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ESE- 2018 (Prelims) - Offline Test Series

Test - 7

MECHANICAL ENGINEERING

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

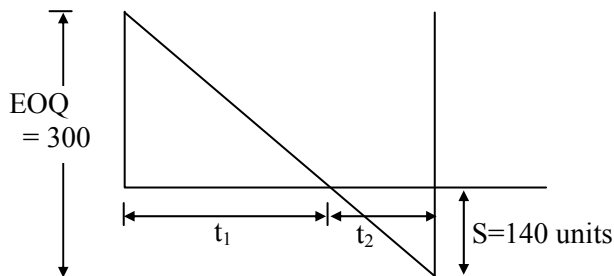
01. Ans: (a)

Sol:

- Back rake is the angle between the rake face of the tool and line passing through the tip of the tool, parallel to the base plane.
- Back rake angle is measured in machine transverse plane which is observed in front view of the tool.

02. Ans: (c)

Sol:



t_1 = time period during which there is availability of stock

$$= \frac{EOQ - S}{\text{Consumption rate (demand)}}$$

$$= \frac{300 - 140}{20} = 8 \text{ days}$$

03. Ans: (c)

Sol: Shoulder and elbow joints have high compliance and soft to maintain high speed.

04. Ans: (b)

Sol: During the machining of brittle material, only discontinuous chips are produced because the chips lack plasticity and fail to accumulate. So, the material ahead of the tool edge fails in a brittle fracture manner along the shear zone.

05. Ans: (d)

Sol: Despatching is in Production Planning Control



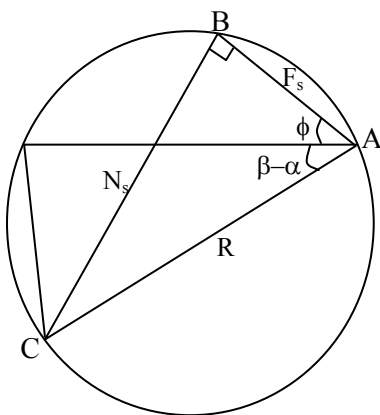
Bucket refers to an individual period indicated by MRP list. Speaking of "The size of Bucket", it shows the size of one period, and how detailed MRP's plan is depends on how long or what days the bucket is set.

06. Ans: (c)

Sol: When an analog signal is converted to digital data a virtual (or imaginary) wave is obtained which does not contains the original signal however it is a representative to the acquired signal and this phenomenon is called aliasing. To overcome the aliasing, when a signal is composed of the components and the sample must be with frequencies higher than 2xsmaller frequency component. Hence the sampling frequency in this problem should be $\geq 16\text{kHz}$ ($\geq 2 \times 8\text{kHz}$).

07. Ans: (c)

Sol:



From the triangle ABC,

$$N_s = R \sin (\phi + \beta - \alpha)$$

08. Ans: (b)

Sol: Production from a line is controlled by the slowest operation.

Therefore, the system efficiency

$$\begin{aligned} &= \frac{\text{Actual capacity}}{\text{System capacity}} \\ &= \frac{80}{150} = 53.33\% \end{aligned}$$

09. Ans: (b)

Sol: An oscilloscope used to detect the shaft vibrations by providing visual representation of the vibrational signal with "Time domain".

Some oscilloscopes enable a phase-indicating pulse of extra-bright beam to be displaced on the orbit once per revolution of the shaft and the shape of the orbit is called as Lissajous figure which most useful tool in monitoring machine health.

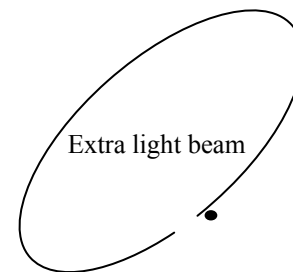


Fig: Lissajous figure



10. Ans: (c)

Sol: Following are some ideal conditions that enhance the promotion of continuous chips without BUE formation.

- high cutting speed
- low feed rate
- large back rake angle
- less friction in tool-chip interface

11. Ans: (c)

Sol:

| Job | Due Date (days) | Process Time (days) | Slack = Due Date – Processing Time |
|-----|-----------------|---------------------|------------------------------------|
| A | 8 | 7 | 8 – 7 = 1 |
| B | 3 | 4 | 3 – 4 = –1 |
| C | 7 | 5 | 7 – 5 = 2 |
| D | 9 | 2 | 9 – 2 = 7 |

As per least slack rule, the jobs are loaded in the increasing order of their slack values.

