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Assistant Executive Engineer Examination (AEE)

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S.No.	Name of the Subject	No. Of Questions
1	Engineering Mechanics	5
2	Strength of Materials	23
3	Theory of Machines & Vibrations	5
4	Machine Design	12
5	Fluid Mechanics & Hydraulic Machines	21
6	Heat Transfer	14
7	Material Science	5
8	Industrial Management & Operations Research	4
9	Production Engineering	31
10	Thermal Engineering	30
Total No. Of Questions		**150**

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MAHATRANSCO	450 +

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01. Consider a fully developed flow in a circular pipe of diameter 20 cm with an average velocity of 1 m/s. The fluid flowing in the pipe has a kinematic viscosity of 0.00016 m/s and thermal conductivity of 2.0 W/m-K. The heat transfer coefficient for constant heat flux and constant wall temperature boundary conditions are, respectively

(a) 43.6 and 36.6 W/m^2K
(b) 43.6 W/m K for both the cases
(c) 36.6 and 43.6 W/m^2 K
(d) 36.6 W/m K for both the cases

01. Ans: (a)

Sol:

For constant heat flux boundary condition,

$$h = 4.36\frac{k}{D}$$

$$h = 4.36 \times \frac{2}{0.2} = 4.36 \times 10 = 43.6 W/m^2K$$

For constant wall temperature boundary conditions,

$$h = 3.66\frac{k}{D} = 3.66 \times \frac{2}{0.2} = 3.66 \times 10 = 36.6\ W/m^2K$$

02. What are the desirable properties of the material that should be used in a cutting tool?

A. High ductility
B. Hot hardness
C. Toughness
D. Wear resistance

(a) B, C and D only (b) A and D only
(c) A, B and C only (d) A, B, C and D

02. Ans: (a)

Sol: The desirable properties of the material that should be used in a cutting tool are

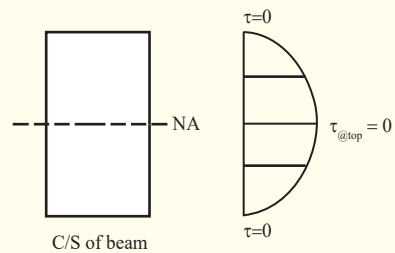
- Hot hardness
- Toughness
- Wear resistance

03. For a rectangular cross-section beam subjected to maximum shear force F, the shear stress at the top edge is

(a) maximum
(b) inversely proportional to F
(c) zero
(d) directly proportional to F

03. Ans: (c)

Sol:



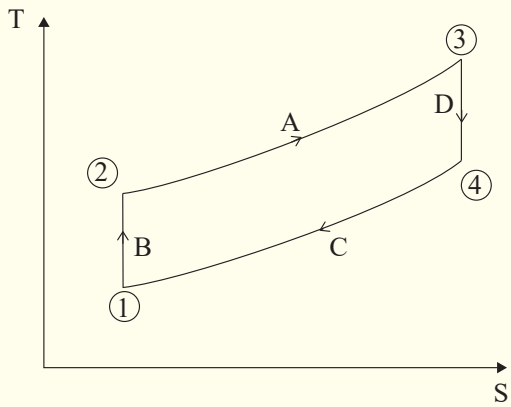
04. In a Brayton cycle for a power plant, choose the option that arranges the following processes in the correct sequence.

A. Isobaric heat addition (Q added)
B. Isentropic compression (W added)
C. Isobaric heat rejection (passive exhaust)
D. Isentropic expansion (W extracted)

(a) A, D, B, C (b) B, C, D, B
(c) A, C, D, B (d) B, A, D, C

04. Ans: (d)

Sol: Brayton cycle



Process (1) - (2) → Isentropic compression
Process (2) - (3) → P = K (Heat addition)
Process (3) - (4) → Isentropic expansion
Process (4)-(1) → P = K (Heat rejection)

05. Arrange the materials in increasing order of their hardness.

(a) Aluminium oxide < Common glass < Hardened steel < Diamond
(b) Common glass < Aluminium oxide < Diamond < Hardened steel
(c) Common glass < Aluminium oxide < Hardened steel < Diamond
(d) Common glass < Hardened steel < Aluminium oxide < Diamond

05. Ans: (d)

Sol: Diamond is hardest and strongest material.

Increasing order of hardness:

Common glass, Hardened steel, Aluminium oxide, Diamond.

06. Consider the following:

A. Forced convection
B. Natural convection
C. Combined free and forced convection
D. Unsteady conduction with convection at surface

1. Reynolds, Grashof and Prandtl number
2. Reynolds and Prandtl number
3. Fourier modulus and Biot number
4. Prandtl number and Grashof number

Choose the option in which given pairs correctly matched.

(a) A-3, B-1, C-4, D-2 (b) A-1, B-2, C-3, D-4
(c) A-2, B-4, C-1, D-3 (d) A-3, B-4, C-2, D-1

06. Ans: (c)

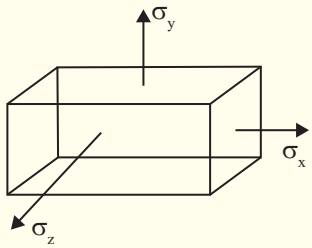
Sol: Forced convection ⇒ Reynolds and Prandtl number
Natural convection ⇒ Prandtl number and Grashof number
Combined free and forced convection ⇒ Reynolds Grashof and Prandtl number
Unsteady conduction with convection surface ⇒ Fourier modulus and Biot number .

07. The volumetric strain of a rectangular body subjected to three mutually perpendicular forces is (where σ_x, σ_y and σ_z are the stresses in x, y and z direction respectively. E and ν are Young's modulus and Poisson's ratio respectively)

(a) $\frac{\sigma_x+\sigma_y+\sigma_z}{E}(1-2\nu)$ (b) $\frac{\nu(\sigma_x+\sigma_y+\sigma_z)}{E}$
(c) $\frac{\sigma_x+\sigma_y+\sigma_z}{E}$ (d) $\frac{\sigma_x}{E}$

07. Ans: (a)

Sol:



Under triaxial condition,

Volumetric strain , $\varepsilon_v = \frac{\sigma_x + \sigma_y + \sigma_z}{e}(1 - 2\mu)$

08. The thermodynamic difference between a Rankine cycle working with saturated steam and the Carnot cycle is that

(a) Rankine cycle is hypothetical

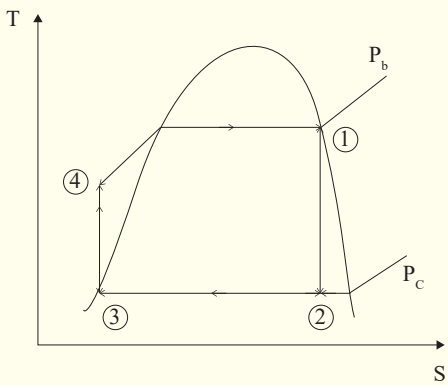
(b) Carnot cycle can't work with saturated steam

(c) Heat is supplied to water at temperature below the maximum temperature of the cycle

(d) A Rankine cycle receives heat at two places

08. Ans: (c)

Sol:



Feed water enters to Rankine cycle under sub cooled state with a temperature less than saturation temperature corresponding to boiler pressure.

∴ The water receives the heat below the maximum temperature of the cycle.

09. The degree of reaction of an impulse stage of a turbine or compressor is

(a) Infinity (b) Zero

(c) One (d) 0.5

09. Ans: (b)

Sol: Since impulse turbine is constructed to work at constant pressure. Degree of reaction is zero for impulse turbine.

∴ dp = 0

dh = 0

$$R_d = \frac{(dh)_{MB}}{(dh)_{FB} + (dh)_{MB}} \quad \text{..... for turbine}$$

$$R_d = \frac{(dp)_{MB}}{(dp)_{FB} + (dp)_{MB}} \quad \text{..... for compressor}$$

10. The static deflection at the free end of a cantilever beam with a uniformly distributed load of w per unit length is

(where L is the length of the cantilever and EI is the flexural rigidity)

(a) $\frac{wL^4}{8EI}$ (b) $\frac{wL^3}{48EI}$

(c) $\frac{wL^3}{3EI}$ (d) $\frac{wL^4}{48EI}$

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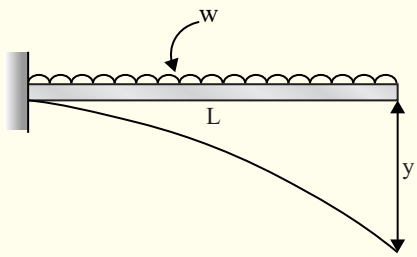
10. Ans: (a)

Sol:



$$y_{\text{at free end}} = \frac{wL^4}{8EI}$$

11. Match the following considering the context of a single-stage axial turbine (assume no frictional and heat losses, and that the radial flow is negligible).

A. Across rotor
B. Across stator
C. Across a stage

1. Stagnation enthalpy is constant
2. Relative stagnation enthalpy is constant
3. Enthalpy is constant

(a) A-2 and 3; B matched to none; C-1, 2 and 3
(b) A-2 and 3; B-1 and 2; C matched to none
(c) A-2 and 3; B-1, 2 and 3; C matched to none
(d) A-1 and 3; B-1 and 3; C-3

11. Ans: (c)

Sol: Across a stage of axial turbine the enthalpy never remains constant.

12. Stream function ____ along a stream line.

(a) is not defined (b) increases
(c) is zero (d) is constant

12. Ans: (d)

Sol: Stream function is constant along a streamline.

13. The unit of shear modulus is same as

(a) Young's modulus and flexural rigidity
(b) Force and stress
(c) Force and pressure
(d) Stress and Young's modulus

13. Ans: (d)

Sol: Unit of shear modulus → MPa
Unit of stress and Young's modulus → MPa

14. A stator in a turbine

(a) Redirects and accelerates/decelerates the flow
(b) Cannot alter the static pressure of the fluid flow
(c) Adds energy to the flow in terms of work
(d) Is otherwise known as a stage of the turbomachinery

14. Ans: (a)

Sol: A stator in a turbine redirects and accelerates/decelerates the flow.

15. In an ultrasonic machining process, the material removal rate increases with

(a) Increase in the frequency and decrease in the amplitude of vibration
(b) Decrease in the frequency and decrease in the amplitude of vibration
(c) Increase in the frequency and increase in the amplitude of vibration
(d) Decrease in the frequency and increase in the amplitude of vibration

15. Ans: (c)

Sol: The MRR in USM is given by

$$Q \propto V Z f$$

where, Q = Volume of work material removal rate (MRR)

V = Volume of material dislodged/impact,

Z = Number of particles making impact/cycle,

f = Frequency

16. The ratio

$$\frac{\text{Conduction resistance within the body}}{\text{Convective resistance at the surface of the body}}$$

is known as

(a) Stanton number (b) Grashof number

(c) Nusselt number (d) Biot number

16. Ans: (d)

Sol: $\text{Biot number} = \frac{\text{Conduction resistance withitn the body}}{\text{Convective resistance at the surface of the body}}$

17. In a horizontal pipe of diameter d mm and length 1 m carrying oil, whose friction factor is f. If the acceleration due to gravity is gm/s^2 and fluid velocity v m/s, then the head loss due to friction is given by

(a) $f l v^2 / 6gd$ (b) $f l v^2 / 4gd$

(c) $f l v^2 / 8gd$ (d) $f l v^2 / 2gd$

17. Ans: (d)

Sol: Head loss due to friction in a pipe is given by:

$$h_f = \frac{f\ell v^2}{2gd}$$

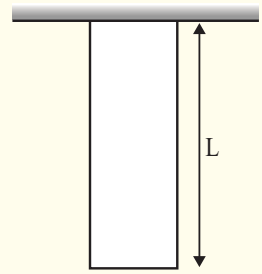
18. The total elongation of a bar due to its self-weight is (where w, L and E are the specific weight, length, and Young's Modulus of the bare respectively)

(a) $\frac{w^2L}{E}$ (b) $\frac{wL^2}{2E}$

(c) $\frac{wL^2}{E}$ (d) $\frac{w^2L}{2E}$

18. Ans: (b)

Sol:



$$\delta L_{sw} = \frac{\gamma L^2}{2E}$$

$$= \frac{wL^2}{2E} \quad (\because \gamma = w \text{ given})$$

19. In Carnot cycle, the thermal efficiency may be increased by

(a) decreasing the lowest temperature

(b) keeping the lowest temperature constant

(c) increasing the highest temperature

(d) increasing the lowest temperature

19. Ans: (a)

Sol: Efficiency of Carnot cycle is

$$\eta_c = 1 - \frac{T_2}{T_1}$$

T_2 = Lowest absolute temperature

T_1 = Highest absolute temperature

If $T_2 \downarrow$ at $T_1 = K \Rightarrow \eta_c \uparrow$

If $T_1 \uparrow$ at $T_2 = K \Rightarrow \eta_c \uparrow$

But the efficiency of Carnot cycle can be increased in the better manner by decreasing the lowest absolute temperature

If T_1 increases, then T_1 changes to $T_1 + \Delta T$

$$\eta_c = 1 - \frac{T_2}{T_1 + \Delta T}$$

$$= \frac{T_1 + \Delta T - T_2}{T_1 + \Delta T} \quad \text{------ (1)}$$

If T_2 decreases, then T_2 changes to $T_2 - \Delta T$

$$\eta_c = 1 - \frac{(T_2 - \Delta T)}{T_1}$$

$$= \frac{T_1 - T_2 + \Delta T}{T_1}$$

$$= \frac{T_1 + \Delta T - T_2}{T_1} \quad \text{------ (2)}$$

From eq. (1) & (2), it can be evidently concluded that the efficiency can be increased in the better manner by decreasing the lowest absolute temperature rather the increasing the highest absolute temperature.

20. Consider the following statements for the coefficient of fluctuation of speed (K) of flywheel.

A. $K = \dfrac{\text{maximum speed} - \text{minimum speed}}{\text{mean speed}}$

B. $K = \dfrac{\text{maximum fluctuation of energy}}{\text{2 times kinetic energy of the flywheel at mean speed}}$

C. $K = \dfrac{\text{maximum fluctuation of energy}}{\text{kinetic energy of the flywheel at mean speed}}$

Which of the following statements is/are correct?

