# ACE
## Engineering Academy

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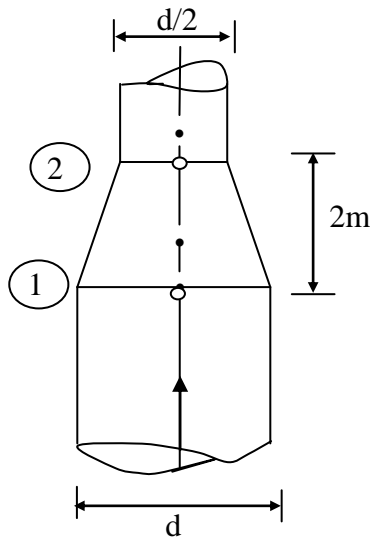Ph: 040-23234418, 040-2324419, 040-2324420, 040-24750437

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### Branch: PRODUCTION & INDUSTRIAL ENGINEERING-MOCK-A – Solutions

**01.  Ans: (B)**

**Sol:**



By continuity equation:

$$Q = A_1 V_1 = A_2 V_2$$

$$\frac{\pi}{4} d^2 . V_1 = \frac{\pi}{4} \left( \frac{d}{2} \right)^2 . V_2$$

$$V_2 = 4V_1 = 4 \times 2 = 8 \text{ m/s}$$

By Bernoulli's equation:

$$\frac{P_1}{\rho g} + Z_1 + \frac{V_1^2}{2g} = \frac{P_2}{\rho g} + Z_2 + \frac{V_2^2}{2g}$$

(By neglecting the losses),

$V_2 = 4V_1$ from continuity equation.

Thus, $\dfrac{200 \times 10^3}{1000 \times 9.81} + 0 + \dfrac{2^2}{2 \times 9.81}$

$$= \frac{P_2}{1000 \times 9.81} + 2 + \frac{8^2}{2 \times 9.81}$$

On simplification,

$\Rightarrow P_2 = 150 \text{ kN/m}^2$

**02.  Ans: (B)**

**Sol:** For 'n' radiation shields inserted,

increase in space resistances = n

Total no. of space resistances = n + 1

$$= 11 + 1 = 12$$

and increase in surface resistances = 2n

Total number of surface resistances

$$= 2n + 2$$
$$= 2 \times 11 + 2$$
$$= 24$$

**03.  Ans: 0          (Range: 0 to 0)**

**Sol:** Since there is no external force acting on the block so the value of frictional force will be 0 N.

**04.  Ans: (A)**

**Sol:** The given function is odd function since

$$f(-x) = -f(x).$$

For odd function $\int\limits_{-1}^{1} f(x) = 0$
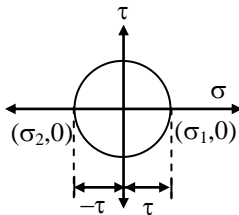
**05.　Ans: (C)**

**Sol:** For a state of pure shear,

$\sigma_x = 0$

$\sigma_y = 0$

$\tau_{xy} = \tau$

Principal stresses for given state are,

$\sigma_1 = \tau$　　and　　$\sigma_2 = -\tau$

For these principal stresses, Mohr's Circle can be drawn as shown in the figure below.



**06.　Ans: (B)**

**Sol:** If the clearance provided is greater than the optimum clearance, no shearing action takes place and the sheet is simply pulled into the die.

**07.　Ans: (C)**

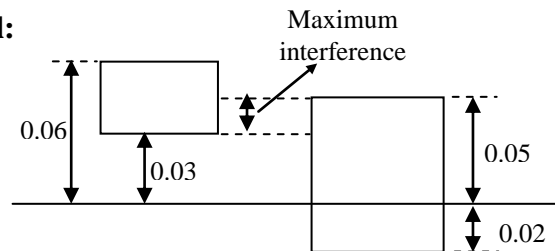**Sol:** Shear strain, $\gamma = \tan(\phi - \alpha) + \cot\phi$

$$\gamma = \gamma_{min}\,,$$

when $2\phi - \alpha = 90°$

Now, if $\alpha = 0$, then $\phi = 45°$

$\therefore \gamma_{min} = \tan45 + \cot45 = 2$

**08.　Ans: (A)**

**Sol:**



Maximum interference

$$= (U.L)_{shaft} - (L.L)_{hole}$$

$$= 0.05 - 0.03 = 0.02 mm$$

**09.　Ans: (C)**

**Sol:** In a gas turbine engines combustion is carried out isobarically.
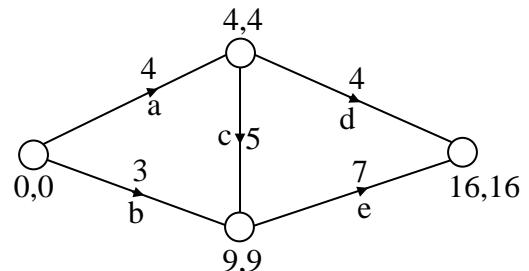
**10.　Ans: (D)**

