
- Directional solidification can be achieved by using chills in the molds and exothermic materials in the risers or in facing sand and also by increasing thickness of certain sections by using exothermic padding.

60. Ans: (a)

Sol:

- In resistance welding, a low voltage and high current power supply is used to produce heat in the resistance between two surfaces of the components.
- Copper in alloyed form is generally used for making electrodes to take advantage of minimum electrical resistance offered.
- Due it inherent advantage for high speed and easy set-up, resistance welding is the most suitable for mass production.
- Spot welding uses the resistance of spots on the workpiece. If the metal is electrical conductor, that is, offering less resistance, less heat will be generated in spots, thus making the process difficult.

61. Ans: (c)

Sol: The continuous welding voltage is expressed in terms of open circuit voltage (V_o), the short circuit current (I_s) and continuous welding current (I) as

$$V = V_o\left(1 - \frac{I}{I_s}\right)$$

62. Ans: (d)

Sol: Severe vibration condition of a material is Fatigue condition of design

63. Ans: (c)

Sol: Weldability of cast iron is quite low. Therefore, brazing is used and arc and gas welding with special electrodes are used.

64. Ans (a)

Sol: Continuous path commands use geometry elements such as lines, circles, and planes.

For example, the command

GORGT = L3; PAST; L4

Directs the tool to go right (GORGT) along line L3 until it is positioned just past line.

65. Ans: (c)

66. Ans: (b)

Sol: The iron carbon alloy is an interstitial solid solution because the size of the carbon atom is smaller than iron so, carbon atoms get easily placed at interstitial position of Fe.

67. Ans: (b)

Sol:

- In climb milling, the chip thickness is maximum at the beginning and decreases to the minimum at the end of milling operation. So, statement (I) is correct
- Climb milling is not suitable for hot worked metals, forging, castings because these have scales on their surfaces which causes excessive damage to cutter teeth. So, statement (II) is correct but doesn't justify statement (I).

68. Ans: (b)

Sol:

- If shear is provided on the punch, the blank gets bent and becomes unuseful. So, when blank is desired, the shear is provided on die and not on punch. So, statement (I) is correct.
- When shear is provided on punch or die, less area is subjected for shear. So, punch load reduces. Hence, statement (II) is correct but doesn't justify statement (I).

69. Ans: (b)

Sol:

- Hole basis system is preferred over shaft basis system because it is easy to machine the shaft and obtain the desired fit than machining of hole. So, statement (I) is correct.
- In hole-basis system, the basic size of hole is the lower limit of the hole. So, statement (II) is correct but doesn't justify statement (I).

70. Ans: (c)

71. Ans: (a)

Sol: All u_i and v_j can be obtained if no of allocation are equal to (R+C-1) and allocations are in independent positions.

72. Ans: (b)

73. Ans: (b)

74. Ans: (b)

Sol: The function of the arm-and-body is to position an object or tool, and the wrist function is to properly orient the object or tool. Positioning is concerned with moving the part or tool from one location to another. Orientation is concerned with precisely aligning the object relative to some stationary location in the work area. To accomplish these functions, arm-and-body designs differ from those of the wrist.

75. Ans: (a)

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