Therefore, the correct order is B-A-C-D

12. Ans: (c)

$$\text{Sol: } R[\psi, -90^\circ] = \begin{bmatrix} C(-90^\circ) & 0 & S(-90^\circ) & 0 \\ 0 & 1 & 0 & 0 \\ -S(-90^\circ) & 0 & C(-90^\circ) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

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

$$P(\text{fixed frame}) = \begin{bmatrix} 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 5 \\ 2 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} -1 \\ 2 \\ 5 \\ 1 \end{bmatrix}$$

$$= [-1, 2, 5]^T$$

13. Ans: (b)

Sol: $V = \pi DN$

$$11 = \frac{22}{7} \times \frac{35}{1000} \times N$$

$$N = 100 \text{ rpm}$$

$$f_m = f_t \times z \times N$$

$$= 0.025 \times 20 \times 100$$

$$f_m = 50 \text{ mm/min}$$

14. Ans: (a)

Sol: Orthogonal and linear are prismatic joints and SCARA ARM, first joint is revolving (V).

15. Ans: (c)

Sol: Tactile sensors: Micro switches, Piezoelectric Crystals, Potentiometers, Electric strain gauges, LVDT, Resolver, Encoders.

Non Tactile Sensors: Proximity sensors (Hall Effect sensor), Range imaging sensors, ultrasonic sensors, Electro optimal vision sensors, magnetic sensor.



16. Ans: (c)

Sol: Annual Demand, $A = 3200$

Cost per order, $S = 150$

Cost per unit, $C = 6$

Inventory carrying cost = 0.25

$$Q = \text{EOQ} = \sqrt{\frac{2AS}{CI}}$$

$$= \sqrt{\frac{2 \times 3200 \times 150}{6 \times 0.25}} = 800 \text{ units}$$

Time between two consecutive orders

$$= \frac{Q}{A} \times \text{Time} = \frac{800}{3200} \times 12 = 3 \text{ months}$$

17. Ans: (c)

18. Ans: (c)

Sol:

- Reaming is the operation used for sizing and finishing the hole to get exact dimension of the hole. With reamer very less amount of material is removed. So (a) is incorrect.

- Boring is an internal turning operation performed by using single point cutting tool. So (b) is incorrect.
- Counter boring is the process of enlarging the end of hole by using single point cutting tool.
- Trepanning is the operation used for producing large size holes without drilling. So (d) is incorrect.

19. Ans: (c)

Sol: $270^\circ \rightarrow 0.06 \text{ sec}$ then $360^\circ \rightarrow ?$

$$\frac{360}{270} \times 0.06 = 0.08 \text{ sec}$$

1 Rotation $\Rightarrow 0.08 \text{ sec}$

$$\frac{1R}{0.08 \text{ sec}} = \frac{100}{8} R/S = 12.5 \text{ RPS}$$

$$12.5 \times 60 = 750 \text{ RPM}$$

Pre GATE-2018

COMPUTER BASED TEST

Date of Exam : 20th Jan 2018

Last Date To Apply : 05th Jan 2018



20. Ans: (b)

Sol: At EOQ with shortages

Ordering cost = inventory carrying cost =
shortage cost

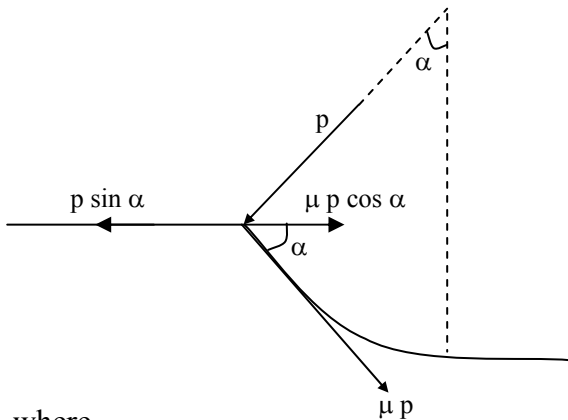
Total variable cost = ordering cost +
inventory carrying cost + shortage cost

