# Complete Coal India Mechanical Question Paper 2017 with Detailed Solutions

1. As per maximum shear stress theory of failure. The relation between yield strength in shear ($\tau_y$) and yield strength in tension ($\sigma_t$) is:

1. $\tau_t = 1.2\ \sigma_t$
2. $\tau_t = 0.7\ \sigma_t$
3. $\tau_t = 0.3\ \sigma_t$
4. $\tau_t = 0.5\ \sigma_t$

Ans: 4

Solution: **Maximum shear stress Theory (or) Guest & Tresca's** Theory
According to this theory, failure of specimen subjected to any combination of load when the maximum shearing stress at any point reaches the failure value equal to that developed at the yielding in an axial tensile or compressive test of the same material

$$\tau_y \leq \frac{\sigma_t}{2}$$

Where $\sigma_t$ is the yield strength in tension and $\tau_y$ is the yield strength in shear.

2. Which micrometer is used for measuring the span between the teeth of a gear?

1. Blade micrometer
2. Screw thread micrometer
3. Disc micrometer
4. Dial micrometer

Ans: 3

Solution: Disc micrometer is used for measuring span between the teeth of a gear.

3. What is the correct sequence of operations in powder metallurgy?

1. Compacting, Sintering, Blending, Production of metal powder
2. Production of metal powder, Compacting, Sintering, Blending
3. Production of metal powder, Blending, Compacting, Sintering
4. Production of metal powder, Blending, Sintering, Compacting

Ans: 3

Solution: Powder metallurgy is the name given to the process by which fine powdered materials are blended, pressed into a desired shape (compacted), and then heated (sintered) in a controlled atmosphere to bond the contacting surfaces of the particles and establish the desired properties.

4. An element is subjected to pure shear stress ($+\tau_{xy}$). What will be the Principal stress induced in the element?

1. ($\sigma_{1,2} = \pm 2\tau_{xy}$)
2. ($\sigma_{1,2} = 0$)
3. $\left(\sigma_{1,2} = \frac{\tau_{xy}}{2}\right)$
4. ($\sigma_{1,2} = \pm \tau_{xy}$)

Ans: 4

Solution: In case of pure shear stress, the principal stress is equal to the shear stress.

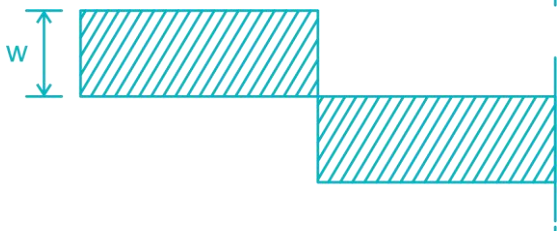
5. A cantilever carries a concentrated load (W) at its free end. Its Shear force diagram will be:

1.



2.



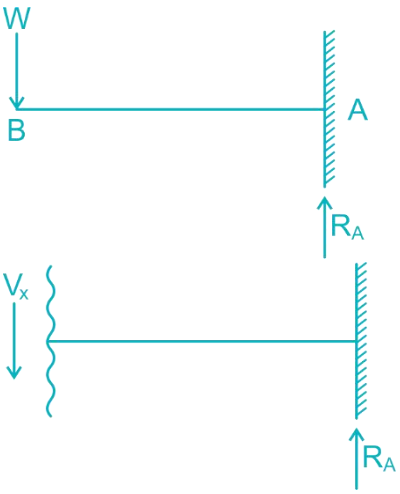
3.



4.



Ans: 4

Solution: $R_A = w$




$V_x = R_A = w$
$V_A = w$, $V_B = w$
Hence, S.F.D is as shown in figure below


6. A closed system of constant volume experiences a temperature rise of 50°C when a certain process occurs. The heat transferred in the process is 100 kJ. The specific heat at constant volume for the pure substance comprising the system is 1 kJ/kg °C, and the system contains 3 kg of this substance. Work done in this case is:

1. 50 kJ
2. -100 kJ
3. -50 kJ
4. 100 kJ

Ans: 3

Solution: Temperature rise $\Delta T = 50°C$
Heat Transferred = 100 KJ
Specific heat at constant volume $C_V$ = 1 KJ/kg
Mass of substance in system (m) = 3 kg
According to First Law of Thermodynamics.
$Q = \Delta U + W$
$Q = mc_vdT + W$
$W = Q - mc_vdT = 100 - 3 \times 1 \times 50 = -50$ kJ

7. In natural convection heat transfer, Nusselt number is a function of:

1. Reynolds number and Prandtl number
2. Prandtl number and Rayleigh number
3. Reynolds number and Grashof number
4. Prandtl number and Grashof number

Ans: 4

Solution: In case of natural convection heat transfer,

Nusselt Number $(Nu) = \frac{h\delta}{k} = cR_a^n$

Where constant C and n depend on the geometry of the surface and the flow. $R_a$ is the Rayleigh Number

$R_a$ = Gr.Pr

So Nusselt Number is function of Grashof number and Prandtl number

8. Choose the correct order of tool materials arranged, according to the decreasing order of their hot hardness.

1. Ceramics, Cermets, Tungsten Carbide, HSS
2. Cermets, Ceramics, Tungsten Carbide, HSS
3. Tungsten Carbide, Ceramics, Cermets, HSS
4. Cermets, Tungsten Carbide, Ceramics, HSS

Ans: 1

Solution: The correct order of decreasing hot hardness is Ceramics, Cermets, Tungsten Carbide and HSS.

Ceramics are essentially alumina based high refractory materials introduced specifically for high speed machining of difficult to machine materials and cast iron. These can withstand very high temperatures, are chemically more stable, and have higher wear resistance than the other cutting tool materials.

Cermets are aluminium oxide based material containing titanium carbide, titanium nitride and titanium carbo nitride. Cermets have higher hot hardness and higher oxidation resistance over cemented carbides.

Carbides, which are nonferrous alloys, are also called, sintered (or cemented) carbides because they are manufactured by powder metallurgy techniques. These tool materials are much harder, are chemically more stable, have better hot hardness, high stiffness, and lower friction, and operate at higher cutting speeds than do HSS.

9. The angular motion of a disc is defined by the relation ($\theta = 3t + t^3$), where $\theta$ is in radians and t is in seconds. What will be the angular position after 2 seconds?

1. 14 rad
2. 12 rad
3. 18 rad
4. 16 rad

Ans: 1

Solution: Angular motion $\theta = 3t + t^3$

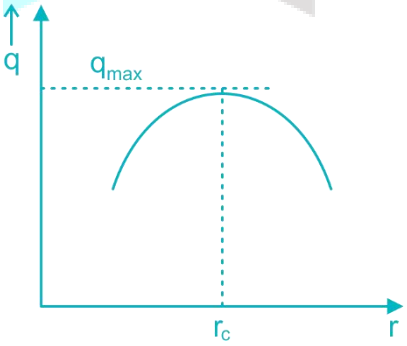
Motion covered in 2 seconds = $3 * 2 + 2^3 = 14$ rad. So the angular position after 2 seconds will be 14 rad.