(a) only B (b) both A and C
(c) only A (d) both A and B

20. Ans: (d)

Sol: Maximum fluctuation in energy

$$(\Delta KE)_{max} = (KE)_{max} - (KE)_{min} = \frac{1}{2}(I\omega_{max}^2 - I\omega_{min}^2)$$

$$(\Delta KE)_{max} = I\omega_{avg}^2 \frac{(\omega_{max} - \omega_{min})}{\omega_{avg}}$$

$$= I\omega_{avg}^2 . C_s$$

$$C_s = \frac{\omega_{max} - \omega_{min}}{\omega_{avg}}$$

$$C_s = \frac{(\Delta KE)_{max}}{I\omega_{avg}^2} = \frac{(\Delta KE)_{max}}{2.(KE)_{avg}}$$

21. For a simply supported beam carrying distributed load w per unit length, consider the following relations between shear force F and bending moment M.

A. $w = -\dfrac{dF}{dx}$

B. $w = -\dfrac{d^2M}{dx^2}$

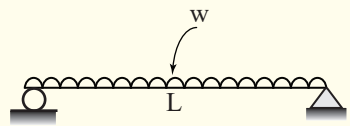
C. $F = \dfrac{dM}{dx}$

Which of the above statements is/are correct?

(a) B and C only (b) A, B and C
(c) A and B only (d) A only

21. Ans: (b)

Sol:



(1) $\dfrac{dF}{dx} = (-) \downarrow w$ (or) $w = (-)\dfrac{dF}{dx}$

(2) $\dfrac{dM}{dx} = F$

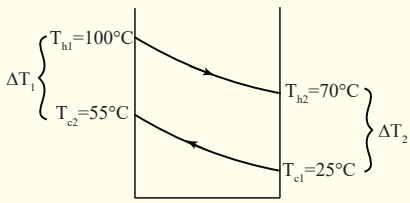
(3) $\dfrac{d^2M}{dx^2} = (-) \downarrow w$

22. In a counter-flow heat exchanger, a hot fluid is cooled from 100°C to 70°C by using a cold fluid that gets heated from 25°C to 55°C. The LMTD value of the heat exchanger is

(a) 25°C (b) 100°C
(c) 45°C (d) 70°C

22. Ans: (c)

Sol:



$\Delta T_1 = T_{h1} - T_{c2} = 100 - 55 = 45°C$
$\Delta T_2 = T_{h2} - T_{c1} = 70 - 25 = 45°C$
In counter flow when $\Delta T_1 = \Delta T_2$ then
LMTD = $\Delta T_1 = \Delta T_2 = 45°C$

23. Which of the following statement is TRUE?
Fins are used to enhance heat transfer from a heated surface by

(a) Increasing the convective heat transfer coefficient
(b) Decreasing the effective surface area
(c) Increasing the effective surface area
(d) Increasing the temperature difference

23. Ans: (c)

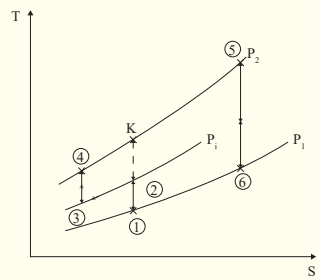
Sol: The purpose of fin is to increase surface area so that convective heat transfer will increase.

24. Comparing the case of intercooling with no intercooling, the heat supplied in Brayton cycle is

(a) greater (b) constant
(c) lower (d) varying

24. Ans: (a)

Sol:



With intercooling the gas enters CC with T_4 temperature.
Without intercooling the gas enters CC with T_K temperature.
To increase the temperature from T_4 to T_5 more heat is required (with intercooling) than to raise the temperature from T_K to T_5 (without intercooling)

25. Young's modulus is given by
(where K and G are bulk and shear modulus respectively)

(a) $\frac{9KG}{3G+K}$ (b) $\frac{12KG}{2G+3K}$
(c) $\frac{9KG}{G+3K}$ (d) $\frac{3G+K}{9KG}$

25. Ans: (c)

Sol: Relation between E, G,K

$$E = \frac{9KG}{3K+G}$$

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26. Following are the reasons for high specific energy requirements in grinding compared to single point tools.
A. Average rake angle is negative.
B. Average rake angle is positive.
C. Plowing consumes additional energy without contributing to chip removal.
D. Sliding consumes additional energy without contributing to chip removal

(a) B, C and D only
(b) A and D only
(c) A, C and D only
(d) A and C only

26. Ans: (c)

Sol: High specific energy requirements in grinding because
- irregular and random geometry of abrasive grits
- lot of rubbing and ploughing action

Negative rake angle is used in grinding.

27. The maximum principal stress theory is associated with the name of
(a) Rankine (b) Hencky
(c) Von-Mises (d) Tresca

27. Ans: (a)

Sol: The maximum principal stress theory is associated with the name of Rankine.

28. In an electro discharge machining process, which of the properties are desirable for the dielectric fluid?
A. Chemical neutrality
B. High viscosity
C. Absence of inflaming tendency
D. Low cost
(a) A and D only (b) B, C and D only
(c) A, B, C and D (d) A, C and D only

28. Ans: (a)

Sol: The dielectric fluid is a spark conductor, coolant and also a flushing medium. The requirements are:
1. The dielectric fluid should have sufficient and stable dielectric strength to serve as insulation between the tool and work till the breakdown voltage is reached.
2. It should de-ionise rapidly after the spark discharge has taken place.
3. It should have low viscosity and a good wetting capacity to provide effective cooling mechanism and remove the swarf particles from the machining gap.
4. It should flush out the particles produced during the spark out of the gap. This is the most important function of the dielectric fluid. Inadequate flushing can result in arcing decreasing the life of the electrode and increasing the machining time.
5. It should be chemically neutral so as not to attack the electrode, the work piece, the table or the tank.
6. Its flash point should be high so that there are no fire hazards.
7. It should not emit any toxic vapours or have unpleasant odours.

8. It should maintain these properties with temperature variation, contamination by working residuals and products of decomposition.
9. It should be economical and easily available.

29. Tensile strength of the butt joint is defined as (where σ is the permissible tensile stress in the plate, t is the throat thickness, *l* is the length of weld)
(a) σt^2 (b) σl^2
(c) $2\sigma lt$ (d) σlt

29. Ans: (d)

Sol: Tensile strength of the butt joint is maximum load carrying capacity of the joint which is given as,
Maximum load = Tensile strength × Area
$= \sigma lt$

30. For an opaque body, the relationship between reflectivity (ρ), absorptivity (α) and transmissivity (τ) is given as
(a) $\rho + \alpha = \tau$ (b) $\rho + \alpha = 1$
(c) $\rho + \alpha + \tau = 0$ (d) $\rho + \alpha = 0$

30. Ans: (b)

Sol: For opaque body trasmissivity is zero $\tau = 0$
Therefore, $1 = \alpha + \rho + \tau$
$1 = \alpha + \rho$

31. The compression process for uncooled rotary compressor is
(a) reversible (b) adiabatic
(c) isothermal (d) isochoric

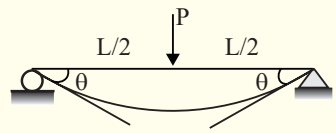
31. Ans: (b)

Sol: Uncooled compressor means no heat transfer.
Only adiabatic system can maintain zero heat transfer.

32. For a simply supported beam of length L carrying concentrated load P (vertically downward) at the centre. The slope at the ends will be
(where EI is the flexural rigidity)
(a) equal and $-\frac{PL^2}{4EI}$ (b) equal and $-\frac{PL^2}{EI}$
(c) equal and $-\frac{PL^2}{16EI}$ (d) equal and $-\frac{PL^3}{48EI}$

32. Ans: (c)

Sol:

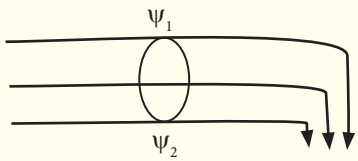


$\theta = \frac{PL^2}{16EI}$ (std.case)

33. Which of the following statements are true?
A. A streak line is a curve connecting all points in the flow along which a fluid particle moves in time.
B. Two stream lines can never cross each other.
C. For a steady flow, path lines, stream lines and streak lines coincide.
D. The separation between two stream lines is proportional to the velocity.
E. Path line and streak line originating from a point in flow can never intersect elsewhere in the flow.
(a) B and C (b) A, B, D and E
(c) A, C and D (d) B and D

33. Ans: (a)

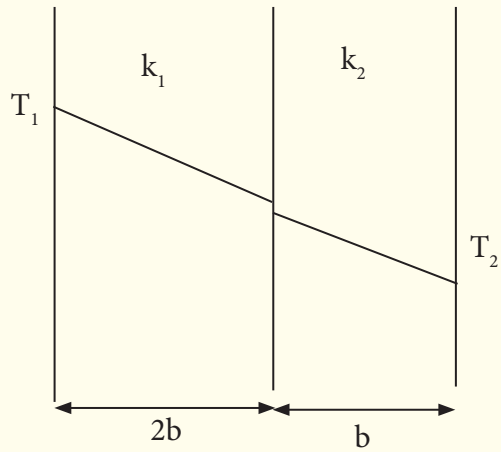
Sol: The separation between two stream lines is proportional to discharge not velocity.



$\psi_1 - \psi_2$ = discharge per unit length

Statement 'D' is wrong. So by elimination trick option (a) is correct.

34. The temperature at the interface (T_{inter}) of the composite wall shown in the figure below is equal to the average temperature at the two ends. Assuming steady one-dimensional heat conduction, with equal height and depth of the entire wall.



Which of the following options is true about the respective thermal conductivities?

(a) $k_1 = k_2$ (b) $k_1 = 2k_2$

(c) $2k_1 = k_2$ (d) $2k_1 = 3k_2$

34. Ans: (b)

Sol: $T_{inter} = \frac{T_1 + T_2}{2}$

This is possible only when both the wall have equal resistance

$$R_1 = R_2$$

$$\frac{2b}{k_1 A} = \frac{b}{k_2 A}$$

$$k_1 = 2k_2$$

35. The distorsion energy theory is based on the work of

(a) Treaca

(b) Beltrami

(c) Rankine

(d) Von-Mises, Hencky and Huber

35. Ans: (d)

Sol: The distorsion energy theory is based on the work of Von-Mises, Hencky and Huber.

36. Just-in-time manufacturing is most effective in

A. Low volume manufacturing

B. High volume manufacturing

C. Repetitive manufacturing

D. Innovative manufacturing

(a) A and D only

(b) C and D only

(c) A and C only

(d) B and C only

36. Ans: (a)

Sol: Just-in-time manufacturing is most effective in low volume manufacturing and innovative manufacturing.

37. Consider the following statements:

A. Equal and opposite axial stresses act on two mutually perpendicular planes.

B. Equal axial stresses act on two mutually perpendicular planes.

C. Planes are free of shear.

Now, for a Mohr's circle to reduce to a point, which of the following statements is/are true?

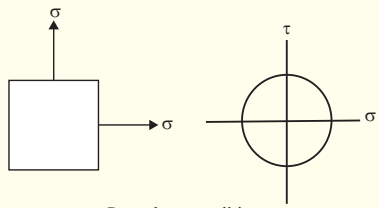
(a) B only (b) C only

(c) A and C only (d) B and C only

37. Ans: (a)

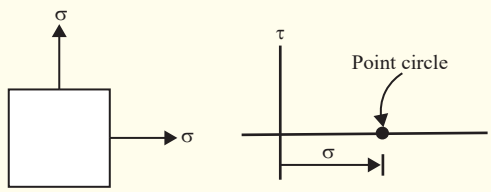
Sol: Under hydrostatic stress condition only, Mohr's circle become a point circle.

Statement (A):



Pure shear condition

Statement (B):



Hydrostatic condition

Statement (C):

If planes are free of shear then they are principal planes on P-planes , P =stresses are may be (or) may not be equal in magnitudes and also they have same nature or else they have opposite in nature.

∴ Most relevant option is statement B correct.

38. Which of the following are characteristics of just-in-time manufacturing.

A. Low inventory carrying cost.

B. Reduced need for inspection.

C. Presence of large stock in the inventory.

D. Parts can be retrieved from the storage as and when needed.

(a) B and C only (b) C and D only

(c) A and C only (d) A and B only

38. Ans: (d)

Sol: The following are characteristics of just-in-time manufacturing.

- Low inventory carrying cost.
- Reduced need for inspection.
- Small Lot Sizes
- Closer Supplier Ties
- Maintaining High Quality
- Quick and Economic Setups

39. The maximum stress intensity due to suddenly applied axial load is

(a) twice of the stress intensity produced by the same magnitude of gradually applied axial load

(b) one-fourth of the stress intensity produced by the same magnitude of gradually applied axial load

(c) half of the stress intensity produced by the same magnitude of gradually applied axial load

(d) equal to the stress intensity produced by the same magnitude of gradually applied axial load

39. Ans: (a)

Sol: The maximum stress intensity due to suddenly applied axial load is twice of the stress intensity produced by the same magnitude of gradually applied axial load.