$$= 1000 + 1000 + 1000$$

$$= \text{Rs. } 3000 \text{ /-}$$

21. Ans: (c)

Sol:



where,

p = pressure exerted by roll on strip
material,

μp = frictional force

For self-entry,

$$\mu p \cos \alpha \geq p \sin \alpha$$

$$\therefore \mu \geq \tan \alpha$$

22. Ans: (a)

Sol: Inherent availability (A_i) = $\frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}$

where, MTBF = Mean time between failure,

MTTR = Mean time to repair / mean time to
replace (if given, mean waiting time for

spares and mean administrative time is also
included)

$$\text{Availability} = \frac{500}{500 + 5 + 48 + 2}$$

$$= \frac{500}{555} = 0.90$$

The automobile would be available 90% of
the time.

23. Ans: (b)

Sol: Welding → pressure vessels

Extrusion → collapsible tubes

Forging → connecting rods

Casting → machine tool beds

24. Ans: (b)

Sol: Since it is a blanking operation, die size will
be exact.

$$\therefore d_{\text{die}} = d_{\text{blank}} = 20 \text{ mm}$$

$$\text{and } d_{\text{punch}} = d_{\text{die}} - 2c$$

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

$$= 20 - 1 = 19 \text{ mm}$$

25. Ans: (c)

Sol: In metal subjected to cold forming, plastic
deformation increases dislocation density,
which creates resistance to further
deformation. Hence, the strength and
hardness of material increases.



26. Ans: (c)

27. Ans: (b)

Sol: In a 3-high mill, the sheet being rolled is repeatedly raised to the upper roll gap, rolled and then lowered to the lower roll gap by elevators and various manipulators. Thus the direction of material movement is reversed after each pass giving two reduction in thickness.

28. Ans: (d)

29. Ans: (a)

Sol: Compressive stress generated on punch \geq crushing strength

$$\begin{aligned} \therefore \sigma_{cp} &\geq \frac{\sigma_{cp,allowable}}{FOS} \\ \Rightarrow \frac{F_{max}}{A} &\geq \frac{\sigma_{cp,allowable}}{FOS} \\ \Rightarrow \frac{\pi d t \tau_u}{\left(\frac{\pi d^2}{4}\right)} &\geq \frac{\sigma_{cp,allowable}}{FOS} \\ \Rightarrow d_{min} &= \frac{4 t \tau_u}{\sigma_{cp,allowable}} \times FOS \\ &= \frac{4t}{4} \times 2 \\ d_{min} &= 2t \end{aligned}$$

30. Ans: (d)

$$\text{Sol: Efficiency} = \frac{\text{actual output}}{\text{effective capacity}}$$

$$= \frac{36}{40} = 0.9 \text{ or } 90\%$$

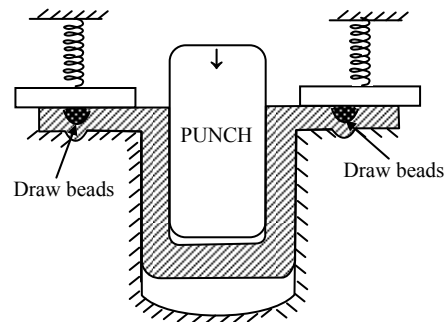
$$\text{Utilisation} = \frac{\text{actual output}}{\text{Design capacity}}$$

$$= \frac{36}{50} = 0.72 \text{ or } 72\%$$

31. Ans: (b)

Sol:

- Draw beads restrict the flow of the sheet metal by bending and unbending it during drawing; they thereby increase the drawing load, so option 1 is incorrect.
- Draw beads also help to reduce the required blank holder forces, because the beaded sheet has a higher stiffness and hence a lower tendency to wrinkle. So, option 2 and 3 are correct.





32. Ans: (b)

$$\text{Sol: } P(QS > N) = \left(\frac{\lambda}{\mu}\right)^{N+1}$$

$$\mu = 1/6 \text{ min}^{-1}, \quad \lambda = 1/10 \text{ min}^{-1}$$

A queue will be there when there is more than one customer in system.

$$P(QS > 1) = \left(\frac{\lambda}{\mu}\right)^2$$

$$= \left(\frac{1/10}{1/6}\right)^2 = \left(\frac{3}{5}\right)^2 = \frac{9}{25} = 0.36$$

33. Ans: (b)

Sol: For 'H' type holes,

Shafts with 'a' to 'g' → clearance fit

'p' to 'zc' → interference fit

'h' to 'n' → transition fit

∴ H8p7 is an example of interference fit.