10. A copper pipe carrying refrigerant at T°C is covered by cylindrical insulation of thermal conductivity k W/mK. The heat transfer co-efficient over the insulation surface is h W/m$^2$K. The critical thickness of insulation would be.

1. k/h
2. 2 k/h
3. 2 h/k
4. h/k

Ans: 1

Solution: For sufficient thin wires, putting the insulation around the wire may result in increase of heat transfer rate from the wire as compare to the case where there is no insulation.




For cylindrical wire, critical radius of insulation is given as

$$r_c = \frac{k}{h}$$

For spherical wire

$$r_c = \frac{2k}{h}$$

11. Which one of the following is not the controllable process parameter in ECM?

1. Inter electrode gap
2. Voltage
3. Pulse on time
4. Feed rate

Ans: 3

Solution: Controllable processes parameter and their range is given below for ECM.

| | |
|---|---|
| Current | 50 to 40000 Amp |
| Current Density | 8 to 233 Amp/cm$^2$ |
| Voltage | 4 to 30 V DC |
| Inter Electrode gap | 0.025 to 0.75 mm |
| Electrolyte velocity | 15 to 60 m/s |
| Electrolytic pressure | 0.069 to 2.7 MPa |
| Electrolytic temperature | 24 to 65°C |
| Feed rate | 0.5 to 19 mm/min |

So, pulse on time can't be controlled in ECM.

12. In which of the following non-traditional machining processes, tool wear doesn't occur?

1. EDM
2. USM
3. ECM
4. EBM

Ans: 3

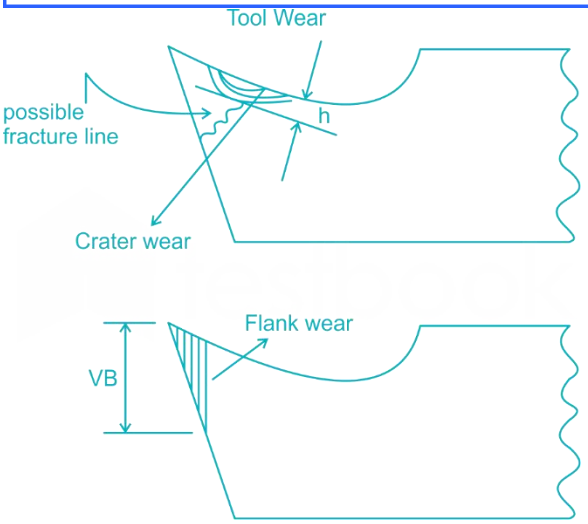
Solution: Tool wear is practically zero in Electro-chemical Machining (ECM).

13. In a turning tool, crater wear occurs on _____.

1. Base
2. Flank face
3. Rake face
4. Shank

Ans: 3

Solution: Crater wear occurs on the rake face. For crater wear temperature is the main culprit and tool diffuse into the chip material and tool temperature is maximum at some distance from the tool tip. So crater wear starts at some distance from tool tip.




14. _____ is the capacity of material to absorb energy when it is elastically deformed and then upon unloading, to have this energy recovered.

1. Toughness
2. Tensile strength
3. Plasticity
4. Resilience

Ans: 4

Solution: Resilience: It is energy absorbed by a member in elastic region. It denotes the capacity of material to absorb energy when it is elastically deformed and then upon unloading, to release this energy.
Toughness: It is energy absorbed by member just before its fracture.

15. Which force is acting on the core when the metal is poured into mould cavity?

1. Gravity
2. Inertia
3. Buoyancy
4. Drag

Ans: 3

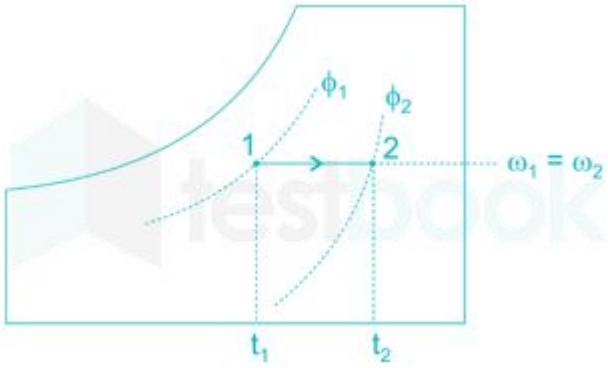
Solution: As the density of core (made of sand) is less than the density of metal being poured in the cavity. So there will be an upward buoyancy force on the core. To overcome this force the core prints are used.

16. During a simple sensible heating process, the relative humidity _____.

1. Increases
2. Decreases
3. Is zero
4. Remains constant

Ans: 2

Solution: Sensible heating: It is the process of increasing the Dry bulb temperature at constant specific humidity.




Effects of sensible heating:

i) Dry bulb temperature increases

ii) Sp. Humidity or humidity ratio remains constant

iii) Dew point temp is constant.

iv) Relative humidity decreases

v) Enthalpy increases

vi) Specific Volume increases.

vii) Wet bulb temp increases

17. The head loss due to friction in turbulent flow through a pipe is:

1. Directly proportional to velocity
2. Inversely proportional to square of velocity
3. Inversely proportional to velocity
4. Directly proportional to square of velocity

Ans: 4

Solution: Head loss in turbulent flow $h_f = \frac{flV^2}{2gD}$

So head loss is directly proportional to square of velocity

18. The gating ratio refers to the cross sectional areas of:

1. Sprue : In-gate : Runner
2. Sprue : Runner : In-gate
3. In-gate : Runner : Sprue
4. Runner : Sprue : In-gate

Ans: 2

Solution: Gating ratio = Sprue area : Runner area : Ingate area

19. If u and v represents velocity components in x and y directions of a two-dimensional potential flow, then $\frac{\partial u}{\partial x}$ is equal to:

1. $\frac{\partial v}{\partial x}$
2. $\frac{\partial v}{\partial y}$
3. $\frac{\partial u}{\partial y}$
4. $-\frac{\partial v}{\partial y}$

Ans: 4

Solution: According to continuity eq.

$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \Rightarrow \frac{\partial u}{\partial x} = \frac{-\partial v}{\partial y}$

20. What is the atomic packing factor of BCC structure?

1. 0.64
2. 0.68
3. 0.74
4. 0.52

Ans: 2

Solution:

| Structure | Atomic packing factor |
|---|---|
| BCC | 0.68 |
| HCP | 0.74 |
| FCC | 0.74 |
| Diamond cubic | 0.34 |
| SC | 0.52 |

21. If the proportion of oxygen is less than the proportion of acetylene is oxy acetylene gas welding, the flame produced is _____.

1. Plasma arc
2. Carburizing flame
3. Oxidizing flame
4. Neutral flame

Ans: 2

Solution: A carburizing flame is one in which the supply of acetylene is in excess as compared to the oxygen. If the supply of acetylene is less than the supply of oxygen than the flame is known as oxidizing flame. If both acetylene and oxygen are in the ratio of 1:1 then flame is called neutral flame.