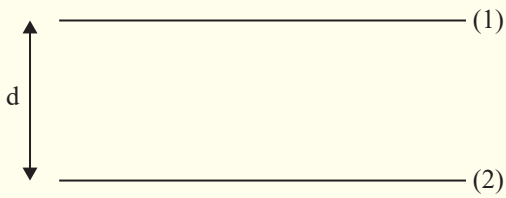
$$\sigma_{SAL} = 2\left(\frac{P}{A}\right) = 2\sigma_{GAL}$$

40. What will be the value of the shape factor for two infinite parallel surfaces separated by a distance d?

(a) ∞ (b) d (c) 0 (d) 1

40. Ans: (d)

Sol:



$F_{11} = 0$

$F_{11} + F_{12} = 1 \qquad (F_{11} = 0)$

$F_{12} = 1$

41. According to the maximum normal stress theory, the diameter of circular shaft subjected to bending moment M and torque T is

(where σ_y is the yield stress in the uniaxial tensile test and N is the factor of safety)

(a) $\left[\frac{1}{\pi N\sigma_y}\left(16M + 16\sqrt{M^2+\tau^2}\right)\right]^{\frac{1}{2}}$

(b) $\left[\frac{N}{\pi\sigma_y}\left(16M + 16\sqrt{M^2+\tau^2}\right)\right]^{\frac{1}{3}}$

(c) $\left[\frac{N}{\pi\sigma_y}\left(16M + 16\sqrt{M^2+\tau^2}\right)\right]^{\frac{1}{2}}$

(d) $\left[\frac{1}{\pi N\sigma_y}\left(16M + 16\sqrt{M^2+\tau^2}\right)\right]^{\frac{1}{3}}$

41. Ans: (b)

Sol: According to maximum normal stress theory,

$$\sigma_{max} = \frac{S_{yt}}{FOS}$$

For combined bending & twisting

$$\sigma_{max} = \frac{32}{\pi d^3}\left[\frac{1}{2}\left(M + \sqrt{M^2+T^2}\right)\right]$$

$$\Rightarrow \frac{16}{\pi d^3}\left(M + \sqrt{M^2+T^2}\right) = \frac{\sigma_y}{N}$$

$$d = \left[\frac{N}{\pi\sigma_y}\left(16M + 16\sqrt{M^2+T^2}\right)\right]^{\frac{1}{3}}$$

42. The relation for specific heats is given by

(a) $C_V - C_P = \frac{vT\beta^2}{K}$ (b) $C_P - C_V = \frac{pT\beta^2}{K}$

(c) $C_P - C_V = \frac{vT\beta^2}{K}$ (d) $C_P - C_V = \frac{vT}{K\beta^2}$

42. Ans: (c)

Sol: We know that

$$C_p - C_v = -T\left(\frac{\partial v}{\partial T}\right)_P^2\left(\frac{\partial P}{\partial v}\right)_T$$

$$\beta = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_p \qquad \ldots\ldots (1)$$

$$K_T = \frac{-1}{V}\left(\frac{\partial V}{\partial T}\right)_T \qquad \ldots\ldots (2)$$

From equation (1) and (2)

$$C_P - C_v = -T(V\beta)^2\frac{-1}{K_T V}$$

$$C_p - C_v = \frac{TV\beta^2}{K_T}$$

where,

V = Specific volume (m^3/kg)

T = Absolute temperature (K)

β = Volume expansivity

K_T = Isothermal compressibility

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43. Schottky defect is a following type of imperfection in a crystalline solid

(a) Line defect (b) Dislocation
(c) Point defect (d) Surface defect

43. Ans: (c)

Sol: Schottky defect is generated by missing of pair of atoms (cations & anions) from lattice structure.

44. If the thermal conductivity of insulating material is K (W/mK) and the surface heat transfer coefficient h (W/m^2K), then the critical radius of insulation for the cylinder is given by

(a) K/2h (b) h/K
(c) 2K/h (d) K/h

44. Ans: (d)

Sol: For cylinder critical radius of insulation is K/h.

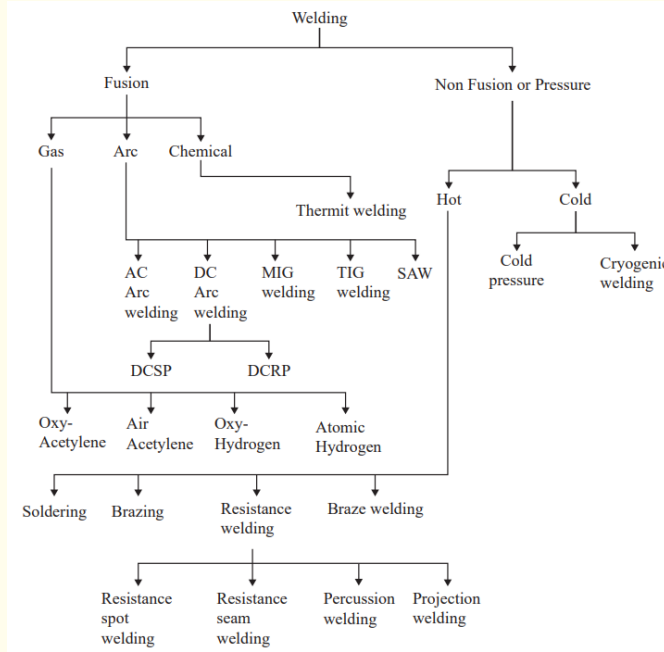
45. Match the following:

A. Shielded arc welding	1. Fusion welding
B. Electric-resistance welding	2. Forge welding
C. Gas welding	
D. Thermal welding	

(a) A-1, B-1, C-1, D-1 (b) A-1, B-2, C-1, D-1
(c) A-2, B-1, C-1, D-1 (d) A-1, B-2, C-2, D-1

45. Ans: (a)

Sol: The figure shown below characterizes the welding process into fusion and non-fusion process. We can see that shielded arc welding, electrical resistance welding, gas welding and thermit welding are not the part of forge welding.



46. The discharge in m^3/s for laminar flow through a pipe of diameter 0.04 m having a centre line maximum velocity 1.5 m/s is

(a) $3\pi/2500$ (b) $3\pi/5000$
(c) $3\pi/50$ (d) $3\pi/10000$

46. Ans: (d)

Sol: Given data:

Flow is laminar

diameter, d = 0.04 m,

centre line maximum velocity = 1.5 m/s

$$\text{Average velocity} = \frac{1.5}{2} = 0.75 \text{ m/s}$$

$$\text{Discharge} = \frac{\pi}{4}d^2 \times \text{Average velocity}$$

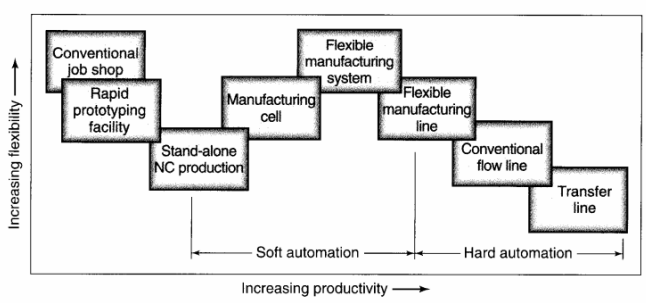
$$= \frac{\pi}{4} \times 0.04 \times 0.04 \times \frac{3}{4} \text{ m}^3/\text{s}$$

$$= \frac{3\pi}{10^4} = \frac{3\pi}{10,000} \text{ m}^3/\text{s}$$

47. Arrange the following manufacturing technologies from lowest to highest in terms of their production capability per year.
   (a) Transfer line < Flexible manufacturing system < Flexible manufacturing cell < Standalone NC machine
   (b) Standalone NC machine < Flexible manufacturing cell < Flexible manufacturing system < Transfer line
   (c) Transfer line < Flexible manufacturing cell < Flexible manufacturing system < Standalone NC machine
   (d) Standalone NC machine < Flexible manufacturing system < Flexible manufacturing cell < Transfer line

47. Ans: (b)

Sol: The arrangement of various systems based on productivity and flexibility is shown in the figure below:



48. The linear velocity of a body rotating with angular velocity ω along a circular path of radius r is defined as
   (a) $\frac{\omega}{r}$ (b) $\frac{\omega}{r^2}$
   (c) $\omega^2 r$ (d) ωr

48. Ans: (d)

Sol: The linear velocity of a body rotating with angular velocity ω along a circular path of radius r is defined as V = ωr (For no slip)

49. A floating body can attain stable equilibrium if
   (a) Meta center point coincides with the center of gravity
   (b) Meta center point is above the center of gravity
   (c) Meta center point is parallel to the center of gravity
   (d) Meta center point is below the center of gravity

49. Ans: (b)

Sol: A floating body can attain stable equilibrium if meta center point is above the centre of gravity.

50. Which of the following statements are true?
   A. Hot-rolled and hot-drawn products have a wider dimensional tolerances and rougher surface finish than cold-rolled and cold-drawn products.
   B. Seamless tubing made by the tube-rolling process have more thickness variation than that of roll-formed and welded tubing
   C. Castings generally have higher dimensional accuracy and smoother surface finish than parts made by cold extrusion
   D. Extrusions have smaller cross-sectional dimensional tolerances than parts made by roll forming.
   (a) A, B and D only (b) A, C and D only
   (c) A, B and C only (d) B, C and D only

50. Ans: (b)

Sol: Cast component generally have lower dimensional accuracy and more rough surface than metal formed component.

51. For a thin cylindrical shell, the ratio of hoop stress to longitudinal stress is

(a) $\frac{1}{2}$ (b) 3 (c) 2 (d) 1

51. Ans: (c)

Sol: $\sigma_c = \frac{PD}{2t}$

$\sigma_L = \frac{PD}{4t}$

$\frac{\sigma_C}{\sigma_L} = \frac{\left(\frac{PD}{2t}\right)}{\left(\frac{PD}{4t}\right)} = \frac{4}{2} = 2$

52. Thermal diffusivity of a substance is

(a) Directly proportional to thermal conductivity
(b) Inversely proportional to the square of thermal conductivity
(c) Inversely proportional to thermal conductivity
(d) Directly proportional to the square of thermal conductivity

52. Ans: (a)

Sol: Thermal diffusivity, $\alpha = \frac{k}{\rho c}$

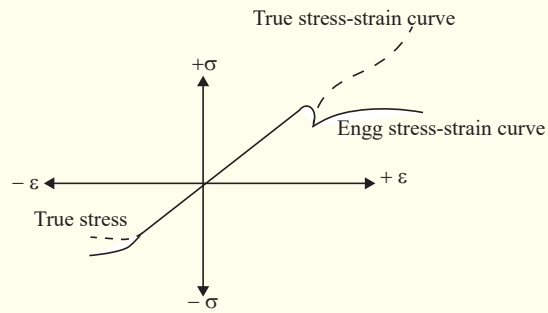
α is directly proportional to k.

53. Which of the following statement is TRUE?

(a) True stress is always greater than the engineering stress in the plastic region
(b) True stress is always less than the engineering stress in the elastic region
(c) True stress is always less than the engineering stress in the plastic region
(d) True stress is equal to the engineering stress in the plastic region

53. Ans: (a)

Sol:



In plastic region,

In tensile test true stress > engineering stress

In compression test true stress < engineering stress

Most fundamental test in laboratory is simple tension test.

∴Under simple tension test, in plastic region true stress > engineering stress.

54. What happens to the entropy if a closed system undergoes an irreversible process?

(a) must decrease
(b) remains constant
(c) can increase, decrease or remain constant
(d) must increase

54. Ans : (c)

Sol: If irreversible process taking place with Q = 0, entropy increases.

If irreversible process taking place with heat addition, entropy increases.

If the irreversible process taking place with heat rejection, entropy may be equal to zero or less than zero.

55. The coefficient of performance (COP) of a refrigerator working as a heat pump is given by

(a) $(COP)_{heat\ pump} = (COP)_{refrigerator} - 1$

(b) $(COP)_{heat\ pump} = (COP)_{refrigerator} + 2$

(c) $(COP)_{heat\ pump} = (COP)_{refrigerator}$

(d) $(COP)_{heat\ pump} = (COP)_{refrigerator} + 1$

55. Ans : (d)

Sol: $(COP)_{HP} = 1 + (COP)_{R}$

56. An engine drives the line shaft through a belt of thickness t. If d_1 and d_2 are the diameter of the follower and driver respectively, the velocity ratio is

(a) $\frac{d_1 - t}{d_2 - t}$ (b) $\frac{d_2 + t}{d_1 + t}$

(c) $\frac{d_1}{d_2}$ (d) $\frac{d_1 + t}{d_2 + t}$

56. Ans: (d)

Sol: Velocity ratio,

$$\frac{N_2}{N_1} = \frac{d_1 + t}{d_2 + t}\left(1 - \frac{S_1}{100} - \frac{S_2}{100}\right)$$

S_1 = % slip between driver & belt

S_2 = % slip between belt & follower

Consider, $S_1 = S_2 = 0$

$$\frac{N_2}{N_1} = \frac{d_1 + t}{d_2 + t}$$

57. The resultant upward pressure of the fluid on an immersed body due to its tendency to uplift the submerged body is called

(a) Centre of pressure (b) Buoyancy

(c) Meta centre (d) Centre of gravity

57. Ans : (b)

Sol: The resultant upward pressure of the fluid on an immersed body due to its tendency to lift the submerged body is called buoyancy.

58. A stepping motor has 36 step angles. Its output shaft is coupled to a leadscrew with a 5:1 gear reduction (five turns of the motor shaft moves each turn of the leadscrew). The leadscrew pitch is 5.0 mm. The worktable of a positioning system is driven by the leadscrew. The table must move 50.0 mm from its current position. Determine how many pulses are required to move the table the specified distance.

(a) 360 (b) 180

(c) 3600 (d) 1800

58. Ans : (d)

Sol: Gear ratio = 1/5

1 step = 1 pulse

Pitch = 5 mm

36 pulse $\rightarrow$ 1 revolution of meter

= G × 1 rev. of lead screw

$= \frac{1}{5} \times$ pitch

$= \frac{1}{5} \times 5 = 1$mm

36 pulse $\rightarrow$ 1 mm

1 pulse $\rightarrow$ BLU

BLU× 36 = 1

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$$BLU = \frac{1}{36} = 0.027 \text{ mm}$$
$$1 \text{ P} \rightarrow 0.027 \text{ mm}$$
$$x_P \rightarrow 50 \text{ mm}$$
$$x_P = \frac{50}{0.027} = 1805.05 \approx 1800$$

59. A Bourdon tube can be used to measure
(a) Density (b) Temperature
(c) Pressure (d) Velocity

59. Ans : (c)

Sol: A Bourdon tube can be used to measure pressure.

