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ESE- 2020 (Prelims) - Offline Test Series Test - 5

MECHANICAL ENGINEERING

Subject: MANUFACTURING, INDUSTRIAL AND MAINTENANCE ENGINEERING + MECHATRONICS AND ROBOTICS — SOLUTIONS

01. Ans: (d)

Sol: Plaster-mold Casting process, the ceramic-mold and investment casting processes are known as precision casting, because of the high dimensional accuracy and good surface finish obtained.

02. Ans: (c)

Sol: Variance along the critical path never be zero.

03. Ans: (c)

Sol: In absolute optical encoder, the preferred coding technique used is Gray code.

04. Ans: (c)

05. Ans: (a)

Sol: The GTAW process is used for a wide variety of applications and metals, particularly aluminum, magnesium, titanium, and the refractory metals; it is especially suitable for *thin metals.*

The temperatures generated in GMAW are relatively low; consequently, this method is suitable only for *thin sheets* and sections of less than 6 mm; otherwise incomplete fusion may result.

06. Ans: (c)

07. Ans: (b)

Sol: D = 10000 units

C_O = 500/order

C_C = 10 /unit/year

$$EOQ = \sqrt{\frac{2DC_O}{C_C}} = \sqrt{\frac{2\times 10000\times 500}{10}}$$

$$= 1000 \text{ units}$$

08. Ans: (a)

Sol: Power = Force × Velocity

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

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

$= 1000 = 1 \text{ kW}$

09. Ans: (b)

10. Ans: (d)

Sol: Electrode Coatings:

Electrodes are coated with claylike materials that include silicate binders and powdered materials, such as oxides, carbonates, fluorides, metal alloys, cotton cellulose, and wood flour. The coating, which is brittle and takes part in complex interactions during welding, has the following basic functions:

- Stabilize the arc
- Generate gases, to act as a shield against the surrounding atmosphere; the gases produced are carbon dioxide, water vapor, and small amounts of carbon monoxide and hydrogen
- Control the rate at which the electrode melts
- Act as a flux, to protect the weld against the formation of oxides, nitrides, and other inclusions and, with the resulting slag, to protect the molten-weld pool
- Add alloying elements, to the weld zone to enhance the properties of the joint — among these elements are deoxidizers to prevent the weld from becoming brittle

11. Ans: (d)

12. Ans: (c)

Sol: No. of basic variables (No. of allocations)

$\geq m + n - 1$

$\geq 4 + 5 - 1$

≥ 8

13. Ans: (a)

Sol: $R(Z,\theta)=\begin{bmatrix}\cos\theta & -\sin\theta & 0\\ \sin\theta & \cos\theta & 0\\ 0 & 0 & 1\end{bmatrix}$, $\theta = 45°$ then

$$=\begin{bmatrix}\frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} & 0\\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0\\ 0 & 0 & 1\end{bmatrix}$$

Point Q = R(Z, 45°) P

$$=\begin{bmatrix}0.707 & -0.707 & 0\\ 0.707 & 0.707 & 0\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}4\\3\\2\end{bmatrix}=\begin{bmatrix}0.707\\5\\2\end{bmatrix}$$

14. Ans: (D)

Sol: Shear strain, $\gamma = \tan(\phi-\alpha) + \cot\phi$

$\Rightarrow \gamma = \tan\phi + \cot\phi[\alpha = 0 \text{ (given)}]$

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

Where, r : chip thickness ratio

$\tan\phi = r = 0.25$

$\therefore \quad \gamma = r + \frac{1}{r} = 0.25 + 4$

$\gamma = 4.25$

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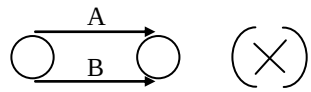
15. Ans: (c)

16. Ans: (a)

Sol: A Robot with more DOF has more dexterity and flexibility.

17. Ans: (c)

Sol: Two different activities can not be identified by the same beginning and end events.