**Sol:** $P(x = 1) = 0.5\,P(x = 2)$

$$\frac{\lambda e^{-\lambda}}{1!} = \frac{1}{2}\frac{\lambda^2 e^{-\lambda}}{2!}$$

$$\Rightarrow \lambda = 4$$

$$P(x = 4) = \frac{\lambda^4 e^{-\lambda}}{4!} = \frac{4^4 e^{-4}}{24} = \frac{32}{3}e^{-4}$$

**11.　Ans: (B)**

**Sol:**



In project management, float or slack is the amount of time that a task in a project network can be delayed to:

- Subsequent tasks ("free float")

- Project completion date ("total float")

Here,

Slack for activity 'b' in months = Total float

$= L_j - E_i - t_{ij} = 9 - 0 - 3 = 6$

**12.   Ans: (A)**

**Sol:** Human movements at the workplace should be of the lowest possible order.

The following is the classification of the order of movements

- Class 1 *pivot :* knuckle, *body member :* finger

- Class 2 *pivot :* wrist, *body members :* finger, hands

- Class 3 *pivot :* elbow, *body members:* forearm, hands, and fingers

- Class 4 *pivot :* shoulder, *body members:* upper arm, forearm, hands, and fingers

- Class 5 *pivot :* trunk , *body members:* torso, upper arm, forearm, hands, and fingers

As the order of movement increases, from class1 to class5, more limbs get involved. This increases physical strain, and time and energy requirements of completing the movements. Therefore, it is desirable to use the lowest orders of movements at the workplace.

**13.   Ans: (D)**

**Sol:  Internal rate of return method (IRR)**

Internal rate of return is that discount rate, for which NPV value is zero.

$$NPV = \sum_{i=0}^{n}\left(\frac{B_i - C_i}{(1+r)^n}\right)$$

where, $B_i$ is the benefit of the $i^{th}$ year,

$C_i$ is the cost of the $i^{th}$ year,   and

n is the number of years.

This can be obtained by setting the value of NPV in equation as zero, and solving (by trail and error) for the value of r. If the rate of return thus calculated is more than the market interest, then the project is adjusted to be acceptable.

**14.   Ans: (C)**

**Sol:** If runner blades of propeller turbine are adjustable then it is called Kaplan turbine.

**15.   Ans: (C)**

**Sol:**

- Alligatoring → Rolling

- Lap → Forging

- Bamboo defect → Extrusion

- Blister → Casting

**16. Ans: (A)**

**Sol:** $(COP)_R = \dfrac{T_1}{T_2 - T_1}$

$T_1 = -3 + 273 = 270$ K

$T_2 = 27 + 273 = 300$ K.

$(COP)_R = \dfrac{270}{(300 - 270)} = 9$

$\Rightarrow \quad \dfrac{5}{P} = 9$

$\Rightarrow \quad P = 0.55$ kW

**17. Ans: (B)**

**Sol:** The given differential equation

$$4y''' + 4y'' + y' = 0$$

$$\Rightarrow 4D^3 + 4D^2 + D = 0$$

$$\Rightarrow D(2D + 1)^2 = 0$$

$$D = 0, \dfrac{-1}{2}, \dfrac{-1}{2}$$

$\therefore y_c = C_1 + (C_2 + C_3x)^{-x/2}$

**18. Ans: (D)**

**Sol:** In down milling, the uncut chip thickness is maximum in beginning and becomes minimum at the end.

**19. Ans: 12.56** **[Range: 12 to 13]**

**Sol:** Given: $\phi = 150°$, h = 20 mm

$\omega = \dfrac{2\pi N}{60} = \dfrac{2\pi \times 100}{60} = 10.47$ rad/sec

$V_{max} = \dfrac{h}{2} \times \dfrac{\pi \omega}{\phi_a}$

$V_{max} = \dfrac{0.02}{2} \times \dfrac{\pi \times 10.47}{150 \times \dfrac{\pi}{180}}$