22. Kaplan turbine is a:

1. Low discharge, high head turbine
2. High discharge, low head turbine
3. Low discharge, low head turbine
4. High discharge, high head turbine

Ans: 2

Solution: Pelton turbine – Low discharge and high head

Francis turbine – Medium discharge and medium head

Kaplan Turbine – High discharge and low head

23. Which of the following welding method is not a solid state welding process?

1. Friction welding

2. Forge welding
3. Resistance spot welding
4. Ultra-sonic welding

Ans: 3

Solution: Solid state welding is a group of welding processes which produces coalescence at temperatures essentially below the melting point of the base materials being joined, without the addition of brazing filler metal. Pressure may or may not be used. Some examples of solid state welding are (friction welding, ultrasonic welding, forge welding etc.). Resistance spot welding is not a solid state welding.

24. Which is the isothermal reversible reaction in which a solid phase is converted into two or more intimately mixed solids on cooling?

1. Peritectoid
2. Peritectic
3. Eutectic
4. Eutectoid

Ans: 4

Solution: Peritectic reaction: Liquid + solid 1 → solid 2

Peritectoid reaction: solid 1 + solid 2 → solid 3

Eutectic reaction: Liquid → sold 1 + solid 2

Eutectoid reaction: Solid 1 → solid 2 + solid 3

Monotectic reaction: Liquid 1 → liquid 2 + solid

25. Elliptical gear train used in differential gear of automobile helps in:

1. Reducing jerk
2. Assisting in speed change
3. Reducing speed
4. Turning

Ans: 4

Solution: When a vehicle takes a turn, its other rear wheel covers a greater distance than inner rear wheel. Hence differential gears are used so that both the rear wheel can rotate at different speed. This is achieved with the help of elliptical gear train.

26. The cutting speed of the tool in turning operation is:

1. Directly proportion to diameter of the workpiece
2. Inversely proportional to the workpiece
3. Inversely proportional to the square of the workpiece
4. Directly proportional to the square of the diameter of the workpiece

Ans: 1

Solution: Cutting speed (also called surface speed) may be defined as the rate (or speed) at the workpiece surface, irrespective of the machining operation used.

Cutting speed = $r \times \omega = \pi DN\ mm/min$

Where D is in mm and N is in RPM.

So cutting speed is directly proportion to diameter of the workpiece

27. A car starting from rest attains a maximum speed of 100 kmph in 20 seconds. What will be its acceleration assuming it is uniform?

1. 1.0 $m/s^2$
2. 1.4 $m/s^2$
3. 1.8 $m/s^2$
4. 2.0 $m/s^2$

Ans: 2

Solution: Initial velocity (u) = 0

Final velocity $(v) = 100kmph = 100 \times \frac{5}{18} = \frac{500}{18} m/s$

Time (t) = 20 sec

v = u + at

$\Rightarrow a = \frac{v-u}{t} = \frac{\frac{500}{18}-0}{20} = \frac{500}{18\times20} = 1.38\, m/s^2$

28. A disc with mass moment of inertia (I) and an angular velocity ω rad/s is spinning about the axis of spin. The angular velocity of precession of the axis of spin is ($\omega_p$), the causing precession will be given by:

1. $(I\omega^2\omega_p)$
2. $(I\omega\omega_p)$
3. $\left(\frac{1}{2}I\omega^2\omega_p\right)$
4. $\left(\frac{1}{2}I\omega\omega_p\right)$

Ans: 2

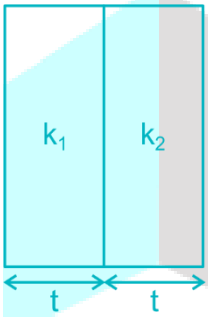
Solution: Mass moment of inertia = I
Angular velocity = w rad / s
Angular velocity of precession = $w_p$
Angular acceleration ($\alpha$) = $ww_p$
Precession Torque = $Iww_p$

29. Two walls of same thickness and cross-sectional area have thermal, conductivities in the ration 1:2. If the ratio of temperature drop across the two walls is 2:3, what is the ratio of heat flow?

1. 1 : 2
2. 1 : 3
3. 2 : 1
4. 3 : 1

Ans: 2

Solution:




$\frac{k_1}{k_2} = \frac{1}{2}$
$\frac{\Delta T_1}{\Delta T_2} = \frac{2}{3}$
$Q = \frac{kA\Delta T}{t}$
As $A_1 = A_2$ and $t_1 = t_2$
$\therefore \frac{Q_1}{Q_2} = \frac{k_1\Delta T_1}{k_2\Delta T_2} = \frac{1}{2} \times \frac{2}{3} = \frac{1}{3}$
$Q_1 : Q_2 = 1:3$

30. A hole of diameter (d) is to be punched through a sheet metal of thickness (t). How much force is required to punch the hole if the ultimate shear stress of the sheet metal is ($\tau$)?

1. $dt\tau$
2. $\frac{\pi}{4}d^2t\tau$

3. Πdtτ
4. $\frac{\pi}{4}d^2\tau$

Ans: 3

Solution: Punching force F = Lt τ
Where L is Length of periphery
t = thickness
τ = Ultimate shear strength
For circular section L = π d
∴ F = π dtτ

31. Which of the following locating device is used to locate cylindrical jobs?

1. Drill jigs
2. V-blocks
3. Angle plates
4. Metal pins

Ans: 2

Solution: V(vee) Locators are used mainly for round work. So for locating cylindrical jobs, V – block locators are used

32. In rolling process, roll separation force can be reduced by:

1. Increasing the roll diameter
2. Increasing the friction between the rolls and workpiece
3. Providing backup roll
4. Reducing the roll diameter

Ans: 4

Solution: Roll separating force (F) = Stress × Projected area

= $\sigma_o \times L_P \times b$

Where Lp = Projected length = $\sqrt{R\Delta h}$

So by reducing the size of diving roller, roll separating force can be reduced.

On the other hard backing rollers are used to support the diving roller.

33. The frequency of the vibrations generated by the transducer in ultra-sonic machining will in the order of _____.

1. 10 kHz
2. 5 kHz
3. 2 kHz
4. 20 kHz

Ans: 4

Solution: In ultrasonic machining, a tool of desired shape vibrates at an ultrasonic frequency (19 - 25 kHz) with an amplitude of around 15 – 50 μm over the workpiece. In this machining generally the tool is pressed downward with a feed force, F. Between the tool and workpiece, the machining zone is flooded with hard abrasive particles generally in the form of water based slurry. As the tool vibrates over the workpiece, the abrasive particles act as the indenters and indent both the work material and the tool.