18. Ans: (a)

Sol: When we observe the curves both the curves are parallel which means that 'n' for both tools is same and for a given cutting velocity for tool 'A' the Tool life is greater. Hence, the 'C' is greater for tool 'A'.

19. Ans: (a)

Sol: For SCARA Robot the ratio of work volume to floor space is high.

20. Ans: (a)

Sol: The main reasons for low values of undeformed chip thickness in grinding are:

1. Small grains
2. High cutting speed
3. Low feed rate
4. Close packed grain structure
5. Smaller depth of cut.

21. Ans: (c)

22. Ans: (a)

23. Ans: (b)

Sol:

(a) Unnecessary usage of dummy activity in between 4 & 5.

(b) Correctly drawn.

(c) Fulkerson's rule is violated for representing dummy activity (3) to (2).

(d) Looping error.

24. Ans: (c)

Sol: It is exactly same effect as that of the setting of tool below center line in case of external turning operation.

25. Ans: (a)

Sol: $\lambda = 6/hr$,

$\mu = 60/6 = 10/hr$

$$\rho = \frac{\lambda}{\mu} = \frac{6}{10} = 0.6$$

Probability that the customer does not have to wait = $P(0) = 1 - \rho = 1 - 0.6 = 0.4$

26. Ans: (c)

27. Ans: (a)

Sol: The minimum and maximum risk priority numbers in Failure Mode Effects & Criticality are 1 and 1000.

28. Ans: (a)

Sol: The material-removal rate is calculated from

$$MRR = \left(\frac{\pi D^2}{4}\right) f\ N$$

$$MRR = \frac{\pi \times 10^2}{4} \times 0.2 \times \frac{800}{60}$$

The power required, P = MRR × 0.5

$$\omega = \frac{2\pi N}{60} = \frac{2 \times \pi \times 800}{60}$$

$$P = T\omega$$

$$T \times \frac{2\pi 800}{60} = 0.5 \times \frac{\pi}{4} \times 100 \times 0.2 \times \left(\frac{800}{60}\right)$$

Torque, $T = \frac{P}{\omega} = \frac{5}{4}$ = 1.25 N-m

29. Ans: (b)

30. Ans: (a)

Sol: Economic order quantity is the quantity at which annual cost is minimum

31. Ans: (c)

Sol: 60° in 0.02 sec.

So, 360° (1 Rotation) → ?

$$\frac{360}{60} \times 0.02 = 0.12 \text{sec}$$

$$\frac{1R}{0.12 \text{sec}} = \frac{100}{12} \text{rps}$$

Speed = $\frac{100}{12} \times 60$ = 500 rpm

32. Ans: (c)

Sol: Counterboring and countersinking drills produce depressions on the surface to accommodate the heads of screws and bolts below the workpiece surface.

Centerless grinding is a high-production process for grinding cylindrical surfaces; *the workpiece is supported not by centers (hence the term "centerless") or chucks, but by a blade*.

Capstan lathe is ram type turret lathe and the movement of the ram is limited.

33. Ans: (b)

34. Ans: (d)

Sol: Forecasting → Aggregate plan → MPS → MRP → CRP

35. Ans: (a)

Sol: Cartesian arm configuration gives large work volume with low dexterity.

36. Ans: (a)

Sol: Engineering stress (S) = 460 MPa

Initial cross sectional area (A_o) = 10 mm

Instantaneous area (A) = 8 mm

Load, (F) = $S \times A_o = 460 \times \frac{\pi}{4} \times 10^2$

$$\text{True stress} = \frac{F}{A} = \frac{460 \times \frac{\pi}{4} \times 10^2}{\frac{\pi}{4} \times 8^2} \approx 718 \text{ MPa}$$

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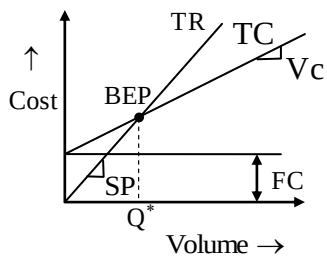
37. Ans: (c)

Sol: Based on 3×3 rotation matrix and 3×1 position vector, change in both position and orientation.