34. Ans: (b)

35. Ans: (a)

Sol: In die casting process, die acts as a heat sink for the molten metal. The metal chills rapidly, developing a fine-grain hard skin with higher strength. As a result, the strength-to-weight ratio of die-cast parts increases with decreasing wall thickness.

36. Ans: (d)

$$\text{Sol: } Z = \frac{ROL - \mu}{\sigma} = \frac{120 - 100}{20} = +1$$

$$\mu = 100, \text{ ROL} = 120, \sigma = 20$$

For $Z = +1$ service level is 84.13%

37. Ans: (c)

Sol: Casting defects are attributed to improper gating system:

- Misruns, cold-shuts and laps - too slow a rise of metal.
- Sand, slag and dross inclusions - turbulence of metal.
- Rough surface, metal penetration - too fast a rise of metal.
- Localised shrinkage, porosity - improper directional solidification.
- Excessively oxidized metal - improper gating ratio.
- Scabbing - too slow a rate of pouring.

38. Ans: (c)

Sol: Dispatching starts with input as route sheet and schedule chart. It concerns itself with starting the process and operation of production.

39. Ans: (d)

Sol: During the cooling of a liquid alloy, on reaching liquidus temperature, solid



particles or nuclei are first formed. They gradually grow in different directions based on the rate of heat loss, in tree-shaped dendrites, trapping the balance liquid in between their solid branches. The dendrites grow till they touch the adjoining ones, finally forming solid grains or crystals. The impurities are normally pushed to the grain boundaries. The size and type of grains formed depend upon the type of alloy, rate of heat extraction from liquid metal in the mold cavity and the geometry of the casting. As finer grains have superior mechanical properties like tensile strength, toughness and ductility, it is the attempt of every foundry to create conditions favourable to their formation and avoid coarse and columnar grains.

40. Ans: (b)

Sol: $Z_{\min} = -3x_1 + 4x_2$

subjected to

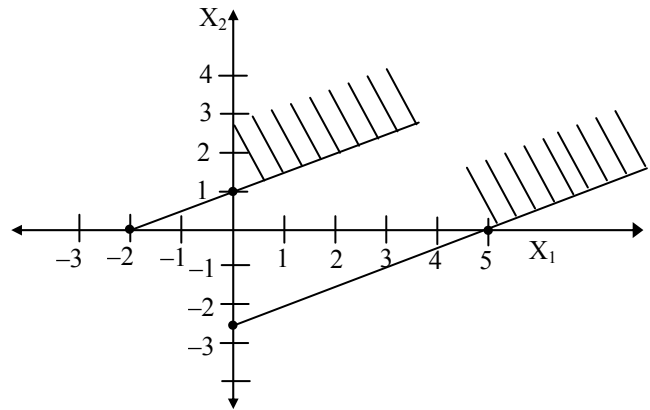
$$-x_1 + 2x_2 \geq 2$$

$$x_1 - 2x_2 \geq 5$$

$$x_1, x_2 \geq 0$$

$$\frac{x_1}{-2} + \frac{x_2}{1} \geq 1$$

$$\frac{x_1}{5} + \frac{x_2}{-2.5} \geq 1$$



∴ It is unbounded solution

41. Ans: (b)

Sol: The sequential steps design of gating system is:

- Estimation of optimum pouring time of casting,
- Calculation of sprue choke-area,
- Selection of gating ratio,
- Selection of type of gating/location and finally
- Calculation of runner, ingate sizes.

42. Ans: (c)

Sol: More data lines (data bus width) in micro processor means high speed and with different architecture and application.

43. Ans: (c)

Sol: Voltage is a function of arc length, so to maintain constant arc length, voltage is kept constant.



44. Ans: (b)

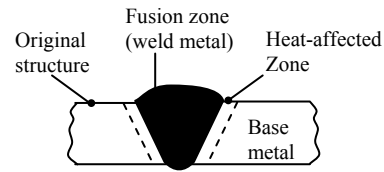
Sol: Artificial variable does not have any physical significance if it is in solution it indicates infeasibility

45. Ans: (b)

Sol: The mechatronics system design as concurrent (simultaneous design of all parts).