34. An eye bolt is to be used lifting a load of 70 KN and the tensile stress is not to exceed 100 MPa. The core diameter of the bolt will be given by:

1. $\left(\frac{2100}{\pi}\right)^{\frac{1}{2}}$
2. $\left(\frac{2800}{\pi}\right)^{\frac{1}{2}}$
3. $\left(\frac{210}{\pi}\right)^{\frac{1}{2}}$
4. $\left(\frac{280}{\pi}\right)^{\frac{1}{2}}$

Ans: 2

Solution: Given load P = 70 kN = 70 × $10^3$ N
Tensile stress $\sigma_t$ = 100 MPa
Load on the bolt
$P = \frac{\pi}{4} \times (d_c)^2 \times \sigma_t$
Where $d_c$ is the core diameter
$70 \times 10^3 = \frac{\pi}{4} \times d_c^2 \times 100$
$\Rightarrow d_c = \sqrt{\frac{2800}{\pi}}$

35. A heat engine which receives 80 kJ of heat at 100°C and rejects 70 kJ of heat to the ambient at 30°C is to be designed. The thermal efficiency of the heat engine is:

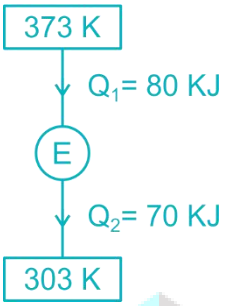
1. 70%

2. Cannot be determined.
3. 1.88%
4. 12.5%

Ans: 4

Solution: $T_1 = 100°C = 100 + 273 = 373$ K

$T_2 = 30°C = 30 + 273 = 303$ K




Thermal efficiency $(\eta) = 1 - \frac{Q_2}{Q_1}$

$= 1 - \frac{70}{80} = 0.125 = 12.5\%$

Note that no where it is mentioned that it is reversible engine. So Finding efficiency by $\eta = 1 - \frac{T_2}{T_1}$ Will be wrong.

36. In flat belt drive the condition for maximum power transmission is given by: (where T maximum tension and $T_c$ centrifugal tension in belt)

1. $T = 3T_c$
2. $T = 2T_c$
3. $T = \pi T_c$
4. $T = 3\pi T_c$

Ans: 1

Solution: Centrifugal Tension: Since the belt continuously runs over the pulleys, therefore some centrifugal force is caused, whose effect is to increase the tension on both the tight as well as the slack sides. The tension caused by centrifugal force is called centrifugal tension ($T_c$)
For maximum power transmission
$T = 3T_c$

37. How many elements are present in tool signature of a single point cutting tool used for turning operation?

1. 5
2. 6
3. 7
4. 8

Ans: 3

Solution: Tool signatures have 7 elements in both systems.

American Standards System (ASA) system ⇒ Back rake angle – side rake angle – end relief angle (ERA) – side relief angle – end cutting Edge angle – side Cutting Edge Angle- Nose Radius

Orthogonal Rake system (ORS) or International system ⇒ i (inclination angle) – $\alpha_n$ (Normal rake angle) - Side relief angle- end relief angle, end cutting edge angle – Approach angle – Nose radius

38. What is the coordination number for simple cubic structure?

1. 4
2. 8
3. 12
4. 6

Ans: 4

Solution:

| Crystal Structure | Coordination No. |
|---|---|
| Simple cubic | 6 |
| BCC | 8 |
| FCC, HCP | 12 |

39. Which of the following is the best suited for production of hollow pipes?

1. Centrifugal casting
2. Investment casting
3. Continuous casting
4. Hot chamber die casting

Ans: 1

Solution: Centrifugal casting is used for making bigger size hollow symmetrical pipes. For producing a hollow part, the axis of rotation is placed at the center of the desired casting. The

speed of rotation is maintained as high as to produce a centripetal acceleration of the order of 60g to 70g. It should be noted casting of hollow parts need no core in this process.

40. What is the maximum possible theoretical efficiency of a heat engine operating with a hot reservoir of gases at 2127°C, when the cooling water available is at 27°C?

1. 98.8%
2. 90%
3. 87.5%
4. 100%

Ans: 3

Solution: $T_1$ = 2127°C = 2127 + 273 = 2400 K
$T_2$ = 27°C = 27 + 273 = 300 K
Efficiency will be maximum, when engine is reversible.

$$\eta_{max} = 1 - \frac{T_2}{T_1} = \left(1 - \frac{300}{2400}\right) \times 100 = 87.5\%$$

41. A ball and socket joint is example of _____ pair.

1. Screw
2. Spherical
3. Turning
4. Rolling

Ans: 2

Solution: When the two elements of a pair are connected in such a way that one element (with spherical shape) turns or swivels about the other fixed element, the pair formed is called a spherical pair. The ball and socket joint, attachment of a car mirror, pen stand etc., are the examples of a spherical pair.

42. Though vibration cannot be eliminated completely, it can be suppressed to a greater extent using :

1. Damper
2. Accumulator
3. Receiver
4. Reducer

Ans: 1

Solution: The process of diminishing the vibration is called damping. The equipment used for this purpose is called damper.

43. In Euler's formula, the ratio of the effective length of column to least radius of gyration of the cross section is known as:

1. Expansion ratio
2. Slenderness ratio
3. Thickness ratio
4. Compression ratio

Ans: 2

Solution: Slenderness Ratio is the ratio between the length and least radius of gyration. It is used to classify the columns.

| Type of Column | Slenderness Ratio |
|---|---|
| Short | Less than 32 |
| Medium | 32-120 |
| Long | Greater than 120 |

44. Which of the following is used as a dielectric medium in EDM?

1. Salt solution
2. Silicon carbide solution
3. $Al_2O_3$ solution
4. Kerosene

Ans: 4

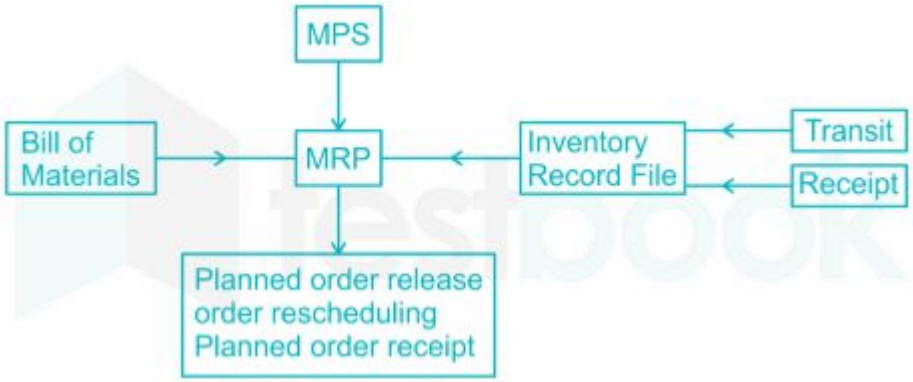
Solution: In EDM a fluid is used to act as a dielectric and to help carry away debris. Quite often kerosene based oil is used as dielectric in EDM. The dielectric fluid is circulated through the tool at a pressure of 0.35 $N/m^2$ or less to free it from eroded metal particles, it is circulated through a filter.

45. Which of the following is not an input for material requirement planning?

1. Bill of materials
2. Purchase order
3. Inventory record file
4. Master production schedule

Ans: 2

Solution: Material Requirement Planning (MRP) is a method of working out the production plan in a multi – stage production system that produces many product and requires their raw material and sub – assemblies. It is used so that all the things needed are available at an appropriate time and production can be carried out without any delay




Master production Schedule: It is a complete time table of scheduled production in future. It contains information about what product is to be produced, when it is to be produced and in what Quantity.