60. A vehicle has circular wheel or radius of gyration 0.5 and mass 1000 kg. If the starting torque of the vehicle is 1000 N-m, the angular acceleration of the wheel is
(a) 2 rad/s^2 (b) 0.25 rad/s^2
(c) 4 rad/s^2 (d) 0 rad/s^2

60. Ans : (c)

Sol: Angular acceleration,

$$\alpha = \frac{\text{Torque}}{I} = \frac{\text{Torque}}{mk^2}$$
$$= \frac{1000}{1000 \times 0.5^2} = 4 \text{ rad/s}^2$$

61. A hollow cylinder has length L, inner radius r_1, outer radius r_2 and thermal conductivity K. The thermal resistance of the cylinder for radial conduction is
(a) $ln(r_2/r_1)/2\pi KL$
(b) $2\pi KL/ln(r_2/r_1)$
(c) $ln(r_1/r_2)/2\pi KL$
(d) $2\pi KL/ln(r_1/r_2)$

61. Ans : (a)

Sol: $$Q = \frac{T_1 - T_2}{\frac{\ell n\left(\frac{r_2}{r_1}\right)}{2\pi K L}} = \frac{\Delta T}{R}$$

$$R_{cylinder} = \frac{\ell n\left(\frac{r_2}{r_1}\right)}{2\pi KL}$$

62. What are the characteristics of job shop production?
A. Different product types are produced.
B. Very large quantities are produced.
C. Single type of product is produced.
D. Low quantities of product are produced.
(a) C and D (b) A and D
(c) A and B (d) B and C

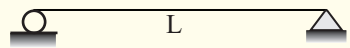
62. Ans : (b)

Sol: In job shop production different product types and low quantity of products are produced.

63. For simply supported beams, the bending moment at supports (or ends) is always
(a) unity
(b) proportional to the shear force
(c) zero
(d) inversely proportional to the shear force

63. Ans : (c)

Sol:



For SSB, @ supports B.M = 0

64. Consider the following:

The various process with their types for an air refrigerator working on a Reverse Brayton cycle is given below:

A.	Compression	1.	Isobaric
B.	Heat rejection	2.	Isothermal
C.	Expansion	3.	Isentropic
D.	Heat absorption	4.	Isenthalpic

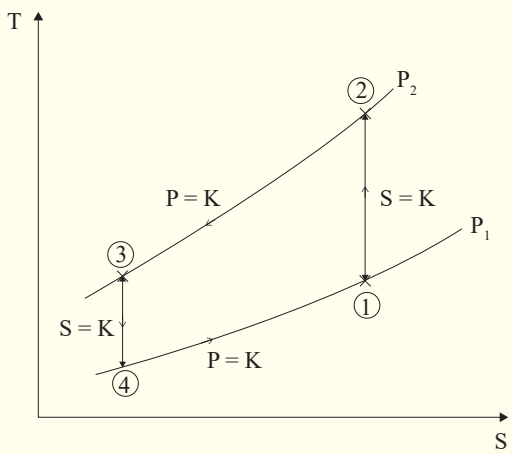
Choose the option in which given pairs are correctly matched.

(a) A-3, B-2, C-3, D-2 (b) A-3, B-1, C-3, D-1

(c) A-3, B-1, C-4, D-2 (d) A-3, B-1, C-2, D-2

64. Ans : (b)

Sol:



For reversed Brayton cycle

(1) - (2) compression at S = K

(2) - (3) Heat rejection at P = K

(3) - (4) Expansion at S = K

(4) - (1) Heat absorption at P = K

65. The length of a mold sprue is 45 cm and the cross-sectional area at tis base is 5 cm^2. The sprue feeds a horizontal runner leading into a mold cavity whose volume is 3000 cm^3.

Determine the time to fill the mold. Assume, gravity, g = 10 m/s^2.

(a) 2s (b) 20s

(c) 1s (d) 10s

65. Ans: (a)

Sol: Sprue height, h = 45 cm

A_{min} = 5 cm^2

Volume = 3000 cm^3

g = 10 m/s^2

Pouring time (P.T)

$$P.T = \frac{\text{Volume}}{\text{Area} \times \text{velocity}}$$

$$= \frac{3000}{5 \times \sqrt{2 \times 1000 \times 45}} = 2 \text{ sec}$$

66. In laminar flow through round tube, the discharge varies

(a) inversely as the viscosity

(b) inversely as the pressure drop

(c) linearly as the viscosity

(d) as the cube of the diameter

66. Ans: (a)

Sol: In laminar flow through round tube, the discharge is expressed as

$$Q = \frac{\pi D^4 \times \Delta P}{128 \mu L}$$

From the above equation, we conclude that $Q \propto \frac{1}{\mu}$.

67. For a redundant frame, the number of members (m) and the number of joints (j) are related as
(a) $m < 2j - 3$ (b) $m > 2j - 3$
(c) $m = 2j$ (d) $m = 2j - 3$

67. Ans: (b)

Sol: For a redundant frame, the number of members (m) and the number of joints (j) are related as $m > 2j - 3$

68. Identify the correct statements in the following with respect to heat and work.
A. They are exact differentials.
B. They are path functions.
C. They are boundary phenomena.
D. They are point functions.
(a) A, C and D only (b) B and C only
(c) A, B and C only (d) B, C and D only

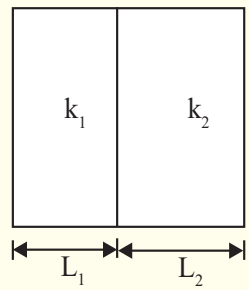
68. Ans: (b)

Sol: Heat and work:
(i) They are path function quantities
(ii) They are boundary phenomena
Heat and work not only depend on initial and final states, but also the path followed by the process. Therefore these two quantities are path dependent quantities.

69. Consider two walls, 1 and 2, both have the same surface area and the same temperature drop across their thickness. The ratio of the thermal conductivity between two walls is given as $k_1/k_2 = 2$. The thickness ratio between the two walls is given as $L_1/L_2 = 4$. Then the ratio of the heat transfer rate between the two walls Q_1/Q_2 will be
(a) 1 (b) 4 (c) 0.5 (d) 2

69. Ans : (c)

Sol:



Given $\frac{k_1}{k_2} = 2, \frac{L_1}{L_2} = 4$

$$\frac{Q_1}{Q_2} = \frac{k_1 \frac{\Delta T}{L_1}}{k_2 \frac{\Delta T}{L_2}}$$

$$\frac{Q_1}{Q_2} = \frac{k_1 \Delta T}{L_1} \times \frac{L_2}{k_2 \Delta T} = 2 \times \frac{1}{4} = \frac{1}{2} = 0.5$$

70. The Grubler's criterion for plane mechanisms with constrained motion is given by (where, l is the number of links and j is the number of binary joints)
(a) $3l - 2j - 3 = 0$ (b) $3l - 2j - 1 = 0$
(c) $3l - 2j - 2 = 0$ (d) $3l - 2j - 4 = 0$

70. Ans : (d)

Sol: According to Grubler's equation,
Mobility of mechanism is given as:
$DOF = 3(l - 1) - 2j$
For mechanism completely constrained motion
$DOF = 1$
$3(l - 1)2j = 1$
$3l - 2j - 4 = 0$

71. Which of the following is NOT a valid representation of a solid CAD model?
(a) Octree Representation
(b) Boundary Representation
(c) Spline Representation
(d) CSG Representation

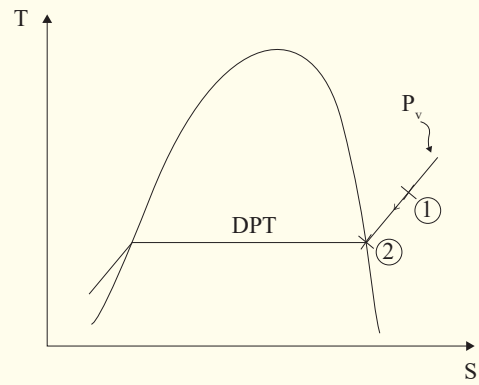
71. Ans : (a)

Sol: The Octree representation of a solid object is a three dimensional analog to pixels on a television screen. just as any area can be broken down into quadrants, any volume can be broken down into octants, which are then identified as solid, void, or partially filled. Partially filled voxels (from volume pixels) are broken into smaller octants and are reclassified. With increasing resolution, exceptional part detail can be achieved. This process may appear to be somewhat cumbersome, but it allows for accurate description of complex surfaces. It is used particularly in biomedical applications, such as modeling bone geometries. Although it is not a valid representation of a solid CAD model.

72. When a mixture of air and water vapour is cooled at constant pressure upto saturation temperature of water vapour, the temperature attained is known as
(a) Dew point temperature
(b) Dry bulb temperature
(c) Wet bulb temperature
(d) Critical temperature

72. Ans : (a)

Sol:

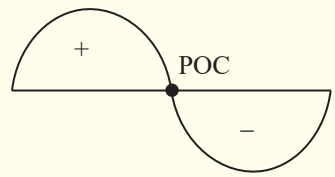


(1) - (2) Isobaric cooling of mixture of air and water. The saturation temperature corresponding to partial pressure of water vapor is DPT

73. At the point of contraflexure
(a) shear force is zero
(b) bending moment is maximum
(c) bending moment changes sign
(d) shear force is maximum

73. Ans : (c)

Sol:



BMD

At point of contraflexure, bending moment changes its sign from +ve to –ve or vice-versa.

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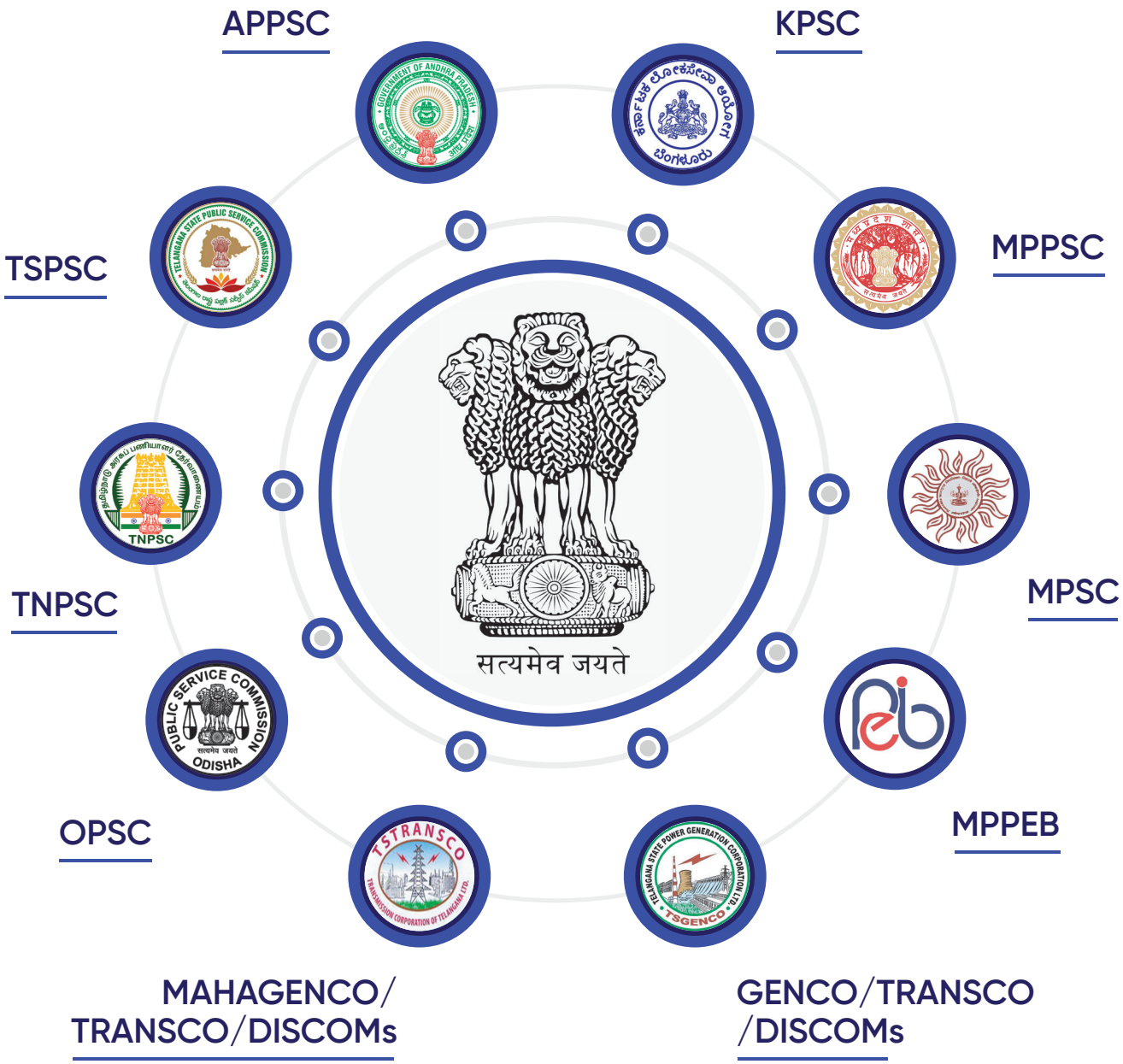


74. Match the following:

A.	Pressure	1.	Thermocouple
B.	Velocity	2.	Venturimeter
C.	Flow rate	3.	Manometer
D.	Temperature	4.	Prandtl tube (Pitot Static Tube)

(a) A-4, B-3, C-2, D-1 (b) A-2, B-4, C-3, D-1
(c) A-2, B-4, C-1, D-3 (d) A-3, B-4, C-2, D-1

74. Ans : (d)

Sol: Pressure → Manometer
Velocity → Prandtl tube
Flow rate → Venturimeter
Temperature → Thermocouple

75. In order to generate a casting with an internal surface, which part is typically used in a casting operation?
(a) Riser (b) Pattern
(c) Chaplets (d) Core

75. Ans : (d)

Sol: Core part is typically used in casting operation to generate a casting with an internal surface.