$= 0.1256$ m/s $= 12.56$ cm/sec

**20. Ans: (A)**

**Sol:** Fe is face centered cubic structure at 1000°C

$\therefore \quad 4R = \sqrt{2}a$

$a = \dfrac{4R}{\sqrt{2}} = 2\sqrt{2}R = 2 \times \sqrt{2} \times 0.15\,\text{nm}$

$= 0.42$ nm

**21. Ans: 0.9** **[Range: 0.88 to 0.92]**

**Sol:** $\lambda = \dfrac{1}{4}$

$\mu = \dfrac{2}{3}$

$W_q = \dfrac{\lambda}{\mu(\mu - \lambda)} = \dfrac{\dfrac{1}{4}}{\dfrac{2}{3}\left(\dfrac{2}{3} - \dfrac{1}{4}\right)} = 0.9$ minutes

**22. Ans: (B)**

**Sol:**

$\text{Biot number}\,(Bi) = \dfrac{\text{conductive resistance inside the solid body}}{\text{convective resistance on the solid surface}}$

$[\because Bi \to 0]$

∴　Conductive resistance inside the solid body

$\approx 0$ (Uniform temperature inside solid body)

∴　Lumped capacity analysis can be used.

**23.　Ans: (C)**

**Sol:** $\dfrac{dy}{dx} = 4x^3 \, e^{-y}$

Using variable separable method

$e^y = x^4 + c$

at $x = 1$, $y = 0$,

$\Rightarrow c = 0$

$\Rightarrow e^y = x^4$

**24.　Ans: 16　　　(Range: 16 to 16)**

**Sol:** Given:

$\psi = 2x^2 y + (3 + t)y^2$

The flow rate per unit width across the face

AB is $= \psi_B - \psi_A$

$= \psi(0, 2) - \psi(3, 0)$

$= 2(0)^2(2) + (3 + t)(2)^2 - 2(3)^2(0) - (3 + t)\times 0$

$= 0 + (3 + 1)2^2 - 0 - 0$　　　　　$(t = 1s)$

$= 16$ units

**25.　Ans: (D)**

**Sol:** $z^2 + 9 = 0 \Rightarrow z = \pm\, 3i$

$z_0 = 3i$ lies inside the circle.

$\therefore I = 2\pi i \, \underset{z \to 3i}{\text{Lim}} \, \dfrac{(z - 3i)}{(z + 3i)(z - 3i)}$

$= 2\pi i \cdot \dfrac{1}{6i} = \dfrac{\pi}{3}$

**26.　Ans: (D)**

**Sol:** Given:

$T = xy + z + 3t$ and $\vec{V} = xy\vec{i} + z\vec{j} + 5t\vec{k}$

$u = xy$,

$v = z$, $w = 5t$

Rate of change of temperature of a particle

at time t is given by

$\dfrac{DT}{dt} = \dfrac{\partial T}{\partial t} + u\dfrac{\partial T}{\partial x} + v\dfrac{\partial T}{\partial y} + w\dfrac{\partial T}{\partial z}$

$= 3 + (xy)(y) + (z)(x) + (5t)(1)$

$= 3 + xy^2 + xz + 5t$

Thus, at $(2, -2, 1)$ and $t = 2s$, we get

$\dfrac{DT}{Dt} = 3 + (2)(-2)^2 + (2)(1) + 5(2) = 23 \text{ K/s}$

**27.　Ans: (B)**

**Sol:** Given data:

Uncut chip thickness,　　$t_1 = 0.25$ mm

Feed rate,　　　　　　　$f = 0.50$ mm

Inclination angle,　　　　$i = 1.5°$

Side rake,　　　　　　　$\alpha_s = 10°$

$\Rightarrow$　　　　$\sin\lambda = \dfrac{t_1}{f} = \dfrac{0.25}{0.50} = 0.5$

　　　　　　　$\lambda = 30°$

Now,　　$\tan i = \sin\lambda \, \tan\alpha_b - \cos\lambda \, \tan\alpha_s$

$\Rightarrow$　　　$\tan 15 = 0.5 \tan\alpha_b - \dfrac{\sqrt{3}}{2}\tan 10$

$\Rightarrow$　　　$\alpha_b = 40°$

28. **Ans: 14.28**        [Range 14 to 15]

**Sol:** Shaping time, $T = \dfrac{LW(1+m)}{fv_c}$

Where, L = length of stroke

W = width of workpiece

m = quick return ratio

f = feed in mm/double stroke

$v_c$ = cutting velocity

$\Rightarrow T \propto 1 + m$ [under similar conditions]

