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ESE- 2020 (Prelims) - Offline Test Series Test - 17

MECHANICAL ENGINEERING

Subject: Engineering Materials + Manufacturing, Industrial and Maintenance Engineering + Mechatronics & Robotics — SOLUTIONS

01. Ans: (c)

Sol:

- Sprue is the connecting passage between the pouring basin and runner for supplying molten metal to the casting cavity. It is always vertical with straight tapered circular cross section.
- Riser supplies molten metal to compensate for liquid shrinkage.
- Gate regulates flow of molten metal into mould cavity.
- Pouring basin acts as a reservoir for molten metal.

02. Ans: (d)

Sol:

- Safety stock varies with the fluctuation in demand and not with the level of demand.
- In ABC analysis, the items are classified on the basis of their annual usage/consumption value and not only on their cost.
- As the batch size rises (i.e. more units per lot), the company orders fewer times in a year thus the stock moves to lower points fewer times a year and the number of times the company is vulnerable to stock out diminishes.
- EOQ is the size of inventory order, which minimizes total annual cost of ordering and carrying inventory. It does not take into account the shortage costs at all.

03. Ans: (c)

Sol: Ultimate or yield strength values of steel is independent of diameter of steel bar or wire.

04. Ans: (b)

05. Ans: (a)

Sol: Investment casting process:

Advantages: Intricate part shapes; excellent surface finish and accuracy; almost any metal can be cast

Limitations: Part size limited; expensive patterns, molds and labor

06. Ans: (d)

Sol: The unit cell shown in the problem statement belongs to the tetragonal crystal system since a = b = 0.30 nm, c = 0.40 nm and $\alpha = \beta = \gamma = 90°$.

07. Ans: (d)

08. Ans: (a)

Sol: The Vogel's approximation method is also known as the penalty method. It uses the concept of penalty, which is the difference of two minimum unit cost elements in the row or column.

09. Ans: (d)

Sol:

- In gas *tungsten-arc welding* (GTAW): The filler metal is supplied from a *filler wire*. Because the tungsten electrode is not consumed in this operation, a constant and stable arc gap is maintained at a constant current level.
- The filler metals are similar to the metals to be welded, and flux is not used. The shielding gas is usually argon or helium, or a mixture of the two gases. Welding with GTAW may be done without filler metals, such as in welding close-fit joints.
- In general, AC is preferred for aluminium and magnesium because the cleaning action of AC removes oxides and improves weld quality.
- Thorium or zirconium may be used in the tungsten electrodes to improve their electron emission characteristics.

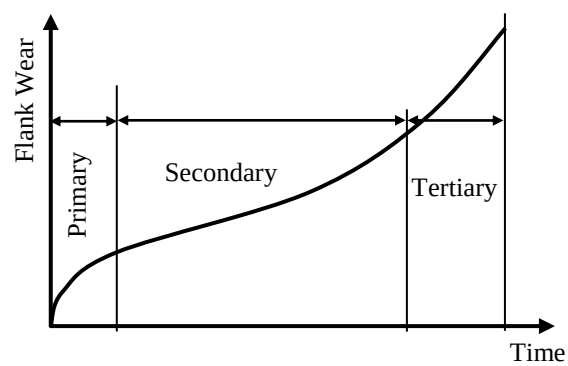
10. Ans: (c)

11. Ans: (b)

Sol: Mechanism of plastic deformation in crystals is twinning, in which a portion of the crystal forms a mirror image of itself across the plane of twinning

12. Ans: (b)

Sol:



- Tool wear is a function of cutting time.
- In the tertiary region the wear of the cutting tool becomes highly sensitive to increased tool temperature due to high wear land.
- Re-grinding is recommended before they enter this region.

13. Ans: (d)

14. Ans: (c)

Sol: Interstitial diffusion is normally more rapid than vacancy diffusion because: (1) interstitial atoms, being smaller, are more mobile; and (2) the probability of an empty adjacent interstitial site is greater than for a vacancy adjacent to a host (or substitutional impurity) atom.

15. Ans: (d)

Sol: Slope of objective function and slope constraint equation is same and optimal point lies on constraint equation having same slope as objective function then the problem has alternate optima.