Inventory Record File: This file gives complete and up to date information about on hand inventory, scheduled receipt and transit inventory.

Bill of material (BOM): It gives information about how each final product is manufactured specifying all sub component item and their sequence of build – up in the final product

So out of given options, Purchase order is not required for MRP.

46. Tolerances for a hole and shaft assembly having a nominal size of 40 mm are as follows :

$Hole = 40^{+0.06}_{+0.02}\ mm\ and\ shaft = 40^{-0.06}_{-0.08} mm$

Determine MML of hole.

1. 39.94 mm
2. 40.06 mm
3. 40.02 mm
4. 39.92 mm

Ans: 3

Solution: Maximum material Limit (MML) in case of hole is the condition when hole is at lower limit.
So MML for hole

$40^{+0.06}_{+0.02} = 40 + 0.02 = 40.02\ mm$

47. In belt drive power transmitted is given by:

(Where $T_t$, $T_s$ and v are tight side tension, slack side tension and linear velocity of belt respectively)

1. $= \frac{(T_t - T_s)}{2v}$
2. $= \frac{(T_t + T_s)}{2v}$
3. $(T_t - T_s)v$
4. $(T_t + T_s)v$

Ans: 3

Solution: Power Transmitted in belt drive $= (T_t - T_s)V$ watt
Where $T_t$ the tension on tight side (N)
T is the tension on slack side (N)
V is the velocity of the belt in m/s

48. In which of the following operations performed on lathe machine, chips does not occur?

1. Knurling
2. Boring
3. Reaming
4. Threading cutting

Ans: 1

Solution: Knurling: Knurling is a manufacturing process whereby a visually-attractive diamond-shaped (crisscross) pattern is cut or rolled into metal. This pattern allows human hands or fingers to get a better grip on the knurled object than would be provided by the originally-smooth metal surface.

Boring: Boring always involves the enlarging of an existing hole, which may have been made by a drill or may be the result of a core in a casting.

Reaming: Reaming removes a small amount of material from the surface of holes. It is done for two purposes: to bring holes to a more exact size and to improve the finish of an existing hole.

Threading: It is the process of making internal or external threads on the workpiece.

Out of above four processes except knurling all other involves the chips. So Knurling is right option.

49. If a particle is in static equilibrium, then the work done by the system of force acting on that particle is:

1. Negative
2. Infinity
3. Zero
4. Positive

Ans: 3

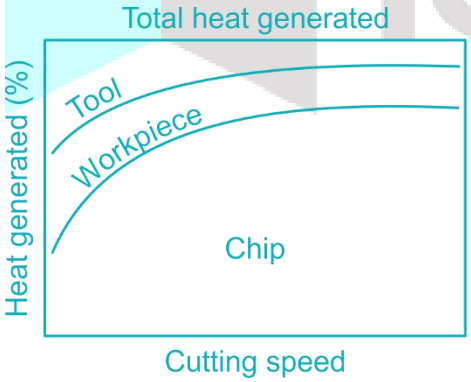
Solution: Static equilibrium is a state in which the net force and net torque acted upon the system is zero. In other words, both linear momentum and angular momentum of the system are conserved.

50. In turning operation, the typical ratio of heat generated in chip, tool and work piece is in the order of:

1. 70 : 20 : 10
2. 10 : 70 : 20
3. 10 : 20 : 70
4. 70 : 10 : 20

Ans: 4 (1 given by CIL)

Solution:




It is clear from the figure that at high speed, maximum heat is carried away by the chip, then work piece and least is carried by tool.
So the ratio 70: 10: 20 will be correct.

51. The pressure inside a Pelton turbine casing during working _____.

1. Increases
2. Remains constant
3. Decreases

4. First decreases and then increases

Ans: 2

Solution: Pelton wheel is a kind of impulse turbine. As in case of impulse turbine pressure throughout turbine is constant and equal to atmospheric pressure, so only energy available for turbine is kinetic energy of fluid. There is no change in pressure energy as it takes place in reaction turbine.

52. The stress-concentration factor (K) is:

1. Ratio of maximum stress occurring near discontinuity to average stress at critical section.
2. Ratio of minimum stress occurring near discontinuity to average stress at critical section.
3. Ratio of average stress at critical section to minimum stress occurring near discontinuity.
4. Ratio of average stress at critical section to maximum stress occurring near discontinuity.

Ans: 1

Solution: Stress concentration factor (K) is defined as the ratio of the maximum stress in a member (at a notch or a fillet) to the nominal or average stress at the same section based upon net area. The value of $K_t$ depends upon the material and geometry of the part.

53. A Wahl's stress factor ($K_s$) is:

(Where C spring index)

1. $\left(\frac{4C-1}{4C-4}+\frac{0.615}{2C}\right)$
2. $\left(\frac{4C-4}{4C-4}+\frac{0.615}{C}\right)$
3. $\left(\frac{4C-1}{4C-4}+\frac{0.615}{2}\right)$
4. $\left(\frac{4C-1}{4C-1}+\frac{0.615}{C}\right)$

Ans : 3

Solution: Wahl's stress factor $K=\frac{4c-1}{4c-4}+\frac{0.615}{c}$

Where C is the spring index $=\frac{D}{d}=\frac{mean\ coil\ diameter}{diameter\ of\ wire}$

54. The position of a particle in rectilinear motion is given by the equation ($x = t^3 - 2t^2 + 10t - 4$), where x is in meters and t is in seconds. What will be the velocity of the particle at 3s?

1. 20 m/s
2. 25 m/s
3. 15 m/s
4. 30 m/s

Ans: 2

Solution: Position (x) = $t^3 - 2t^2 + 10t - 4$

Velocity (v) $= \frac{dx}{dt} = 3t^2 - 4t + 10$

At t = 3 s

V = $3 \times 3^2 - 4 \times 3 + 10 = 25$ m/s

55. When water glides over the runner blades of a hydraulic reaction turbine:

1. Pressure remains constant
2. Pressure decreases
3. Pressure first increases and then decreases
4. Pressure increases

Ans: 2

Solution: Reaction turbine means that water at the inlet of the turbine possesses kinetic energy as well as pressure energy. As the water flows through the runner, a part of pressure energy is converted into kinetic energy. So pressure decreases.

56. A shaft with torsional stiffness (q) has a disc of mass moment of inertia (I) attached at the end, then the natural frequency ($f_n$) of free torsional vibration of the shaft is given by:

1. $f_n = 2\pi\sqrt{qI}$
2. $f_n = \frac{1}{2\pi}\sqrt{qI}$
3. $f_n = \frac{1}{2\pi}\sqrt{\frac{q}{I}}$
4. $f_n = 2\pi\sqrt{\frac{q}{I}}$

Ans: 3

Solution: Mass moment at Inertia = I
Torsional stiffness = q

Frequency of torsional vibration $f_n = \frac{1}{2\pi}\sqrt{\frac{q}{I}}$

57. Electron beam machining can be carried out in _____.

1. Open air
2. Pressurized air
3. Water
4. Vacuum

Ans: 4

Solution: Electron Beam machining (EBM): In this machining work-piece placed in vacuum chamber and High-voltage electron beam directed toward work piece. Energy of electron beam melts/ vaporizes selected region of work piece. Electron beam is moved by deflection coils.