76. Select the correct dimensions for surface tension among the following.
(a) Nm (b) J/m^2
(c) J/m (d) W/m^2

76. Ans : (b)

Sol: The unit of surface tension is $\frac{N}{m} = \frac{N.m}{m^2}$

$= \frac{J}{m^2}$

77. For an overdamped system, the damping factor is
(a) less than 1 (b) zero
(c) equal to 1 (d) greater than 1

77. Ans : (d)

Sol: Damping ratio (ζ):

$$\zeta = \frac{\text{Actual damping coefficient}}{\text{Critical damping coefficient}}$$

If $\zeta = 0$ system is undamped
If $\zeta < 0$ system is underdamped
If $\zeta = 1$ system is critically damped
If $\zeta > 1$ system is overdamped

78. An example of a nearly reversible process is
(a) Expansion and compression of spring
(b) Plastic deformation
(c) Electricity through a resistance
(d) Combustion and heat transfer

78. Ans : (a)

Sol: Expansion and compression of spring ⇒ Reversible process
Plastic deformation ⇒ Irreversible process
Electricity through a resistance ⇒ Irreversible process
Combustion and heat transfer ⇒ Irreversible process

79. A gas engine working on Otto cycle has a clearance volume 10% of the swept volume. Then the compression ratio value is
(a) 9 (b) 11
(c) 8 (d) 10

79. Ans : (b)

Sol: Compression ratio,

$$r_c = \frac{V_c + V_s}{V_c}$$

$$= \frac{V_s + 0.1V_s}{0.1\,V_s}$$

$$= \frac{1.1\,V_s}{0.1\,V_s} = 11$$

80. The movability of a statically indeterminate structure is

(a) 2 (b) ≤–1

(c) 0 (d) 1

80. Ans : (b)

Sol: Movability / DOF / Mobility:

If DOF = 2 mechanism is unconstrained

If DOF = 1 mechanism is completely constrained

If DOF = 0 it is called structure / statically Determinate

If DOF < 0 (–ve value) it is called redundant structure / super structure / statically indeterminate structure,

81. 1.5 kg of water at 20°C will be heated to 90°C in a teapot with a 1500 Watt electric heater. The teapot weights 0.75 kg and has an average specific heat of 0.8 kJ/kg°C. Consider the specific heat of the water to be 4.18 kJ/kg°C. Determine how long it will take to heat the water, assuming no heat loss from the teapot also, assume that the properties of both water and teapot remain constant during the heating process.

(a) 292.6 seconds (b) 318.5 seconds

(c) 302.5 seconds (d) 320.6 seconds

81. Ans : (d)

Sol: Given data: $m_w = 1.5$ kg

$t_{1w} = 20°C$

$t_{2w} = 90°C$

Electrical energy (EE) = 1500 Watts = 1.5 kW

$m_{Teapot} = 0.75$ kg

$c_{pTP} = 0.8$ kJ/kg°C

$c_{pw} = 4.18$ kJ/kg°C

$$EE = (\text{Heat to water} + \text{heat to tea pot}) \times \frac{1}{\text{Time}}$$

$$= [m_w\, c_{pw}\, (t_2 - t_1) + m_{TP}\, c_{pTP} (t_2 - t_1)] \times \frac{1}{\text{Time}}$$

$$= [(1.5\,(4.18)\,(90-20) + 0.75\,(0.8)\,(90-20)] \times \frac{1}{\text{Time}}$$

$$1.5 = (438.9 + 42)\frac{1}{\text{time}}$$

$$\therefore \text{time} = \frac{438.9 + 42}{1.5} = 320.6 \text{ seconds}$$

82. Which of the following operation does NOT use a rotating tool?

(a) Centering

(b) Facing

(c) Reaming

(d) Counter-boring

82. Ans : (b)

Sol: Tool is not rotating in facing operation.

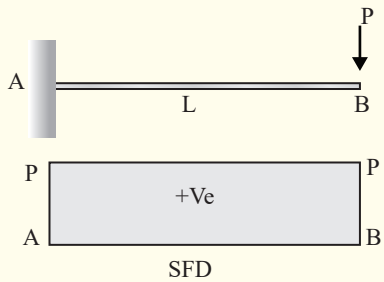
83. The shear force developed in a cantilever beam subjected to a point load P at the free end is

(a) P/2 (b) Zero

(c) P (d) 2P

83. Ans : (c)

Sol:



$\therefore$ Max , S.F = P

84. Assuming that the temperature of the air is constant and that the air is an ideal gas, the atmosphere pressure variation with altitude is

(a) quadratic (b) exponential

(c) linear (d) cubic

84. Ans : (b)

Sol: The atmospheric pressure varies with elevation exponentially

85. Which of the following is TRUE regarding the neutral point in a rolling operation?

(a) The velocity of the rolls is zero

(b) The force on the workpiece is zero

(c) The velocity of the workpiece is zero

(d) The velocity of the workpiece equals the velocity of the rolls

85. Ans : (d)

Sol: In rolling operation, at neutral point, the velocity of workpiece is equal to the velocity of the rolls.

86. Consider the following statements for the force of solid friction (P):

A. P is directly proportional to normal reaction between the two surfaces.

B. Opposes the motion between the surfaces.

C. Does not depend on the material of two surfaces.

Which of the above statements is/are correct?

(a) A and B only (b) A and C only

(c) A only (d) B only

86. Ans : (a)

Sol:

- Friction is directly proportional to normal reaction between the two surfaces.
- Friction always opposes the motion between the surfaces.

87. Among the polytropic processes, which is the correct one for n = 1?

(a) Reversible process

(b) Irreversible process

(c) Adiabatic process

(d) Isothermal process

87. Ans : (d)

Sol: $PV^n = K \Rightarrow$ polytropic law

If $n = 1 \Rightarrow PV = K$ (Isothermal process)

The product of pressure and volume remains constant only in the isothermal process for an ideal gas.

88. Consider the following forming processes:

A. Explosive forming
B. Spinning
C. Stretch forming
D. Roll forming

1. Axially symmetric parts are generally produced
2. High energy rate forming
3. Sheet metal is simultaneously bent and stretched
4. Continuous bending process in which opposing rolls are used to produce long sections of formed shapes from coil or strip stock

Choose the option in which given pairs are correctly matched.

(a) A-1, B-2, C-3, D-4 (b) A-3, B-4, C-1, D-2
(c) A-2, B-1, C-3, D-4 (d) A-3, B-1, C-4, D-2

88. Ans : (c)

Sol:

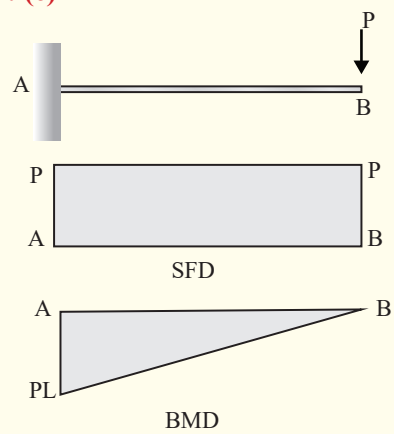
- Explosive forming → High energy rate forming
- Spinning → Axially symmetric parts are generally produced
- Stretch forming → Sheet metal is simultaneously bent and stretched
- Roll forming → Continuous bending process in which opposing rolls are used to produce long sections of formed shapes from coil or strip stock

89. A cantilever beam with concentrated load P (loaded vertically) at the free end. The strain energy in the beam is due to

(a) bending only (b) stretching only
(c) bending and shearing (d) shearing only

89. Ans : (c)

Sol:



As beam is subjected to both bending and S.F.

$U_{total} = U_{B.M} + U_{S.F}$

90. Consider the following statements:

The heat conduction equation for a medium is given as $\frac{\partial^2 T}{\partial x^2} = \frac{1}{\alpha}\frac{\partial T}{\partial x}$

A. The heat transfer is steady
B. The heat transfer is transient.
C. The heat transfer is one-dimensional
D. The thermal conductivity of the medium is constant

Of these statements

(a) A and D are correct
(b) B, C and D are correct
(c) A and C are correct
(d) A, C and D are correct

90. Ans : (b)

Sol: $\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2} + \frac{q_g}{k} = \frac{1}{\alpha}\frac{\partial T}{\partial t}$

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

Valid for unsteady states one dimensional heat flow, Thermal conductivity is constant.

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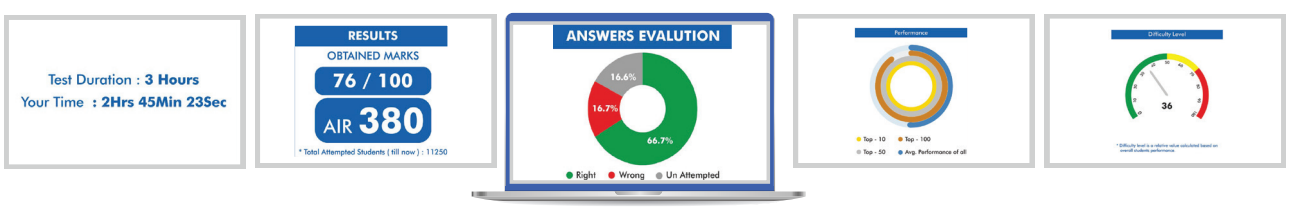

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91. In a cutting tool, the crater wear is found on the following surface
(a) Auxiliary flank surface
(b) Surface of the tool shaft
(c) Principal flank surface
(d) Rake surface

91. Ans: (d)

Sol: The wear over rake surface is known as crater wear. So crater wear occurs on the rake face.

92. An engine having a brake thermal efficiency of 40% produces 20 kW brake power. What is the fuel consumption if the fuel used has a calorific value of 60,000 kJ/kg?
(a) 0.3 kg/hour (b) 2.0 kg/hour
(c) 3.0 kg/hour (d) 1.0 kg/hour

92. Ans : (c)

Sol: $\eta_{Bth} = 0.4$

$BP = 20\ kW$

$CV = 60000\ kJ/kg$

$\dot{m}_f = ?$

$$\eta_{Bth} = \frac{BP}{\dot{m}_f \times CV}$$

$$\dot{m}_f = \frac{BP}{\eta_{Bth} \times CV} = \frac{20}{0.4 \times 60000} = 8.333 \times 10^{-4}\ \frac{kg}{s}$$

$$= 3\ kg/hr$$

93. In an impression die forging, which of the following is NOT a function of the flash?
(a) Allows the bulk of the work material to remain in the work cavity
(b) Eliminates the need of subsequent machining operation
(c) Forces the material to fill in the intricate details of the die cavity
(d) Generates compressive pressures on the part in the die cavity

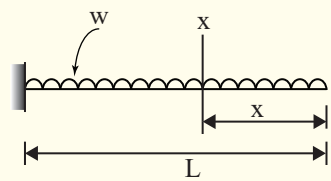
93. Ans : (d)

Sol: Flash is an extra material occupies in gutter. Gutter is a free space provided in die cavity to flow extra material into it. Gutter is provided to get accurate component, but generate compressive stresses on the part of die cavity.

94. For a cantilever beam carrying uniformly distributed load, the shear force across the length.
(a) varies quadratically
(b) varies cubically
(c) is constant
(d) varies linearly

94. Ans : (d)

Sol:



$F_{x-x} = w\ x$

Shear Force varies linearly.

95. For any arbitrary floating body in a liquid, the line of action of the buoyancy force acts through
(a) The centre of gravity of the floating body
(b) The lowest point of the displaced volume
(c) The centre of mass of the floating body
(d) The centroid of the displaced volume

95. Ans : (d)

Sol: The line of action of the buoyancy force for a floating body acts through the centroid of the displaced volume.

96. For a repeated loading, the alternating stress depends on

A. zero stress

B. half of the maximum stress

C. half of the minimum stress

The correct statements are

(a) B only

(b) B and C only

(c) A and B only

(d) C only

96. Ans : (b)

Sol: For a repeated loading, the alternating stress depends on half of the maximum stress and half of the minimum stress.

97. The unit of thermal conductivity is

(a) W/m^2K (b) $W^2/m\ K$

(c) $W/m\ K$ (d) $W/m^2\ K^2$

97. Ans : (c)

Sol: Unit of thermal conductivity is W/m K.

98. For a 2-dimensional flow, vorticity is

(a) Constant

(b) Unsteady

(c) Zero

(d) Not defined

98. Ans : (*)

Sol: **In the question type of flow (rotational or ir-rotational) is not mentioned.**

Vorticity is a measure of rotation of a fluid particle. Vorticity is equal to twice the angular velocity of a fluid particle If the vorticity at a point in a flow field is nonzero, the fluid particle that happens to occupy that point in space is rotating; the flow in that region is called rotational. Likewise, if the vorticity in a region of the flow is zero (or negligibly small), fluid particles there are not rotating; the flow in that region is called irrotational. Physically, fluid particles in a rotational region of flow rotate end over end as they move along in the flow. For example, fluid particles within the viscous boundary layer near a solid wall are rotational (and thus have nonzero vorticity), while fluid particles outside the boundary layer are irrotational (and their vorticity is zero).

99. A screw-jack with helix angle of thread θ, and angle of friction β has the maximum efficiency if

(a) $2\theta = \frac{\pi}{2} - \beta$ (b) $\beta = \frac{\pi}{2} - \theta$

(c) $2\beta = \frac{\pi}{2} - \theta$ (d) $\theta = \frac{\pi}{2} - \beta$

99. Ans : (a)

Sol: For maximum efficiency, $2\theta = \frac{\pi}{2} - \beta$

100. Consider the following parts in gating design for a casting operation:

A. Pouring basin

B. Strainer

C. Splash core

D. Skim bod

1. Used to reduce the pouring force of the molten metal and to maintain a constant pouring head
2. Trap placed in a horizontal gate to prevent impurities from entering the mold
3. Made of ceramic and placed in the sprue to remove dross
4. Made of ceramic and placed at the end of the sprue to reduce the eroding force of the molten metal

Choose the option in which given pairs are correctly matched.

(a) A-1, B-2, C-3, D-4
(b) A-1, B-3, C-4, D-2
(c) A-2, B-1, C-3, D-4
(d) A-3, B-1, C-4, D-2

100. Ans: (b)

Sol: **Pouring basin:** The molten metal from the ladle is poured into the pouring basin from where it moves into the sprue and through the runner to other areas. The basin maintains a constant pouring head through weir (not shown) and holds back slag and dirt which float on the surface of the molten metal.