16. Ans: (c)

17. Ans: (d)

Sol: Specific cutting energy = 2000 J/mm^3

V_C = 120 m / min,

f = t_1 = 0.2 mm/rev,

d = b = 2 mm

$$\text{Specific Energy} = \frac{F_C \times V_C}{t_1 \times b \times V_C}$$

$$\Rightarrow F_C \times V_C = 2000 \times 0.2 \times 2 \times 120$$

$$F_C = \frac{2000 \times 0.2 \times 2 \times 120}{120} = 800 \text{ N}$$

18. Ans: (d)

19. Ans: (a)

Sol:

- In vertical milling machine by using end and side milling cutter are used for producing dovetail recesses.
- Work table in universal milling can be swiveled to required angle.
- In peripheral milling, also called plain milling, the axis of cutter rotation is parallel to the workpiece surface.

20. Ans: (a)

Sol: Power = Force ×Velocity

$= 10 \text{ kN} \times 100 \times 10^{-3}$ /1 sec

$= 10 \times 10^3 \times 100 \times 10^{-3}$

$= 1000 = 1$ kW

21. Ans: (a)

Sol: $\lambda = 3 \text{ day}^{-1}$

$\mu = 6 \text{ day}^{-1}$

$$P_n = \left(1 - \frac{\lambda}{\mu}\right)\left(\frac{\lambda}{\mu}\right)^n = \left(1 - \frac{3}{6}\right)\left(\frac{3}{6}\right)^2 = 0.125$$

22. Ans: (a)

Sol: The Cu-Ni system is especially noted for its complete liquid and solid solubility of its constituents, and is thusly identified as an isomorphous system.

23. Ans: (d)

Sol: Double strokes per min = 30,

Quick return ratio (M) = 0.6

Stroke length = 250 mm

Average cutting velocity = L.N (1+ M)

$= 30 \times 250\ (1 + 0.6)$

$= 12.0$ m/min

24. Ans: (d)

25. Ans: (c)

Sol: Ni and Cu have nearly same lattice parameter while Al has a larger lattice parameter

26. Ans: (d)

Sol: $A_0h_0 = A_fh_f$

$d_0^2h_0 = d_f^2h_f$

$d_0^2h_0 = d_f^2h_f$

$$d_f = d_0\sqrt{\frac{h_0}{h_f}} = 100\sqrt{\frac{50}{25}} = 141.42$$

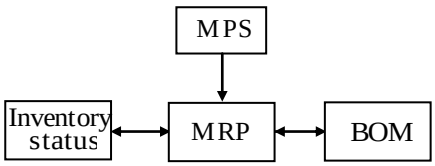
$$\% \text{ change diameter} = \frac{141.42 - 100}{100}$$

$= 41.4\%$

27. Ans: (a)

28. Ans: (d)

Sol:



29. Ans: (b)

Sol: A eutectic system is a homogeneous, solid mixture of two or more substances that form a super-lattice; the mixture either melts or solidifies at a lower temperature than the melting point of any of the individual substances.

30. Ans: (a)

31. Ans: (c)

Sol: In cold working the strength and hardness will increase and better surface finish is produced. Hence statements 3 and 4 are INCORRECT.

32. Ans: (c)

Sol: Carburizing is the most widely used method of surface hardening. Here, the surface layers of low carbon steel are enriched with carbon up to 0.8-1.0%. The source of carbon may be a solid medium, a liquid or a gas. In all cases, the carbon enters the steel at the surface and diffuses into the steel as a function of time at an elevated temperature. Carburizing is done at 920-950^{o} C. This fully austenitic state is essential.

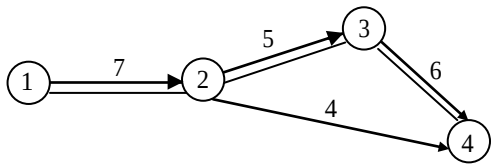
If carburizing is done in the ferritic region, the carbon, with very limited solubility in ferrite, tends to form massive cementite particles near the surface, making the subsequent heat treatment difficult. For this reason, carburizing is always done in the austenitic state, even though longer times are required due to the diffusion rate of carbon in austenite being less that in ferrite at such temperatures.

33. Ans: (d)

34. Ans: (c)

Sol:

Activity	**$\text{CostSlope} = \frac{\Delta C}{\Delta T}$**
1–2	$\frac{1800-1000}{7-3} = 200$
2–3	$\frac{950-800}{4-3} = 150$
2–4	$\frac{850-700}{4-2} = 75$
3–4	$\frac{1200-900}{6-3} = 100$

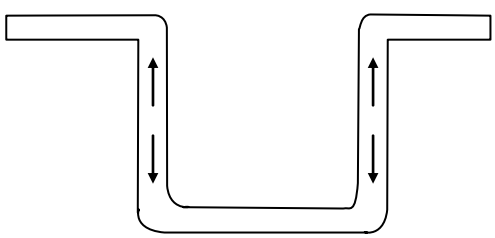


To reduce the project duration, we need to crash critical activities.