$\dfrac{T_2}{T_1} = \dfrac{1+m_2}{1+m_1} = \dfrac{1.6}{1.4} = 1.14$

Percentage increase

$$= \dfrac{1.14 - 1}{1} \times 100 = 14.28\%$$

29. **Ans: 20.4**        [Range 20.0 to 21.0]

**Sol:** Maintaining volume constancy:

Volume before cutting = volume after cutting

$\Rightarrow \ b_o \times h_o \times v_o = b_1 \times h_1 \times v_1$

$\Rightarrow \ b_o \times h_o \times 15 = (1.05 b_o) \times (0.7 h_o) \times v_1$

$\Rightarrow \ 15 = 1.05 \times 0.7 v_1$

$\Rightarrow \ v_1 = 20.4$ m/min

30. **Ans: 43.17**        [Range: 42 to 44]

**Sol:** $m_1 \left[ h_1 + \dfrac{V_1^2}{2} \right] + Q = m_2 \left[ h_2 + \dfrac{V_2^2}{2} \right] - P$

$m_1 \left[ C_p T_1 + \dfrac{V_1^2}{2000} \right] = m_2 \left[ C_p T_2 + \dfrac{V_2^2}{2000} \right] - P$

$m_1 = 1$ kg/s,        $T_1 = 300$ K,   $V_1 = 50$ m/s,

$V_2 = 100$ m/s,    P = 20 kW

$1 \left[ 1.005 \times 300 + \dfrac{50^2}{2000} - \dfrac{100^2}{2000} \right] + 20 = 1.005\, T_2$

$T_2 = 316.17$ K

$T_2 = 43.17°C$

31. **Ans: (D)**

**Sol:** The Characteristic equation is

$$|A - \lambda I| = 0$$

$$\Rightarrow \begin{vmatrix} 4-\lambda & 1 \\ -1 & 2-\lambda \end{vmatrix} = 0$$

$$\Rightarrow \lambda^2 - 6\lambda + 9 = 0$$

$$\Rightarrow \lambda = 3, 3$$

The eigen vectors for $\lambda = 3$ are given by the

equation $[A - 3I]X = 0$ where $X = \begin{bmatrix} x \\ y \end{bmatrix}$

$\Rightarrow x + y = 0$

$\therefore \ (x, y) = (2, -2)$ is an eigen vector

32. **Ans: (A)**

**Sol:** Given data:

$\Delta T = 50$ °C,

$\alpha = 17.5 \times 10^{-6}$ /°C,

E = 120 GPa

Stress due to temperature increase is given by,

$\sigma_x = E\alpha(\Delta T)$

$= 120 \times 10^3 \times 17.5 \times 10^{-6} \times 50$

$= 105$ MPa (compression)

- As the temperature of the bar increases, the bar tries to expand. Due to rigid supports at the ends, expansion of the bar is restricted. Thus, compressive stress is induced in the bar.

- State of stress of an element Q, which is in the direction of longitudinal axis, is shown below.



105 MPa $\longrightarrow$ Q $\longleftarrow$ 105 MPa
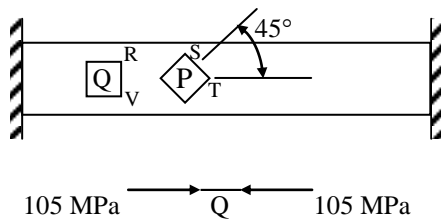
- Mohr's circle for an element Q is shown in the figure below.
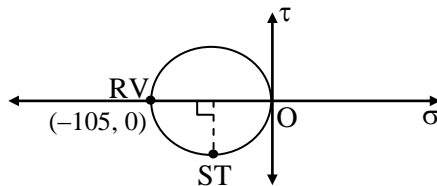


- In above diagram, it is shown that a plane ST which is at 45° to the longitudinal axis (Plane RV) is at 90° to the plane RV in Mohr's circle.
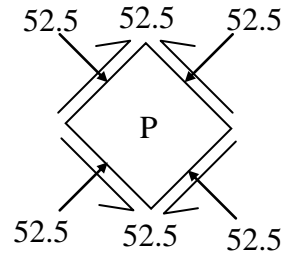