58. If a moment M acting on a rigid body causes an angular displacement θ then work done by the moment is given by :

1. $M * \theta$
2. $3M * \theta$
3. $4M * \theta$
4. $2M * \theta$

Ans: 1

Solution: Moment = M
Angular displacement = θ
Work done = $M \times \theta$

59. The principle most commonly followed for locating work pieces in a fixture is:

1. 2 – 3 – 1
2. 1 – 2 – 3
3. 3 – 2 – 1
4. 1 – 3 – 2

Ans: 3

Solution: 3-2-1 is the principle to locate the work piece firmly so that the required operations like drilling, reaming etc. can be done. According to the principle 3 pins are used in primary datum, 2 pins used on secondary datum which is perpendicular to 1st and 1 in tertiary datum which arrest 9 degrees of freedom.

60. Natural frequency ($\omega_n$) of a passenger car whose weight is w Newton and whose suspension has a combined stiffness of k N/mm is given by:

1. $\omega_n = \sqrt{\frac{1}{km}}$
2. $\omega_n = \sqrt{km}$
3. $\omega_n = \sqrt{\frac{k}{m}}$
4. $\omega_n = \sqrt{\frac{km}{2}}$

Ans: 3

Solution: Natural frequency $\omega_n = \sqrt{\frac{k}{m}}$

Where k is the combined stiffness and m is the mass.

61. Which of the following are provided in mould so as to increase the heat extraction capacity of the sand mould?

1. Chaplets
2. Core
3. Chills
4. Cope

Ans: 3

Solution: Chaplet: Chaplets are used to support cores inside the mould cavity.

Chill: Chills are metallic objects, which are placed in the mould to increase the heat extraction capacity of castings.

Core: Used for making hollow cavities in castings.

Cope: Upper part of mould is cope and lower part is drag. Sometime moulding box contains three parts at that time middle part is known as cheek.

62. The work transfer per unit mass for a steady flow process with reversible adiabatic compression is :

1. $\int vdp$
2. $\int sdT$
3. $\int pdv$
4. $\int Tds$

Ans: 1

Solution: For a steady flow process work transfer = $\int vdp$

63. Which of the following is pessimistic time estimate as per PERT?

1. The most probable time considering all conditions.
2. The shortest possible time in which an activity can be completed.
3. The maximum time that would be required to complete an activity.
4. The minimum time that would be required to complete an activity.

Ans : 3

Solution: Optimistic time ($t_o$): If everything in the project goes well. It is the minimum time required to complete an activity.
Most Likely Time ($t_m$): It is the time for completing an activity which is most likely.
Pessimistic Time ($t_p$): If everything in the project goes wrong. This is the maximum time required to complete an activity.

64. In Mohr's circle $\sigma_1$ and $\sigma_2$ are the principle stress acting at point on the component. The maximum shear stress $\tau_{max}$ is given by:

1. $\tau_{max} = \left(\frac{\sigma_1 * \sigma_2}{2}\right)$
2. $\tau_{max} = \left(\frac{\sigma_1 * \sigma_2}{4}\right)$
3. $\tau_{max} = \left(\frac{\sigma_1 - \sigma_2}{2}\right)$
4. $\tau_{max} = \left(\frac{\sigma_1 + \sigma_2}{4}\right)$

Ans: 3

Solution: In case of Mohr's circle with $\sigma_1$ and $\sigma_2$ are the principle stress acting at point. The maximum shear stress $\tau_{max} = \left(\frac{\sigma_1 - \sigma_2}{2}\right)$

65. In Bernoulli's equation, $\frac{p}{\rho g} + \frac{v^2}{2g} + z$, each term represents :

1. Total energy per unit mass
2. Total energy per unit volume
3. Total energy per unit weight
4. Total energy per unit flow area

Ans: 3

Solution: If the expression is$P + \rho gz + \frac{\rho v^2}{2}$, then it has units of total energy per unit volume. The expression$\frac{p}{\rho g} + \frac{v^2}{2g} + z$, has units of energy per unit weight.

66. Mechanism is said to be converted to structure if the degree of freedom of mechanism reduced to :

1. 3
2. 1
3. 0
4. 2

Ans: 3

Solution: When the degree of freedom of a kinematic chain is zero then it is called structure. A structure with negative degree of freedom is known as super structure.

67. The thickness of laminar boundary layer at a distance x from the leading edge over a flat plate varies as:

1. $x^{-\frac{1}{2}}$
2. $x^{\frac{1}{3}}$
3. $x^{\frac{1}{2}}$
4. X

Ans: 3

Solution: $\delta = \frac{5x}{\sqrt{Re_x}}$

$\delta \propto x^{1-\frac{1}{2}}$

$\delta \propto x^{\frac{1}{2}}$

68. The property relation for enthalpy change, dh is:

1. Tds – pdv
2. Tds + vdp
3. Tds – vdp
4. Tds + pdv

Ans: 2

Solution: The Tds equation are given as
Tds = du + pdv

Tds = dh – vdp

dh = Tds + vdp

69. The period (T) for the pendulum with length (l) and placed at the gravitational acceleration (g) is given by:

1. $T = 2\pi\sqrt{\frac{l}{g}}$
2. $T = 2\pi\sqrt{lg}$
3. $T = 3\pi\sqrt{\frac{l}{g}}$
4. $T = 3\pi\sqrt{lg}$

Ans: 1

Solution: Time period of pendulum $T = 2\pi\sqrt{\frac{l}{g}}$

70. The following limits are specified in a limit system, to give a clearance fit between a hole and a shaft:

$Hole = 25^{+0.02}_{-0.01}\ mm\ and\ shaft = 25^{-0.004}_{-0.02}\ mm$

Determine tolerance on shaft.

1. 0.012 mm
2. 0.016 mm
3. 0.018 mm
4. 0.014 mm

Ans: 2

Solution: Upper limit of shaft = 25-0.004 = 24.996

Lower Limit of shaft = 25-0.02 = 24.98

Tolerance = Upper limit of shaft – Lower limit of shaft = 24.996 – 24.98 = 0.016

71. A polar moment of Inertia (I) for hollow shaft with external diameter (D) and internal diameter (d) is given by:

1. $\frac{32D^4}{\pi d^4}$
2. $\frac{\pi(D^4-d^4)}{64}$
3. $\frac{\pi(D^4-d^4)}{32}$
4. $\frac{32(D^4-d^4)}{\pi}$

Ans: 3

Solution: Polar moment of inertia of hollow shaft = $\frac{\pi(D^4-d^4)}{32}$

72. Sand and oxide layers adhering to the casting are removed by which of the following processes?

1. Heating
2. Shot blasting
3. Gas cutting
4. Air cooling

Ans: 2

Solution: Shot blasting is a post-production finishing service that is processed through the rapid impacting of a part's surface with a defined amount of abrasive material. It helps in removing sand and oxide layer.