Option	Cost Slope
1 – 2	200
2 – 3	150
3 – 4	100

35. Ans: (c)

Sol:



The vertical wall zone is also known as deformation zone, because entire deformation happens in this zone. The stresses responsible for this deformation are tensile stresses only.

36. Ans: (a)

37. Ans: (c)

Sol: Boriding, also called boronizing, is the process by which boron is introduced to a metal or alloy. It is a type of surface hardening. In this process boron atoms are diffused into the surface of a metal component. The resulting surface contains metal borides, such as iron borides, nickel borides, and cobalt borides, as pure materials, these borides have extremely high hardness and wear resistance.

38. Ans: (d)

Sol: To produce 100 units of 'A'

No of 'D' is required = $4\times2\times100+5\times3\times100$

$= 800+1500 = 2300$

39. Ans: (b)

40. Ans: (a)

Sol: *Computer aided process planning*(CAPP) is uses the geometric information (such as shape size etc), and information technology (such as materials, heat treatment, bulk) which are input into the computer to outputs parts of the route of the process and procedures automatically. CAPP uses computer to design and build a bridge between the manufacture and the design. So statement (1) is incorrect.

- *Approaches to cell formation*

  (1) component shape and features

  (2) product flow analysis

  (3) mathematics

  So, statement (2) is Correct.

- *Group technology* is a concept that seeks to take advantage of the design and processing similarities among parts to be produced so statement (3) is incorrect.

41. Ans: (b)

Sol: The quenching process produces residual strains (thermal, phase transformation).

42. Ans: (d)

Sol: Assignment model solution is always a degenerate solution because; only one job could be allocated to one machine or vice versa.

Assignment model is a special case of transportation problem in which each source and destination will have unity capacity and requirement and also allocations are made on one to one basis.

43. Ans: (d)

44. Ans: (b)

Sol:

- Flaws or defects are random irregularities, such as scratches, cracks, holes, depressions, seams, tears, or inclusions.
- Lay (directionality) is the direction of the predominant surface pattern, usually visible to the naked eye.
- Roughness is defined as closely spaced, irregular deviations on a small scale; it is expressed in terms of its height, width, and distance along the surface.
- Waviness is a recurrent deviation from a flat surface; it is measured and described in terms of the distance between adjacent crests of the waves (waviness width) and the height between the crests and valleys of the waves (waviness height).

45. Ans: (a)

Sol: The composition of the steel is 0.2% carbon, 18% chromium and 2% nickel.

46. Ans: (b)

Sol: In Electro-chemical machining an **electrolyte** acts as the current carrier.

In EDM, dielectric fluid is used. So statement 2 is INCORRECT. So option (b) is correct option.

In *ultrasonic machining* (UM), material is removed from a surface by *microchipping* and *erosion*, with loose, fine abrasive grains in water slurry.

47. Ans: (c)

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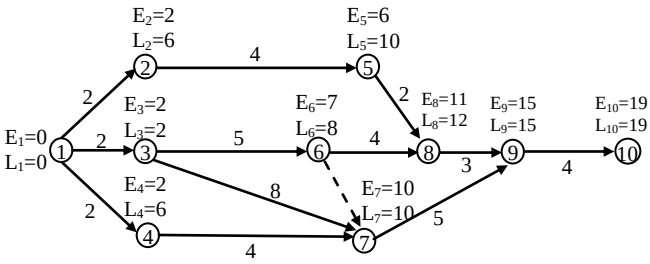
48. Ans: (c)

Sol:



49. Ans: (c)

Sol: Zirconium (Zr, from the mineral zircon) is silvery in appearance; it has good strength and ductility at elevated temperatures and has good corrosion resistance because of an adherent oxide film. Zirconium is used in electronic components and in nuclear-power reactor applications because of its low neutron absorption.

50. Ans: (c)

51. Ans: (c)

52. Ans: (c)

Sol: An MRP system has three major input components:

1. Master Production Schedule (MPS)
2. Bill of Materials (BOM)
3. Inventory Status File

After getting input from these sources, MRP logic processes the available information and gives information about the following.