38. Ans: (b)

Sol:



BEP increases if FC increases and VC increases

$$Q^* = \frac{FC}{SP - VC}$$

39. Ans: (b)

Sol: Statement 1 & 4 are incorrect because in

Statement 1: PLC not replace micro processor, as it is a part of PLC.

Statement 4: Not requires extensive wiring by PLC.

40. Ans: (d)

Sol:

Stresses induced	**Operations**
Shearing	Shearing, blanking, piercing, trimming shaving, *notching*, nibbling
Tension	Stretch forming, *wire drawing*
Compression	Coining, sizing, *ironing*, hobbing
Tension and compression	*Deep drawing*, spinning, bending, forming embossing

41. Ans: (c)

Sol: The Robot inverse kinematics is used to find Joint angles.

42. Ans: (b)

Sol: $\alpha = \frac{2}{n+1}$

Where n = no. of periods

For unstable demand data, 'n' should be less

$\Rightarrow$ 'α' should be high.

43. Ans: (b)

Sol: hydraulic actuator the total volume of fluid enter inside the cylinder decides the piston rod expansion parameter of length.

44. Ans: (b)

Sol: $\text{Spring back} = \frac{R_f}{R_i}$,

$$\text{Spring back} \propto \frac{R}{t}$$

$$= 4\left(\frac{R \cdot \sigma_y}{E \cdot K}\right)^3 - 3\left(\frac{R}{tE}\right) + 1$$

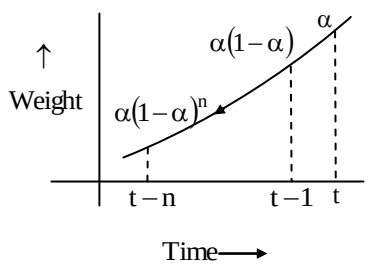
$$\text{Spring back} \propto \sigma_y$$

$$\propto \frac{1}{E}.$$

45. Ans: (d)

46. Ans: (c)

Sol: In exponential smoothening, weights are decreased exponentially as age of the data increases.



Highest weight = α

Lowest weight = $\alpha(1-\alpha)^n$

47. Ans: (c)

48. Ans: (b)

49. Ans: (c)

Sol: Post processor is used in CNC machines only but no post processor is used in NC machines. Hence statement 4 is INCORRECT. A Post Processor is a unique "driver" specific to a CNC machine, robot or mechanism, the Post-Processor works with the CAM software or off-line programming software to make sure the G-Code output or program is correct for a specific machine build.

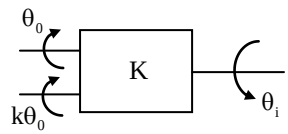
50. Ans: (b)

51. Ans: (c)

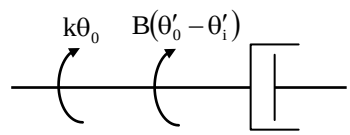
Sol: Dummy activity is not required in Activity-On-Node (AON) diagram. It required in Activity-On-Arrow diagram to satisfy the precedence relationship.

52. Ans: (b)

Sol: Given physical system with damper, spring components, so free body diagram.



Net torque (algebraic sum) = 0



$$B(\theta_i' - \theta_0') + k\theta_0 = 0$$

53. Ans: (d)

Sol: EDM → Die sinking

ECM → Machining contours

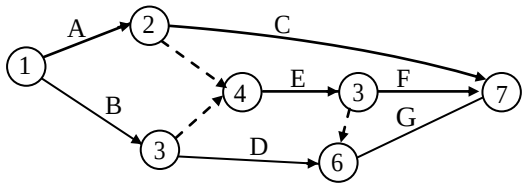
USM → Drilling holes in glass

LBM → Drilling micro holes in very hard metals

54. Ans: (b)

55. Ans: (b)

Sol:



56. Ans: (c)

Sol: Actuators are important control devices these are used in wide variety of applications. Their function is to produce rotational or linear movement.