73. A steady, incompressible flow is given by $u = x^2 + y^2$ and $v = 2xy$. What is the convective acceleration along x direction at the point (1, 1)?

1. 12 unit
2. 6 unit
3. 8 unit
4. 24 unit

Ans: 3

Solution: Convective acceleration along x direction

$= \frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}$

$u = x^2 + y^2$

$v = 2xy$

$\therefore a_x = \frac{\partial}{\partial x}(x^2 + y^2) + 2xy\frac{\partial}{\partial y}(x^2 + y^2)$

$= 2x + 2xy\,(2y) = 2x + 4xy^2$

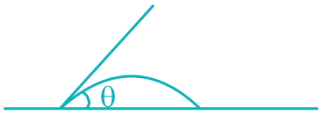
At point (1, 1) $a_x$ = 2 + 4 = 6 unit

74. What happens to the liquid level, when a small diameter tube is inserted into a liquid whose contact angle is 125°?

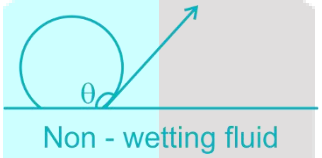
1. Liquid level in the tube will fall first and then rise.
2. Liquid level in the tube falls.
3. Liquid level in the tube remains constant.
4. Liquid level in the tube rises.

Ans: 2

Solution: Case – 1 contact angle is acute




In case of wetting fluid, level in capillary tube will rise.
Case – 2 Contact angle is obtuse




In case of non – wetting fluid, level in capillary tube will fall.

75. If $v_1$ and $v_2$ are the initial velocities of two bodies making direct collision and if $u_1$ and $u_2$ are their respective velocities after collision then the coefficient of restitution is given by:

1. $\frac{(u_1-u_2)}{(v_2-v_1)}$
2. $\frac{(u_1-u_2)}{(v_1-v_2)}$
3. $\frac{(u_1+u_2)}{(v_1+v_2)}$
4. $\frac{(v_1-v_2)}{(u_1-u_2)}$

Ans: 1

Solution: The energy dissipation during impact is called by the term, coefficient of restitution, a scalar quantity

$$e = \frac{velocity\ of\ separation}{Velocity\ of\ approach}$$

$$e = \frac{u_1 - u_2}{v_2 - v_1}$$

76. In blanking operation, clearance is provided to:

1. Stripper
2. Die
3. Punch
4. Die and Punch

Ans : 3

Solution : In Punching or piercing

Punch = size of hole

Die = punch size + 2 clearance

In Blanking

Die = size of product

Punch = Die size - 2 clearance

77. In which of the following processes, metal moulds are used?

1. Sand casting
2. Investment casting
3. Shell moulding
4. Die casting

Ans: 4

Solution: In die casting, the mould, normally called as die, is made in two halves of which one is fixed and other moving. The die is made up of metal.

78. If m is the mass of the body and g is the acceleration due to gravity then the gravitational force is given by:

1. $m * g^3$
2. $m * g^2$
3. m/g
4. m * g

Ans: 4

Solution: Gravitational force = mass * Acceleration due to gravity = m*g

79. How much force will be exerted by the floor of the lift on a passenger of 80 Kg mass when lift is accelerating downward at 0.81 $m/s^2$?

1. 740 N
2. 700 N
3. 720 N
4. 680 N

Ans: 3

Solution: Net acceleration = g – a = 9.81 – 0.81 = 9 $m/s^2$
Mass of passenger = 80 kg
Net force = m (g-a) = 80 × 9 = 720 N

80. Helmholtz function is expressed as:

1. u – Ts
2. – sdT + vdp
3. h – Ts
4. u + pv

Ans: 1

Solution: Helmholtz function of a system is equal to its internal energy minus the product of its absolute temperature and entropy.

F = U – TS

Helmholtz free energy is a thermodynamic potential that measures the useful work obtainable from a closed thermodynamic system at a constant temperature

81. Which of the following is true for self-locking screw?

1. The coefficient of friction is equal to or greater than the tangent of the helix angle.
2. The coefficient of friction is half of the tangent of the helix angle.
3. The coefficient of friction is twice of the tangent of the helix angle.
4. The coefficient of friction is less than the tangent of the helix angle.

Ans: 1

Solution: If friction angle is greater than helix angle, the torque required to lower the load will positive, indicating that an effort is applied to lower the load. Such a screw is known as self-locking screw.

82. The spring rate or stiffness (k) of the spring is given by:

(Where w load and δ deflection of spring)

1. $k = 2w\delta$
2. $k = \delta/w$
3. $k = w\delta$
4. $k = w/\delta$

Ans: 4

Solution: Spring force $w = k\delta$

So stiffness (k) = $w/\delta$

83. Cold chamber die casting is suitable for which of the material listed below?

1. Brass
2. Tin
3. Zinc
4. Lead

Ans: 1

Solution: Cold – Chamber die casting: In this the furnace is separated from casting unit. It is used to produce high melting point material casting. Force required to move the liquid metal into the die will be high when compare to hot chamber die casting. Brass, Copper Aluminium and Magnesium is commonly cold die casting metals.

84. In turning, chip thickness ratio will be _____.

1. Equal to zero
2. Greater than two
3. Greater than one
4. Less than one

Ans: 4

Solution: Chip thickness ratio (r) = $\frac{uncut\ chip\ thickness}{chip\ thickness}$

For turning operation, r is less than 1

85. The viscosity of liquids decreases with increase in temperature due to:

1. Decreased cohesive forces
2. Increased cohesive forces
3. Decreased molecular momentum transfer
4. Increased molecular momentum transfer

Ans: 1

Solution: In liquids main cause of viscosity is cohesion between the molecules. With increase in temperature this cohesive force decreases as the energy of particles become more, hence movement of particles become easy. Hence viscosity of water decreases with increase in temperature.

In gases the important cause of viscosity is randomness/molecular collision due to $C_{rms}$(root mean square) velocity. Due to rise in temperature, kinetic energy of molecules increases which makes $C_{rms}$ increase, hence randomness and collision of molecules increased. This makes the flow difficult and hence viscosity in gases increases with temperature.

86. Which of the following involves planning the production output levels of major product lines produced by the firm?

1. Material requirement planning
2. Master production schedule
3. Computer aided process planning
4. Aggregate production planning

Ans: 4

Solution: Aggregate production planning is concerned with the determination of production, inventory, and work force levels to meet fluctuating demand requirements over a planning horizon.