46. Ans: (d)

Sol: HAZ means, it is the zone where the parent metal will not melt but the temperature of the metal is above upper critical temperature. Hence the metal will undergo micro structural changes.



47. Ans: (d)

Sol: Correlation and Regression is used for short range for fore casting.

48. Ans: (a)

Sol: Available hours are total machine available time and down time are the time machine is not available for performing its normal function. Ratio of down time to available hours gives the machine effectiveness.



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49. Ans: (a)

Sol: The heat applied during welding recrystallizes the elongated grains of the cold worked base metal. On the one hand, grains that are away from the weld metal will recrystallize into fine, equiaxed grains. Also, grains close to the weld metal have been subjected to elevated temperatures for a longer time. Consequently, the grains will grow in size (grain growth), and this region will be softer and have lower strength.

50. Ans: (a)

Sol: Stud welding (SW) is also called stud arc welding. The stud serves as one of the electrodes while being joined to another component, which is usually a flat plate.

51. Ans:(c)

Sol: 1. Analytical ferrography is the most powerful diagnostic tools for oil analysis and provides tremendous information on machine condition under operation in the form of particle size, size distribution, etc.

2. Under ware sound signatures measured by hydrophones and other sound signatures measured by dynamic microphones based on frequency range.

3. Both surfaces of the object which is under test required to detect the faults. One side exposed to radioactive source and other side radioactive sensitivity film will be placed.

4. Predictive maintenance is based on the failure detected during the continuous monitoring of machine parameters. Based on type of failure and problem, the maintenance cost varies

52. Ans: (d)

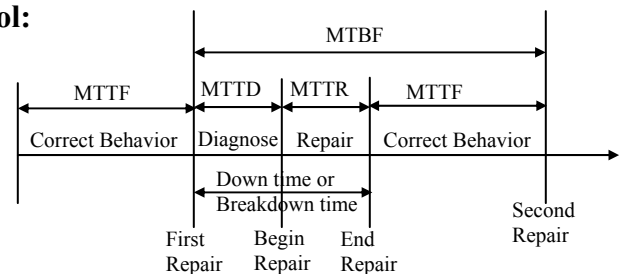
Sol: The distance between two consecutive points is very small, then smoothness of the system of the contour will be better and better, due to this the maximum distance between the two consecutive points on contour is called “interpolation parameter”.

Interpolation parameter = 0.001 to 999.999 mm

As the interpolation parameter is reduced, time taken for manufacturing will increase and cost of manufacturing will also increase.

53. Ans: (c)

Sol:



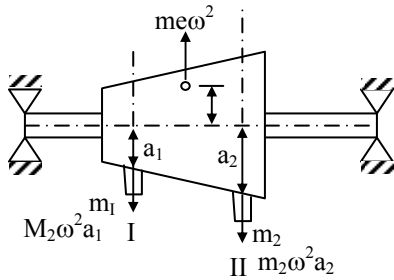


54. Ans: (a)

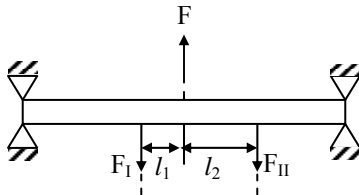
Sol: Resolver used for transformation of co-ordinates in robotics.

55. Ans: (d)

Sol:



(a) Actual system



(b) Equivalent force model

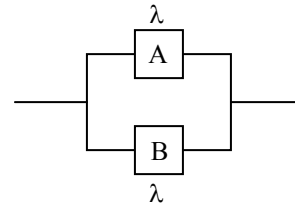
Balancing is attained if the centrifugal force $F = me\omega^2$ is cancelled by the other centrifugal forces by placing weights m_1 and m_2 either by removing parts of the rotor or by attaching correction masses in plane I and II.