1. Planned Orders Receipts
2. Planned Order Release
3. Order Rescheduling

53. Ans: (d)

Sol: Polymer fibers may be made of aramids, nylon, rayon, or acrylics; the most common are aramid fibers. Aramids, such as Kevlar, are among the toughest fibers, with very high specific strength.

54. Ans: (b)

55. Ans: (c)

56. Ans: (d)

Sol: ***Carbon Fiber–Reinforced Polymer (CFRP) Composites***

Carbon is a high-performance fiber material that is the most commonly used reinforcement in advanced (i.e., nonfiber glass) polymer-matrix composites. The reasons for this are as follows:

1. Carbon fibers have the highest specific modulus and specific strength of all reinforcing fiber materials.

2. They retain their high tensile modulus and high strength at elevated temperatures; high-temperature oxidation, however, may be a problem.
3. At room temperature, carbon fibers are not affected by moisture or a wide variety of solvents, acids, and bases.
4. These fibers exhibit a diversity of physical and mechanical characteristics, allowing composites incorporating these fibers to have specific engineered properties.
5. Fiber and composite manufacturing processes have been developed that are relatively inexpensive and cost effective.

57. Ans: (a)

Sol: Optimality test can be performed only if the initial solution is non-degenerate which is possible with total number of allocation equal to (m + n – 1) and these allocations are independent.

If total demand is higher than the supply, then we assume one more row in supply, such that its total supply = demand and all the costs in that row are zero.

58. Ans: (b)

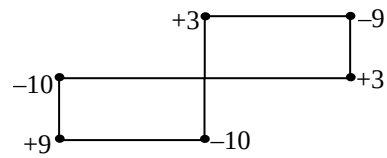
59. Ans: (b)

60. Ans: (c)

Sol: Crevice corrosion is more pronounced on flat and smooth surface

61. Ans: (a)

Sol:



Cell evaluation = +3 – 9 + 3 – 10 + 9 – 10

= –14

Cost decreases at 14 per unit

62. Ans: (b)

Sol: A welded joint can have a low resistance to corrosion due to the varying chemical composition, residual stress and metallurgical structure of the weld zone.

63. Ans: (b)

Sol: $P_{\text{fixed frame}} = R(Z,90°).P_{\text{movable}}$ frame (or)

$P_{\text{movable frame}} = R(Z,-90°).P_{\text{fixed frame}}$

$$= \begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 4 \\ 3 \\ 2 \end{bmatrix} = \begin{bmatrix} 3 \\ -4 \\ 2 \end{bmatrix}$$

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64. Ans: (a)

Sol: Total Cost (TC) = FC+VC(Q)

$$TC|_P = 1{,}00{,}000 + 20(5000) = 2{,}00{,}000$$

$$TC|_Q = 90000 + 25(5000) = 215000$$

$$TC|_R = 85000 + 30(5000) = 2{,}35{,}000$$

$$TC|_S = 25000 + 35(5000) = 2{,}50{,}000$$

'P' is the best option

65. Ans: (d)

Sol: 1D – nanowire, nanotube

2D – nanosheet

3D – nanoparticles

66. Ans: (b)

Sol: At EOQ

Annual procurement = Annual carrying cost

$$= \frac{Q}{2} \times C_c$$

$$= \frac{200}{2} \times 10$$

= Rs. 1000

67. Ans: (a)

68. Ans: (a)

Sol: Fullerene - molecule composed entirely of carbon in the form of a hollow sphere and resemble the balls used in football.

69. Ans: (a)

Sol: With a higher oxygen supply, the flame can be harmful (especially for steels), because it oxidizes the metal; for this reason, a flame with excess oxygen is known as an *oxidizing flame.* Only in the welding of copper and copper-based alloys is an oxidizing flame desirable, because in those situations, a thin protective layer of *slag* (compounds of oxides) forms over the molten metal.

70. Ans: (c)

Sol: Ferritic and austenitic steels are hardened and strengthened by cold work because they are not heat treatable. On the other hand martensitic steels are heat treatable. Austenitic steels are most corrosion resistant, and they are produced in large quantities. Austenitic steels are non-magnetic as against ferritic and martensitic steels, which are magnetic.

71. Ans: (c)

72. Ans: (a)

Sol: The three uncertain time phases in PERT are optimistic, most likely and pessimistic time estimates.

73. Ans: (b)

74. Ans: (a)

Sol: Lathe machine with turret can turn a work piece of limited length only because during turning with turret the cross slide motion is obstructed by the turret.

75. Ans: (b)

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