87. Acceleration of the reciprocating mass of a slider-crank mechanism is given by:

(Where ω is angular speed of the crank, θ is angle of inclination of the crank with the line of stroke, r is radius of crank and n is ratio of the length of the connecting rod to the crank radius)

1. $r\omega^2\left(\sin 2\theta + \frac{\sin 2\theta}{n}\right)$
2. $r\omega^2\left(\sin \theta + \frac{\sin 2\theta}{n}\right)$
3. $r\omega^2\left(\cos 2\theta + \frac{\cos 2\theta}{n}\right)$
4. $r\omega^2\left(\cos \theta + \frac{\cos 2\theta}{n}\right)$

Ans: 4

Solution: Acceleration of reciprocating mass of a slider-crank mechanism is given as $a = -r\omega^2\left(\cos\theta + \frac{\cos 2\theta}{n}\right)$

88. Joule-Thomson coefficient is given by:

1. $\left(\frac{\partial p}{\partial T}\right)_h$
2. $\left(\frac{\partial T}{\partial h}\right)_p$
3. $\left(\frac{\partial h}{\partial p}\right)_T$
4. $\left(\frac{\partial T}{\partial p}\right)_h$

Ans: 4

Solution: The numerical value of the slope of an isenthalpe on a T-p diagram at any point is called Joule-Thomson coefficient and is denoted by $\mu_j$

$\mu_j = \left(\frac{\partial T}{\partial P}\right)_h$

89. A thin cylindrical pressure vessel of 500 mm internal diameter is subjected to an internal pressure of 2 N/mm$^2$. What will be the hoop stress if the thickness of the vessel is 20 mm?

1. 25 N/mm$^2$
2. 23 N/mm$^2$
3. 27 N/mm$^2$
4. 29 N/mm$^2$

Ans: 1

Solution: Hoop stress in the cylindrical pressure vessel = $\frac{pd}{2t} = \frac{2\times500}{2\times20} = 25\ N/mm^2$

90. In resistance welding the voltage supplied is:

1. 100 V
2. 1 V
3. 500 V
4. 1000 V

Ans: 2

Solution: In resistance welding very high-current (up to 100,000 A) and very low-voltage (0.5 to 10 V) is used.

91. What is the number of cycles completed per second for a four stroke diesel engine running at 6000 rpm?

1. 50
2. 500
3. 6000
4. 3000

Ans: 1

Solution: Engine speed = 6000 RPM.

One cycle in four stroke requires two revolutions. So Number of cycles per minute = 6000/2 = 3000 cycles.

So number of cycles per minute = 3000/60 = 50 cycles

92. The temperature distribution at a certain instant of time in a slab during a process sis given by $T = 2x^2 + x + 5$, where x is in cm and T is in K. If the thermal diffusivity is 0.0002 cm+/s, the rate of change of temperature with time is given by:

1. 0.0008 K/s
2. 0.0004 K/s
3. -0.0004 K/s
4. -0.0008 K/s

Ans: 1

Solution: $T = 2x^2 + x + 5$

General equation without heat generation (q = 0) and in x-direction only,

$$\frac{1}{\alpha}\frac{\partial T}{\partial t} = \frac{\partial^2 T}{\partial x^2}$$

$$\frac{\partial T}{\partial t} = 4 \times \alpha = 4 \times 0.0002 = 0.0008\ K/s$$

93. When a shaft with diameter (d) is subjected to pure bending moment ($M_b$), the bending stress ($\sigma_b$) induced in the shaft is given by:

1. $\sigma_b = \left(\frac{32M_b}{\pi d^3}\right)$
2. $\sigma_b = \left(\frac{64M_b}{\pi d^3}\right)$
3. $\sigma_b = \left(\frac{64M_b}{\pi d^2}\right)$
4. $\sigma_b = \left(\frac{32M_b}{\pi d^2}\right)$

Ans: 1

Solution: In case of pure bending, the bending stress induced in the shaft is $\sigma_b = \left(\frac{32M_b}{\pi d^3}\right)$

94. In Electric discharge machining, temperature produced by the spark between tool and work piece while machining will be in the order of _____.

1. 10 °C
2. 10000 °C
3. 100 °C
4. 1000 °C

Ans: 2

Solution: Electro Discharge Machining (EDM) is an electro-thermal non-traditional machining process, where electrical energy is used to generate electrical spark and material removal mainly occurs due to thermal energy of the spark. The kinetic energy of the electrons and ions on impact with the surface of the job and tool respectively would be converted into thermal energy or heat flux. Such intense localized heat flux leads to extreme instantaneous confined rise in temperature which would be in excess of 10,000°C. Such localized extreme rise in temperature leads to material removal.

95. In a reversible adiabatic process the ration $\left(\frac{T_1}{T_2}\right)$ is equal to:

1. $(v_1 v_2)^{\frac{\gamma-1}{\gamma}}$
2. $\left(\frac{v_1}{v_2}\right)^{\frac{\gamma-1}{\gamma}}$
3. $\left(\frac{p_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}}$
4. $\left(\frac{p_2}{p_1}\right)^{\gamma}$

Ans: 3

Solution: In reversible adiabatic process $\left(\frac{T_1}{T_2}\right) = \left(\frac{p_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}}$

96. According to the Ernst and Merchant theory, the relation between the shear angle (ϕ), friction angle (β) and rake angle (α) in single point cutting tool in turning is as follows:

1. $2\phi + \beta + \alpha = 90^\circ$
2. $2\phi + \beta - \alpha = 90^\circ$
3. $\phi + 2\beta - \alpha = 45^\circ$
4. $2\phi + \beta - \alpha = 45^\circ$

Ans: 2

Solution: From the Merchant's analysis

$2\phi + \beta - \alpha = \frac{\pi}{2} = 90^\circ$

Where, ϕ = shear angle

β = friction angle

α = cutting rake angle

97. The Coriolis component of acceleration is applicable for which of the following mechanisms?

1. Pantograph
2. Crank-slider mechanism
3. Quick return motion mechanism (Slotted Lever)
4. Four bar chain

Ans: 3

Solution: Coriolis component of acceleration exists when there is sliding motion of a slider which is sliding on a link which itself is rotating. In quick return motion mechanism, this case happens.

98. In Bryton cycle, heat addition is a _____.

1. Constant enthalpy process
2. Constant entropy process
3. Constant volume process
4. Constant pressure process

Ans: 4

Solution: Brayton cycle is a theoretical cycle for gas turbines. This cycle consists of two reversible adiabatic or isentropic processes and two constant pressure processes. The heat addition and rejection takes place at constant pressure.

99. HSS tool is used to machine a 20 mm diameter steel shaft, at a spindle speed of 1000 revolutions per minute. What is the cutting speed?

1. $\pi$ m/min
2. $20\,\pi$ m/min
3. $\pi$ mm/min
4. $20\,\pi$ mm/min

Ans: 2

Solution: Cutting speed = $\pi DN = \pi \times 20 \times 1000 = 20000\pi\ mm/\min = 20\pi\ m/min$

100. According to Chvorinov, following is the correct formula for solidification time ($T_s$), where k = Mould casting constant, V = volume of casting, SA = surface area.

1. $T_s = V\left(\frac{SA}{k}\right)^2$
2. $T_s = k\left(\frac{SA}{v}\right)^2$
3. $T_s = k\left(\frac{V}{SA}\right)^2$
4. $T_s = V\left(\frac{k}{SA}\right)^2$

Ans: 3

Solution: According to Chvorinov rule

$Solidification\ time = k\left(\frac{V}{SA}\right)^2$

Where V = volume of casting

S.A. = surface area of casting