Strainer: It acts as filter for separating the impurities present in molten metal. It is made by using ceramic material with high porosity.

Splash core: It is used for avoiding sand erosion from bottom of sprue. It is also made by using ceramic material with low porosity.

Skim bob: It is an enlargement along the runner whose function is to trap heavier and lighter impurities such as dross or eroded sand. It, thus, prevents these impurities from going into mould cavity.

101. Choose the correct option for the critical pressure and temperature of water.

(a) 221 bar and 354°C (b) 181 bar and 354°C
(c) 221 bar and 374°C (d) 181 bar and 374°C

101. Ans: (c)

Sol: For water at critical point,

Critical pressure, $P_{cr} = 221$ bar

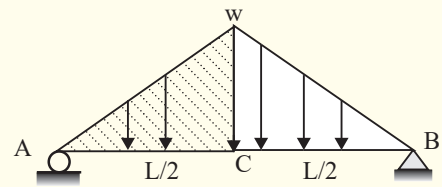
Critical temperature, $t_{cr} = 374.14$ °C

102. For a simply supported beam of length L with a triangular load that varies gradually (linearly) from zero at both ends to w per unit length at the centre, the maximum bending moment is

(a) wL/6 (b) $wL^2/12$
(c) wL^2 (d) $wL^2/6$

102. Ans: (b)

Sol:



$R_A = \frac{wL}{4}$ $R_B = \frac{wL}{4}$

Due to symmetry,

$$R_A = R_B = \frac{\left(\frac{wL}{2}\right)}{2} = \frac{wL}{4}$$

Max. B.M occurs @ mid span $= (M_{max})_{@\, x=\frac{L}{2}}$

$$= \frac{wL}{4}\left(\frac{L}{2}\right) - \left(\frac{1}{2} \times w \times \frac{L}{2}\right)\left(\frac{L}{6}\right)$$

$$= \frac{wL^2}{12}$$

103. Which of the welding process uses a consumable electrode ?
(a) Gas tungsten arc welding
(b) Carbon arc welding
(c) Submerged arc welding
(d) Plasma arc welding

103. Ans: (c)

Sol: Submerged arc welding is an arc welding process in which heat is generated by an arc which is produced between bare consumable electrode and work piece. It is similar to MIG welding. In submerged Arc welding continuously consumable electrodes are wound on to the spool and fed by servo control. The arc is produced between the tip of electrode and work piece which is completely submerged inside the flux powder. So, the name is given as SAW. In the place of inert gas, here large amount of flux powder is used for protecting the weld pool from atmospheric contamination. Out of the flux powder used some quantity of flux powder is melting and forming as slag.

104. For completely reversed stresses, the stress ratio is
(a) 2: –1 (b) 4:2
(c) 1:1 (d) 3:0

104. Ans: (c)

Sol: For completely reversed loading, $\sigma_{max} = -\sigma_{min}$

Stress ratio (R) $= \frac{\sigma_{min}}{\sigma_{max}} = -1$

Stress ratio (R) is 1:1.

105. For a perfect gas, which of the following is true?
(a) $S_2 - S_1 = c_p \ln\frac{T_2}{T_1} - R\ln\frac{P_1}{P_2}$
(b) $S_2 - S_1 = c_p \ln\frac{T_2}{T_1} - R\ln\frac{P_2}{P_1}$
(c) $S_2 - S_1 = c_v \ln\frac{T_2}{T_1} - R\ln\frac{P_2}{P_1}$
(d) $S_2 - S_1 = c_v \ln\frac{T_1}{T_2} - R\ln\frac{P_2}{P_1}$

105. Ans: (b)

Sol: $ds = \frac{\delta Q}{T} = \frac{\delta w + du}{T}$

$= \frac{P}{T}dv + c_v\frac{dT}{T}$

$= R\left(\frac{dv}{v}\right) + c_v\left(\frac{dT}{T}\right)$

Upon integrating,

$S_2 - S_1 = R\ln\left(\frac{v_2}{v_1}\right) + c_v\ln\left(\frac{T_2}{T_1}\right)$

$= R\ln\left(\frac{T_2}{T_1}\times\frac{P_1}{P_2}\right) + c_v\ln\left(\frac{T_2}{T_1}\right)$

$= R\ln\left(\frac{T_2}{T_1}\right) + R\ln\left(\frac{P_1}{P_2}\right) + c_v\ln\left(\frac{T_2}{T_1}\right)$

$= (R + c_v)\ln\left(\frac{T_2}{T_1}\right) + R\ln\left(\frac{P_2}{P_1}\right)^{-1}$

$S_2 - S_1 = c_p\ln\left(\frac{T_2}{T_1}\right) - R\ln\left(\frac{P_2}{P_1}\right)$

106. The phenomenon of springback happens in a bending operation due to the following reason
(a) Due to the presence of plastic energy in the bent part
(b) Due to excessive force imparted on the bent part
(c) Due to the presence of elastic energy in the bent part

(d) Due to insufficient force imparted on the bent part

106. Ans: (c)

Sol: Springback refers to the elastic recovery of deformed parts. Springback occurs because of the elastic relief from the bending moment imparted to the part.

107. A stream line and an equipotential line in the flow field
(a) are identical
(b) intersect at an acute angle
(c) are perpendicular to each other
(d) are parallel to each other

107. Ans: (c)

Sol: A streamline and an equipotential line in the flow field are perpendicular to each other.

108. The number of instantaneous centres for a 5-link mechanism is/are
(a) 1 (b) 3
(c) 10 (d) 5

108. Ans: (c)

Sol: No. of I-center for planer mechanism is given by
$= {}^{n}c_{2}$ (n = no. of link)
No. of I-center for 5 link mechanism is
$${}^{5}c_{2} = \frac{5 \times 4}{2 \times 1} = 10$$

109. Consider the following and choose the only option in which the pairs are matched correctly.
A. Isolated system
B. Open system
C. Closed system
D. Adiabatic system
1. One in which mass cannot cross the boundary
2. One which exchanges neither mass nor energy with its surroundings
3. One which is thermally insulated from its surroundings
4. One in which mass flows into or out of the system
(a) A-4, B-1, C-2, D-3 (b) A-1, B-3, C-2, D-4
(c) A-2, B-1, C-3, D-4 (d) A-2, B-4, C-1, D-3

109. Ans: (d)

Sol: Isolated system → Neither mass nor energy crosses the boundary of the system
Open system → Both mass and energy cross the boundary of the system.
Closed system → Only energy crosses the Boundary but mass not crossing.
Adiabatic system → Thermally insulated system.

110. Which is the sequence of operations in a conventional powder metallurgy process ?
(a) Atomization → Blending and Mixing → Sintering → Compacting
(b) Blending and Mixing → Atomization → Compacting → Sintering
(c) Atomization → Blending and Mixing → Compacting → Sintering

(d) Blending and Mixing → Compacting → Atomization → Sintering

110. Ans: (c)

Sol: Steps in Powder metallurgy process:

- Making powders (Ex: Ball milling, automization)
- Blending & mixing
- Compaction
- Sintering

111. Consider the following energy sources for different machining processes :

A. Electrochemical machining
B. Electrochemical grinding
C. Chemical machining
D. Laser beam machining

1. Electric current and mechanical force
2. Corrosive agent
3. Powerful radiation
4. Electric current

Choose the option in which given pairs are correctly matched.

(a) A-4, B-2, C-3, D-1
(b) A-4, B-1, C-2, D-3
(c) A-2, B-1, C-3, D-4
(d) A-3, B-1, C-4, D-2

111. Ans: (b)

Sol: In a sense, electrochemical machining (ECM) is the opposite of electroplating. Metal ions from the work piece (anode) are washed away by the electrolyte, which serves as the current carrier, in the tool-work piece gap (usually 0.1 to 0.6 mm), preventing them from plating onto the tool (cathode). Keep in mind that the hollow created is the tool's female mating image. Hence electric current is the source of energy.

Electrochemical grinding (ECG) combines conventional grinding with electrochemical machining. The machinery is similar to a standard grinder, except instead of a rotating wheel made of metal, it has an abrasive cathode. The wheel's metal core is joined to diamond or aluminium oxide abrasives, and it rotates between 1,200 and 2,000 m/min. Hence, it is the case where current and mechanical work is the source of energy.

Chemical machining (CM) was created as a result of the discovery that chemicals corrode and etch most metals, stones, and some ceramics, removing minute quantities of surface material in the process. By utilising reagents or etchants, such as acids and alkaline solutions, the CM process is carried out by chemical dissolution.

Light amplification by stimulated emission of radiation, or laser, is the energy source used in laser-beam machining (LBM), which concentrates optical energy on the surface of the work piece. A controlled amount of the work item is melted and evaporated by the highly concentrated, high-density energy source. Numerous metallic and non-metallic materials can be machined using this method, which does not require a vacuum.

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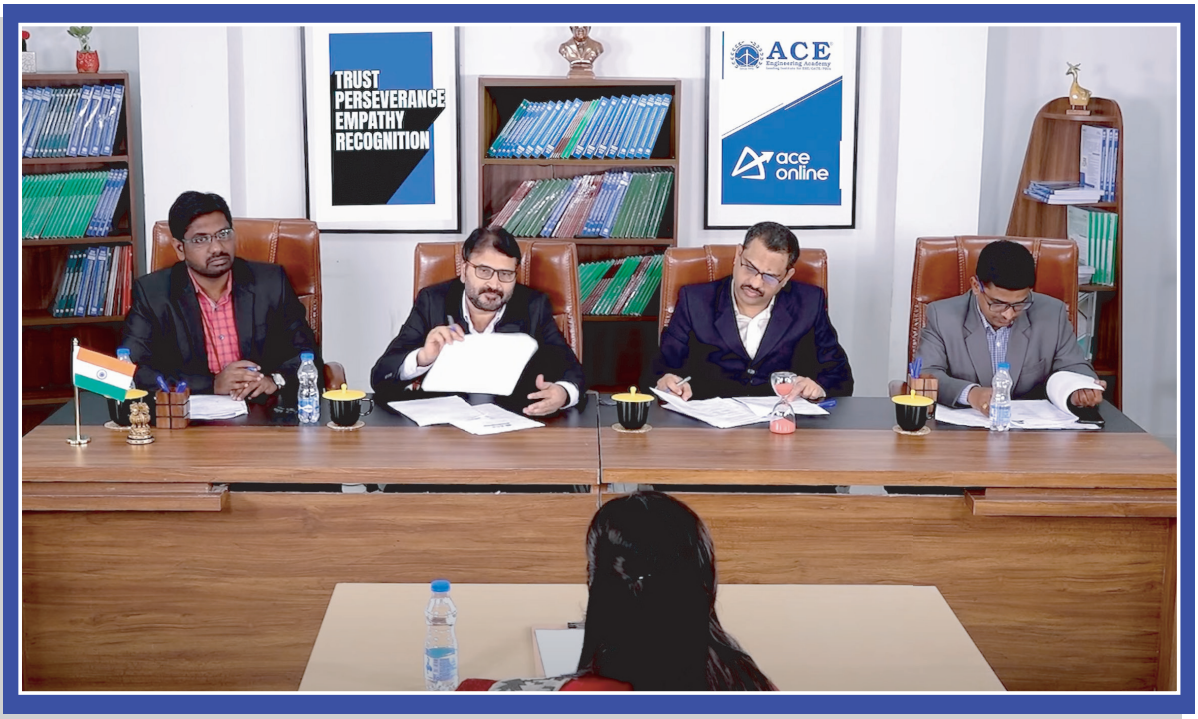

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112. Which of the following statements is true?
(a) The shear angle increases with the increase of the rake angle of a tool and decrease of the friction coefficient.
(b) The shear angle increases with the decrease of the rake angle of a tool and decrease of the friction coefficient.
(c) The shear angle increases with the increase of the rake angle of a tool and increase of the friction coefficient.
(d) The shear angle increase with the decrease of the rake angle of a tool and increase of the friction coefficient.

112. Ans: (a)

Sol: Friction decreases with increasing rake angle and it is increased by shear angle.

113. Working principle of hydraulic lift is based on
(a) Archimedes' Principle
(b) Newton's Law
(c) Bernoulli's Principle
(d) Pascal's Law

113. Ans: (d)

Sol: Working principle of hydraulic lift is based on Pascal's law.

114. The modulus of section of a circular cross- section with diameter d is
(a) $\frac{\pi d^2}{16}$ (b) $\frac{\pi d^4}{64}$
(d) $\frac{\pi d^3}{32}$ (d) $\frac{\pi d^3}{16}$

114. Ans: (c)

Sol: For circular cross- section

$$Z_{N.A} = \frac{I_{N.A}}{y_{max}} = \frac{\frac{\pi}{64}d^4}{\left(\frac{d}{2}\right)} = \frac{\pi}{32}d^3$$

115. Theoretical stress concentration factor is defined as
(a) $\frac{\text{Maximum stress}}{\text{No min al stress}}$ (b) $\frac{\text{Endurance lim it}}{\text{Maximum stress}}$
(c) $\frac{\text{No min al stess}}{\text{Maximum stress}}$ (d) $\frac{\text{Maximum stress}}{\text{Endurance lim it}}$

115. Ans: (a)

Sol: Theoretical stress concentration factor is defined as

$$k_t = \frac{\text{Maximum stress}}{\text{No min al stress}}$$

116. In a non-flow reversible system, the work done per unit mass is expressed as
(a) $W = T.ds + (u_0 - u_1)$
(b) $W = T.ds + (h_0 - h_1)$
(c) $W = T.ds - (u_0 - u_1)$
(d) $W = T.ds - (h_0 - h_1)$

116. Ans: (a)

Sol: $Q = Tds$ for reversible process

$Q = W + dU$

$Tds = W + (u_1 - u_0)$

$W = Tds + (u_0 - u_1)$

where, u_0 = initial internal energy,

u_1 = final internal energy

117. Which of the welding process has the highest power density?
(a) Resistance welding (b) Laser beam welding
(c) Oxyfuel welding (d) Arc welding

117. Ans: (b)

Sol: Laser-beam welding (LBW) utilizes a high-power laser beam as the source of heat, to produce a fusion weld. Because the beam can be focused onto a very small area, it has high energy density and deep-penetrating capability. The beam can be directed, shaped, and focused precisely on the work piece.