57. Ans: (c)

58. Ans: (b)

59. Ans: (d)

Sol: Advantages of ultrasonic machining process are:

(i) The process can machine electrically conductive as well as non-conducting hard and brittle materials.

(ii) There is no direct contact between tool and workpiece therefore, the machined surface is free from excess stress and mechanical damages.

(iii) There is no thermal damage such as thermal cracks and heat affected zone on the machined surface as the water abrasive slurry is used during machining.

(iv) It can produce rough as well as finish surface with good structural integrity.

(v) It can produce burr-free surface.

(vi) It can machine chemically active as well as inert materials.

(vii) It can create any shape depending upon tool shape on very hard and brittle materials, such as glass, silicon, quartz crystal, sapphire, nitride, ferrite and optics.

(viii) Using micro-tool, it can generate micro complex shaped cavity or hole on workpiece.

(ix) Power consumption is less.

60. Ans: (c)

61. Ans: (a)

Sol: Initial solution techniques in transportation problem are :

1. North west corner method
2. Least cost method
3. Vogel's approximation method

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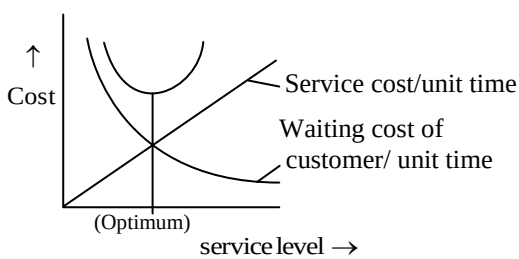
62. Ans: (d)

63. Ans: (b)

Sol: **Pressure Casting:** In *pressure casting* (also called *pressure pouring* or *low-pressure casting),* the molten metal is forced upward by gas pressure into a graphite or metal mold. The pressure is maintained until the metal has solidified completely in the mold. The molten metal also may be forced upward by a vacuum, which also removes dissolved gases and produces a casting with lower porosity. Pressure casting is generally used for high-quality castings, such as steel railroad-car wheels, although these wheels also may be cast in sand molds or semi-permanent molds made of graphite and sand.

64. Ans: (d)

Sol:



65. Ans: (d)

66. Ans: (d)

67. Ans: (a)

Sol: The grade of a bonded abrasive is a measure of its bond strength, including both the type and the amount of bonding material in the wheel. Because strength and hardness are directly related, the grade is also referred to as the hardness of a bonded abrasive. Thus, for example, a hard wheel has a stronger bond and/or a larger amount of bonding material between the grains than a soft wheel.

68. Ans: (b)

Sol: In transportation model, in order to proceed for an optimal solutions the initial solutions must be non-degenerate, i.e., the number or allocations must be greater than or equal to (row + column – 1)

69. Ans: (d)

Sol: Hard automation generally involves mass-production machines that lack flexibility. So Statement (I) is incorrect. Greater flexibility is achieved in *soft automation,* also called **flexible** or **programmable automation,** through the use of computer control of the machine and of its functions; thus, soft automation can produce parts with complex shapes. So Statement (II) is correct. Hence option (d) is correct.

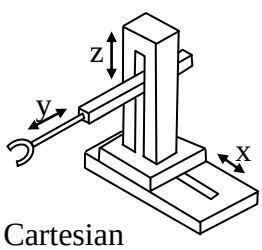
70. Ans: (a)

71. Ans: (b)

72. Ans: (c)

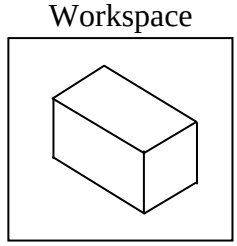
Sol: Features of Cartesian coordinate configuration are:

- It has three mutually perpendicular axes which defined a rectangular work volume.
- Repeatability of motion.
- Rigid structure and load carrying capacity.
- Work volume is rectangular shape.
- This configuration of three linear joints.



Cartesian

Workspace



73. Ans: (b)

74. Ans: (b)

75. Ans: (b)