To cancel the unbalance force $F = me\omega^2$ by centrifugal force $F_I = m_1\omega^2$ and $F_{II} = m_2\omega^2$, the following relationship must hold

$$F_I + F_{II} = F \quad \text{and} \quad F_I \ell_1 = F_{II} \ell_2$$

56. Ans: (a)

Sol:



λ – failure rate of A and B systems

Reliability of system $R = R_1 + R_2 - R_1R_2$

$$[R_1 = e^{-\lambda t}, R_2 = e^{-\lambda t}]$$

$$R = e^{-\lambda t} + e^{-\lambda t} - e^{-(\lambda+\lambda)t}$$

$$R = 2e^{-\lambda t} + e^{-2\lambda t}$$

Mean time to failure MTTF

$$\begin{aligned} &= \int_0^{\infty} R \cdot dt \\ &= \int_0^{\infty} (2e^{-\lambda t} - e^{-2\lambda t}) dt \\ &= \frac{2}{\lambda} - \frac{1}{2\lambda} = \frac{3}{2\lambda} \end{aligned}$$

$$\text{Failure rate of the system} = \frac{1}{\text{MTTF}} = \frac{2\lambda}{3}$$

57. Ans: (a)

Sol: Given robot arm joints (J_1, J_2, J_3) of

- Cantilever (Cartesian arm) – L O O
- spherical – T R L
- jointed arm – T R R
- cylindrical – T L O



58. **Ans: (a)**

Sol: Increasing the SCEA increases the chip equivalent length and decreases the chip thickness. As a result, the cutting force is dispersed on a longer cutting edge so tool life is increased. Hence, both the statements are correct and statement I justified by statement II.

59. **Ans: (d)**

Sol: Statement (I) is false because an optical encoder is delicate.

60. **Ans: (d)**

Sol: Oxidation of diamond starts at about 450°C and thereafter it can even crack. For this reason the diamond tool is kept flooded by the coolant during cutting and light feeds are used. So statement I is incorrect and statement II is correct.

61. **Ans: (b)**

62. **Ans: (a)**

Sol: All geared head stocks machine tool spindles drives need a number of speeds to achieve a minimum loss of cutting speed for any diameter of job. It is found that the best arrangement for such a condition is to arrange the speeds in geometrical progression. Hence statement I is correct and completely justified by statement II.

63. **Ans: (a)**

Sol: SCARA wrist has roll (twisting) motion.

64. **Ans: (a)**

65. **Ans: (c)**

Sol: Statement (II) is false because as wrist for orientation and arm for positioning use.

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- ⊗ Comparison with all India toppers of **ACE** students.

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66. Ans: (a)

Sol:

- Because of the presence of helix angle of the screw thread, the centres of both the wires are not co-axial. Hence, the measurement system becomes unstable. It introduces error in measurement called rake error.
- The force exerted by the anvils of micrometer acts like a point load on the threads. Due to this, thread gets compressed leading to an error in micrometer reading called as compression error.
- In three-wire method, rake error is completely eliminated and compression error is minimized. Hence both the statements are correct and statement I is justified by statement II. So, option (a) is correct.

67. Ans: (a)

68. Ans: (a)

Sol: Chaplets are used as additional supports for supporting the core to prevent movement of core due to buoyancy.

69. Ans: (a)

Sol: Because the aluminum is highly reactive metal and having high thermal conductivity, it is oxidized as soon as it is kept open to atmosphere. So, its weldability is poor.

70. Ans: (a)

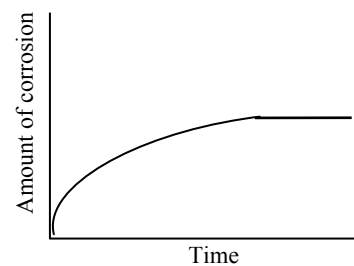
71. Ans: (a)

Sol: CNC machines are more accurate than conventional machines because they have a high resolution encoder and digital readouts for positioning. By using encoder positioned on the axis the actual distance traveled by the axis can be measured accurately and given it as feed back to the MCU so that MCU can generate the pulses required for traveling remaining distance.

72. Ans: (b)

73. Ans: (a)

Sol: The most corrosion films are passivate or cease to grow beyond a certain thickness and this layer act as protective layer to other part of the material. Hence it is desirable and favourable as corrosion process stops its own



Passivation of corrosion.

74. Ans: (c)

Sol: Statement (II) is false because as it has less work volume to floor space as it occupy more floor space.

75. Ans: (b)

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GATE 2017

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