118. The ratio of the equivalent length and actual length of a column with both fixed ends is

(a) $1/\sqrt{2}$ (b) 1

(c) 1/2 (d) 2

118. Ans: (c)

Sol: $L_{eq} = \frac{L}{2}$, for column with both ends fixed.

$$\therefore \frac{L_{eq}}{L} = \frac{\frac{L}{2}}{L} = \frac{1}{2}$$

119. Consider the following different zones in an electric arc:

A. Cathode spot

B. Anode space

C. Anode spot

D. Arc column

1. Gaseous region with a sharp drop in voltage
2. Area where electrons are absorbed
3. Voltage drop is not sharp
4. Small area emitting the electrons

Choose the option in which given pairs are correctly matched.

(a) A-4, B-2, C-3, D-1 (b) A-2, B-1, C-4, D-3

(c) A-2, B-1, C-3, D-4 (d) A-4, B-1, C-2, D-3

119. Ans: (d)

Sol: In arc welding it is generally believed that electrons liberated from the cathode move towards the anode and are accelerated in their movement. When they strike the anode at high velocity, large amount of heat is generated. Also when the electrons are moving through the air gap between the electrodes, also called the arc column, they collide with the ions in the ionised gas column between the electrodes. The positively charged ions, moving from the anode and would be impinging on the cathode, thus liberating heat. Hence, cathode spot is the area from where electrons are emitted and anode spot is the area where electrons are absorbed. Anode space is the region where sharp drop of voltage occurs.

120. Select the right expression for Van der Wall's equation for a real gas.

(a) $\left(p + \frac{a}{v^2}\right)(v - b) = RT^2$ (b) $\left(p + \frac{a}{v^2}\right)(v - b) = RT$

(c) $\left(p + \frac{a}{v^2}\right)(v^2 - b) = RT$ (d) $\left(p + \frac{a}{v}\right)(v^2 - b) = RT$

120. Ans: (b)

Sol: $\left(p + \frac{a}{v^2}\right)(v - b) = RT \Rightarrow$ Van der wall's equation

(Real gas equation)

121. Any linear programming model must have all the following properties EXCEPT

(a) the model must have an objective function

(b) the model must have structural constraints

(c) the relationship between variables and constraints must be non-linear

(d) the model must have non-negativity constraints

121. Ans: (c)

Sol: In LPP model there must be a linear relationship between variables and constraints.

122. Match the following:

A.	Riveted joints	1.	Permanent fastenings
B.	Keys	2.	Temporary fastenings
C.	Cotters		
D.	Screwed		

(a) A-1, B-2, C-1, D-2 (b) 1-2, B-1, C-1, D-2
(c) A-1, B-2, C-2, D-2 (d) A-2, B-1, C-2, D-1

122. Ans: (c)

Sol:

- Riveted and welded joints are permanent joints.
- Bolted joints are temporary joints.
- Keys and cotters result in temporary joint.

123. According to the Clausius statement, which of the following is true?

(a) Heat cannot transfer from a cooler body to a hotter body without any external work
(b) Heat cannot transfer from a cooler body to a hotter body with any external work
(c) Heat can transfer from a cooler body to a hotter body without any external work
(d) Heat cannot transfer from a hotter body to a cooler body without any external work

123. Ans: (a)

Sol: **Clausius Statement:** It states that it is impossible to transfer the heat from cold body to hot body without help of any external work.

124. Which among the following is a wrong assumption to derive Bernoulli equation?

(a) Viscous Flow
(b) Incompressible Flow
(c) Irrotational Flow
(d) Steady Flow

124. Ans: (a)

Sol: Viscous flow is the wrong assumption in deriving Bernoulli's equation.

125. Under what conditions, continuous chips with built up edges could be formed?

(a) Machining ductile materials at high cutting speeds
(b) Machining brittle materials at high cutting speeds
(c) Machining brittle materials at low cutting speeds
(d) Machining ductile materials at low cutting speeds

125. Ans: (d)

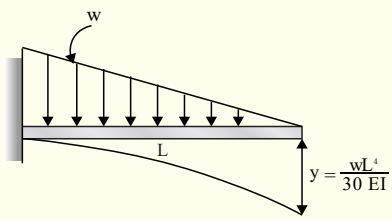
Sol: Continuous chips with built-up edges are formed in machining of ductile materials at low cutting speed.

126. A cantilever of length L carries a gradually (linearly) varying load from zero at its free end to w per unit length at the fixed end. The product of deflection and flexural rigidity at the free end is

(a) $wL^3/30$ (b) $wL^4/24$
(c) $wL^3/24$ (d) $wL^4/30$

126. Ans: (d)

Sol:



$$y \times EI = \frac{wL^4}{30EI} \times EI = \frac{wL^4}{30}$$

127. Consider the following curves for idealized stress-strain curves:

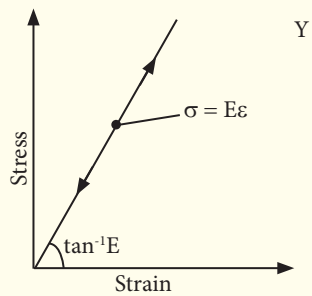
A. Rigid perfectly plastic

B. Rigid linearly strain hardening

C. Perfectly elastic

D. Elastic, perfectly plastic

1.



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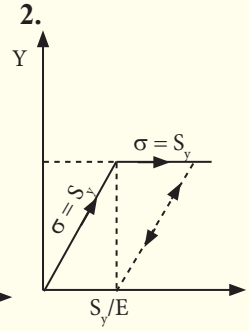

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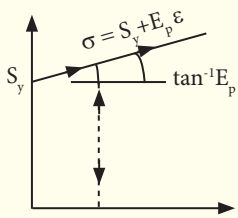

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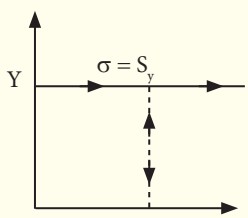


Choose the option in which given pairs are correctly matched.

(a) A - 1, B - 2, C-3, D - 4

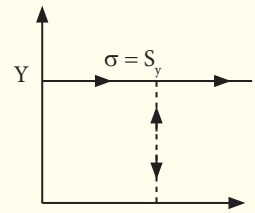
(b) A - 3, B - 4, C-1, D - 2

(c) A - 2, B - 3, C-4, D - 1

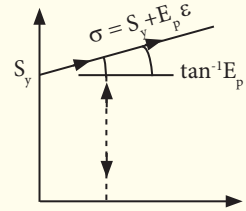
(d) A - 4, B - 3, C-1, D - 2

127. Ans: (d)

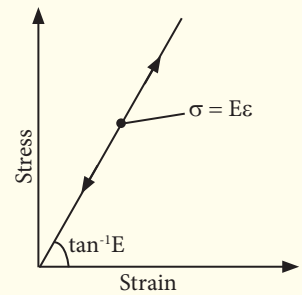
Sol: Rigid perfectly plastic



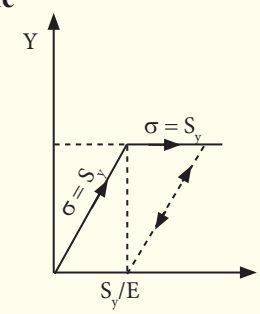
Rigid linearly strain hardening



Perfectly elastic



Elastic, perfectly plastic



Staff Selection Commission JE

About

Staff Selection Commission recruits Junior Engineer posts for diverse Ministries, Departments of the Government of India, and for its subordinate offices. It is a National-level exam conducted at the State and Central levels in Hindi and English Languages.

CUT-OFF MARKS

CE - PAPER-1

Category	2020	2019	2018	2017	2016
UR	120.02	123.52	127.4	136.25	100
OBC	114.21	115.93	122.91	133.25	92.5
EWS	108.14	112.28	118.99	–	–
SC	99.15	101.70	107.61	120	84.5
ST	99.15	102.61	107.01	114.5	85.5
OH	79.83	92.24	–	113	72.5
HH	48.86	55.73	–	83.5	40

ME | EE - PAPER 1

Category	2020	2019	2018	2017	2016
UR	141.59	157.47	152.16	117c	115
OBC	137.46	153.26	149.3	110.75	109.5
EWS	131.23	151.04	147.47	–	–
SC	123.23	140.59	133.39	101.75	99
ST	115.34	135.88	125.49	105	94.5
OH	99.43	127.29	–	91.5	87
HH	63.07	92.49	–	61.75	54

128. How can the penetration be improved in a welding process ?
(a) Lowering travel speed during the welding
(b) Increasing travel speed as well as reducing the heat input simultaneously
(c) Decreasing the heat input
(d) Increasing travel speed during the welding

128. Ans: (a)

Sol: The effect of welding speed on the weld quality is the inverse of that of the current. When welding speed is increased, the amount of heat input and correspondingly, the filler metal per unit length of the joint decreases, so also is the joint reinforcement. The opposite would be true when the welding speed is decreased, that means the heat input will increase and due to that penetration increases.

129. The region between the separation of stream line and the boundary surface of a solid body is known as
(a) drag (b) boundary layer
(c) wake (d) lift

129. Ans: (c)

Sol: The region between the separation of streamline and the boundary surface of a solid body is known as wake.

130. The efficiency of the circumferential lap joint is obtained as (where p_1 is the pitch of the rivets for the lap joint and d is the diameter of the rivet hole)
(a) $\frac{p_1 - d}{d}$ (b) $\frac{p_1 + d}{p_1}$
(c) $\frac{p_1 + d}{d}$ (d) $\frac{p_1 - d}{p_1}$

130. Ans: (d)

Sol: Tearing efficiency, $\eta_t = 1 - \frac{d}{p_1}$

131. Most appropriate turbine to extract energy from water flow when the pressure head, volume flow rate, and total power output are high is
(a) Francis Turbine
(b) Cross Flow Turbine
(c) Pelton Turbine
(d) Kaplan Turbine

131. Ans: (d)

Sol: Kaplan turbines are used when volume flow rate or discharge and power output are high. However,Kaplan turbine is used for low head. From the options given, the nearest answer may be option (d).

132. What is the process called through which the pores of a powder metallurgy part are filled with a molten metal ?
(a) Infiltration (b) Filling
(c) Metallization (d) Impregnation

132. Ans: (a)

Sol: **Infiltration:** The pores of powder metallurgical component is filled with molten metal.

133. Suppose, in an orthogonal cutting operation, the cutting force and the thrust force are F_c = 1500 N and F_t = 1170 N. Assuming rake angle, $\alpha = 0°$, calculate the normal force to the friction.

(a) 1900 N (b) 2670 N
(c) 1170 N (d) 1500 N

133. Ans: (d)

Sol: $F_S = F_C \cos\phi - F_T \sin\phi$

$N = F_C \cos\alpha - F_T \sin\alpha$

$= 1500 \cos 0° - 1170 \sin 0°$

$= 1500$ N

134. Calculate the specific enthalpy of a given substance at a temperature of 25°C and pressure of 25 MPa, whose specific internal energy and specific volume are given as 41 kJ/kg and 0.0005 m^3/kg respectively.

(a) 53.5 kJ/kg (b) 5.35 kJ/kg
(c) 103 kJ/kg (d) 10.3 kJ/kg

134. Ans: (a)

Sol: T = 25°C = 298 K

P = 25MPa = 25000 kPa

Sp. Internal energy (u) = 41 kJ/kg

Sp. Volume (v) = 0.0005m^3/kg

Sp. Enthalpy (h) = u + Pv

= 41 + 25000 (0.0005)

= 53.5 kJ/kg

135. Consider the following defects in castings :

A. Pinholes
B. Misrun
C. Cold shut
D. Gas holes

1. Metal starts freezing before reaching the farthest point in the cavity
2. Entrapped spherical shaped bubbles
3. Tiny blow holes occurring either at or just below the casting surface
4. Metal starts freezing before reaching the center of the casting for a casting with two gates at its two sides

Choose the option in which given pairs are correctly matched.

(a) A - 1, B - 2, C - 3, D - 4
(b) A - 3, B - 4, C - 1, D - 2
(c) A - 2, B - 3, C - 4, D - 1
(d) A - 3, B - 1, C - 4, D - 2

135. Ans: (d)

Sol:

- Pinholes → Tiny blow holes occurring either at or just below the casting surface
- Misrun → Metal starts freezing before reaching the farthest point in the cavity
- Cold shut → Metal starts freezing before reaching the center of the casting for a casting with two gates at its two sides
- Gas holes → Entrapped spherical shaped bubbles

136. For a solid circular shaft under torsion, the strain energy per unit volume is given by (where τ is the shear stress and G is the shear modulus)

(a) $\frac{\tau^2}{2G}$ (b) $\frac{2\tau^2}{G}$
(c) $\frac{\tau^2}{G}$ (d) $\frac{\tau^2}{4G}$

136. Ans: (d)

Sol: $u_{torsion} = \left(\frac{u}{volume}\right)_{torsion} = \frac{\frac{\tau^2}{4G} \times volume}{volume} = \frac{\tau^2}{4G}$

137. The range of specific speed of a Kaplan turbine is
(a) 300 to 600 (b) 600 to 1000
(c) 30 to 60 (d) 60 to 300

137. Ans: (a)

Sol: The range of specific speed of a Kaplan turbine is 300 to 600.

138. Which of the following statements pertaining to entropy are correct ?
A. The entropy of a system reaches its minimum value when it is in a state of equilibrium with its surroundings.
B. Entropy is conserved in all reversible processes.
C. Entropy of a substance is least in solid phase.
D. Entropy of a solid solution is not zero at absolute zero temperature.
(a) A and C only (b) B and D only
(c) A, B and C only (d) B, C and D only

138. Ans: (d)

Sol:

- Entropy is conserved in all reversible processes.
  Entropy of a substance is least in solid phase.
- Entropy of a solid solution is zero at absolute zero temperature.

B and C are absolutely correct but for selecting the answer D is also taken correct. But strictly speaking 'D' is not correct.

139. How does the strength of the filler metal in a brazed joint change with increase in clearance ?
(a) The strength decreases
(b) The strength increases, then decreases
(c) The strength increases
(d) The strength decreases, then increases

139. Ans: (b)

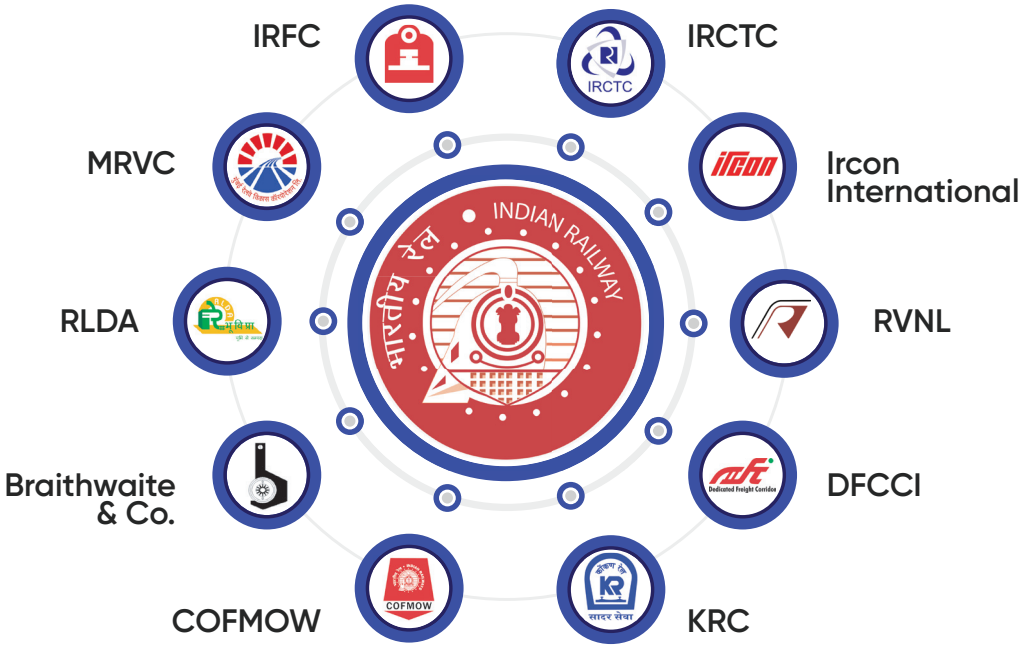
Sol: Brazing uses the principle of capillary action to distribute the molten filler metal between the surfaces of the base metals. Therefore, during the brazing operation, you should take care to maintain a clearance between the base metals to allow capillary action to work most effectively. The tensile strength of the brazed joint varies with the amount of clearance between the parts being joined. The strongest joint is achieved when the joint clearance is 0.038 mm. When the clearance is narrower than this, it's harder for the filler metal to distribute itself adequately throughout the entire joint and joint strength is ultimately reduced. Conversely, if the gap is wider than necessary, the strength of the joint will be reduced almost to that of the filler metal itself.

140. Cavitation in a hydro propeller is mainly caused by
(a) Low pressure region formed due to the relative motion of the fluid and propeller blades
(b) Impingement of contaminants in water on the surface of the propeller
(c) Wear and tear due to constant movement of propellers in water
(d) Increased torque on the propeller leading to increased temperature of fluid around the propeller

Railway Recruitment Board JE

About

Railway Recruitment Board is a government organization in India that was set up in 1998 by the Ministry of Railways. Every year RRB organizes the recruitment for 21 boards situated in Different parts of India to work in Indian railways. It is primarily responsible for recruiting group 'C' staff across the nation.



CUT-OFF MARKS

RRB JE CBT - 1

Category	Ahmedabad	Allahbad	Mumbai
Gen	53.25	74.67	65.4
SC	35.06	59.89	52.55
ST	41.59	51.48	44.025
OBC	39.86	62.61	54.01
-	-	-	-

RRB JE CBT - 2

Category	Min. Qualifying Perc	Min. Qualifying Marks (Out of 150)
Gen	40%	60
EWS	40%	60
SC	30%	45
ST	25%	37.5
OBC	30%	45

140. Ans: (a)

Sol: Cavitation in a hydro propeller is mainly caused by low pressure region formed due to the relative motion of the fluid and propeller blades

141. Using Unwin's empirical formula, the relationship between the diameter of the rivet hole (d) and the thickness of the plate (t) is given by

(a) $t = \frac{d}{2}$ (b) $t = 2d$

(c) $\sqrt{t} = \frac{d}{6}$ (d) $t = 6\sqrt{d}$

141. Ans: (c)

Sol: Unwin's relation, $d = 6\sqrt{t}$

142. What is a reasonable assumption for a flow through a turbine or a compressor?

(a) Isochoric (b) Isobaric

(c) Isothermic (d) Adiabatic

142. Ans: (d)

Sol: The flow through a turbine or a compressor is assumed to be adiabatic.

143. The specific heat of an ideal gas depend on its

(a) Molecular weight (b) Temperature

(c) Density (d) Pressure

143. Ans: (a)

Sol: $M \times R = R_u$

$R = \frac{R_u}{M}$

$\frac{c_p}{c_v} = \gamma$

$c_p = \gamma c_v$

$c_p - c_v = R$

$\gamma c_v - c_v = R$

$c_v(\gamma - 1) = R$

$c_v = \frac{R}{\gamma - 1}$

$c_v = \frac{R_u}{M(\gamma - 1)}$

where, M = molecular weight.

144. What is weld bonding?

(a) Combination of adhesive bonding and soldering

(b) Combination of adhesive bonding and friction stir welding

(c) Combination of adhesive bonding and spot welding

(d) Combination of adhesive boning and brazing

144. Ans: (c)

Sol: Weld bonding is an innovative and promising metal joining technology in which structural adhesives are applied to the faying surfaces of the metal parts to be joined and subsequently spot-welded through before curing of the adhesive is accomplished.

Weld-bonding can improve strength and stiffness; provide additional fixturing capabilities; allow for fewer welds; improve fatigue and impact resistance as well as cycle time; and increase corrosion protection and noise, vibration and harshness (NVH) control properties.

145. An incompressible fluid flow over a flat plate with zero pressure gradient. The boundary layer thickness is 1 mm at location where the Reynolds number is 1000. If the velocity of the fluid alone increased by a factor 4, then the boundary layer thickness at the same location is

(a) 2 mm (b) 0.5 mm
(c) 4 mm (d) 0.25 mm

145. Ans: (b)

Sol: Given:

Flow over a flat plate with zero pressure gradient

$Re = 1000 \Rightarrow$ Laminar flow

$$\frac{\delta}{x} = \frac{5}{\sqrt{Re}} = \frac{5}{\sqrt{\frac{U_\infty x}{\nu}}}$$

$$\delta = \frac{5\sqrt{x}}{\sqrt{\left(\frac{U_\infty}{\nu}\right)}} = \frac{5\sqrt{\frac{x}{\nu}}}{\sqrt{(U_\infty)}}$$

For x & ν constant

$$\delta \propto \frac{1}{\sqrt{U_\infty}}$$

$$\frac{\delta_2}{\delta_1} = \sqrt{\frac{U_{\infty 1}}{U_{\infty 2}}}$$

$$\delta_2 = \delta_1 \sqrt{\frac{U_{\infty 1}}{U_{\infty 2}}} = 1\sqrt{\frac{1}{4}} = \frac{1}{2} \text{ mm} = 0.5 \text{ mm}$$

146. The Chvorinov's rule for calculating the solidification time for the volume of a casting is proportional to

(a) $\left(\frac{\text{Surface Area}}{\text{Volume}}\right)^2$ (b) $(\text{Surface Area})^2$

(c) $\left(\frac{\text{Volume}}{\text{Surface Area}}\right)^2$ (d) $(\text{Volume})^2$

146. Ans: (c)

Sol: $\tau \propto M^2$

$$\tau \propto \left(\frac{\text{Volume}}{\text{Surface}}\right)^2$$

147. The shear stress developed at the centre of a solid circular shaft under torsion

(a) zero (b) average
(c) maximum (d) infinite

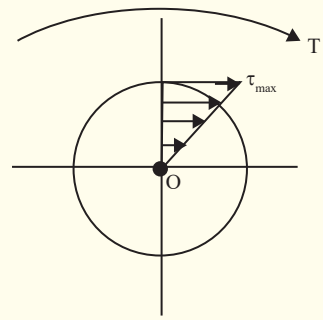
147. Ans: (a)

Sol: Torsional shear stress,

$$\tau = \frac{T}{J} \times r$$

r = distance of particle from centre of shaft.

If r = 0 then $\tau = 0$



$\tau_{@\,centre} = 0$

148. Which of these joining processes is associated with melting of the base metals ?

(a) Soldering
(b) Thermit welding
(c) Explosion welding
(d) Brazing

148. Ans: (b)

Sol: All welding processes may be broadly classified into two groups: *fusion welding and solid-state welding*; each group has subgroups of welding processes.

This section introduces important welding processes in both fusion and solid-state welding. In fusion welding, the base metals are heated above their melting temperatures to cause coalescence resulting in a fusion weld. In solid-state welding there is a combination of heat and pressure, but the temperature is less than the melting temperature of the base metal. Fusion welding processes include oxyfuel welding (OFW), Thermit welding (TW), shielded metal arc welding (SMAW), submerged arc welding (SAW), gas tungsten arc welding (GTAW), gas metal arc welding (GMAW), flux core arc welding (FCAW), RSW, resistance seam welding (RSeW), electron beam welding, and laser beam welding. Important processes in solid-state welding include cold pressure welding (CPW), hot pressure welding, friction welding (FRW), explosive welding (EXW), ultrasonic welding (USW).

149. Select the process that occurs without a change in the internal energy.

(a) Isobaric process (b) Isothermal process

(c) Isentropic process (d) Isochoric process

149. Ans: (b)

Sol: Change in internal energy

$du = m\, c_v\, (dT)$

For Isothermal process

$T = K$

$dT = 0$

$\therefore\ du = mc_v dT = 0$

150. The unriveted or solid plate's strength per pitch length is defined as

(where σ is the permissible tensile stress in the plate, p is the pitch of the rivet, d is the diameter of the rivet, t is the thickness of the plate)

(a) $\sigma(p - d)t$ (b) $\sigma(p + t)d$

(c) $\sigma\, pt$ (d) $\sigma\, dt$

150. Ans: (c)

Sol: Tensile strength per pitch for unriveted or solid plate, $F_t = \sigma\, pt$

For Detailed Solutions click on below link
https://www.youtube.com/watch?v=s5v3cdlE76o

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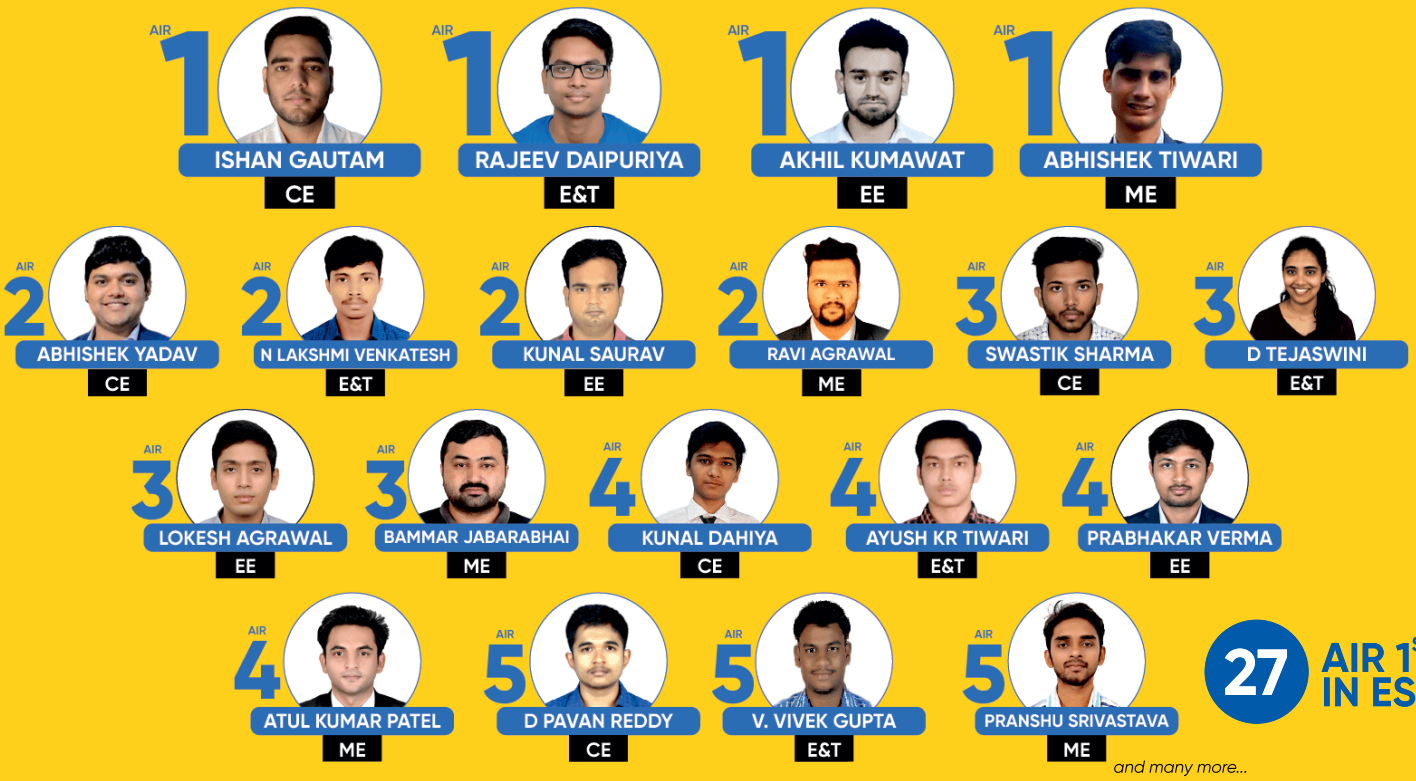

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