At plane ST, $\sigma_x = \dfrac{-105}{2} = -52.5$ MPa

$\sigma_y = -52.5$ MPa

$\tau_{xy} = -52.5$ MPa

**33. Ans: 780.16 [Range: 775 to 785]**

**Sol:** We know that

$P_{max} = \dfrac{T_{max}}{R \times W} = \dfrac{T_1}{R \times W} = 0.25$

$T_1 = R \times W \times P_{max},$

$W = 60$ mm

$T_1 = 250 \times 60 \times 0.25 = 3750$ N

$\dfrac{T_1}{T_2} = e^{\mu\theta}, \quad \mu = 0.4,$

$\theta = \dfrac{\pi}{180} \times 225$

$\theta = 3.925$ radian

$\dfrac{T_1}{T_2} = e^{(0.4 \times 3.925)}$

$T_2 = 780.16$ N

**34. Ans: 261.66  [Range 258 to 264]**

**Sol:** $T_{mean}$ = constant

$$W = \int_0^\pi T d\theta = \int_0^\pi (10000 + 2000 \sin 2\theta - 1800 \cos 2\theta) d\theta$$

$W = 10000\pi$ J

$$T_{mean} = \frac{W}{\pi} = 10000\,N-m$$

Power $= T_{mean} \times \omega$

$$P = 10000 \times 2\pi \times \frac{250}{60}$$

$P = 261.66$ kW

**35. Ans: (B)**

**Sol:** $g(x) = \dfrac{f(x)}{x+1}$

$g(x)$ in continuous and differentiable in [0, 5].

By Lagrange's theorem, there exists a value $c \in (0, 5)$, such that

$$g^1(c) = \frac{g(5) - g(0)}{5 - 0}$$

$$= \frac{\left(-\dfrac{1}{6}\right) - 4}{5} = \frac{-5}{6}$$

**36. Ans: (A)**

**Sol:** The significant advantages of glass-ceramics include

(1) Efficiency of processing in the glassy state,

(2) Close dimensional control over the final product shape, and

(3) Good mechanical and physical properties.

Properties include high strength (stronger than glass), absence of porosity, low coefficient of thermal expansion, and high resistance to thermal shock.

**37. Ans: (A)**

**Sol:** Normal time (NT)

$$= \text{Observed Time}\,(OT) \times \frac{\text{Rating}}{\text{Standard Rating}}$$

$$= 1 \times \frac{120}{100} = 1.2\,\text{min}$$

$$\text{Standard time} = NT\left(1 + \frac{RRA}{100}\right)$$

$$= 1.2\left(1 + \frac{10}{100}\right) = 1.32\,\text{min}$$

**38. Ans: 87 [Range: 85 to 88]**

**Sol:** Forecast for Feb $= F_{Jan} + \alpha\,(D_{Jan} - F_{Jan})$

$$= 90 + 0.3\,(100 - 90) = 93$$

Forecast for March $= F_{Feb} + \alpha\,(D_{Feb} - F_{Feb})$
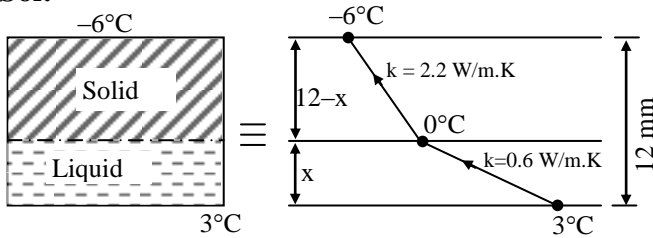
$$= 93 + 0.3\,(70 - 93)$$

$$= 86.1$$

**39.  Ans: 1.44 mm [Range: 1.4 to 1.5]**

**Sol:**



Heat Transfer rate $= \dfrac{3-0}{\left(\dfrac{x}{0.6A}\right)} = \dfrac{0-(-6)}{\left(\dfrac{12-x}{2.2A}\right)}$

$\dfrac{3}{\dfrac{x}{0.6}} = \dfrac{6}{\left(\dfrac{12-x}{2.20}\right)}$

$0.6(12-x) = 2 \times 2.2x$

$12 - x = \dfrac{44}{6}x$

$8.33x = 12$

$x = \dfrac{12}{8.33}$

$x = 1.44$ mm

**40.  Ans: (A)**

**Sol:** The common point defects are

- Vacancy - a missing atom in the lattice structure;

- Ion-pair vacancy (Schottky defect) - a missing pair of ions of opposite charge in a compound;

- Interstitialcy - a distortion in the lattice caused by an extra atom present

- Frenkel defect - an ion is removed from a regular position in the lattice and inserted into an interstitial position not normally occupied by such an ion.

**41.  Ans: (D)**

**Sol:**

$[A/B] = \begin{bmatrix} 1 & 2 & 3 & 14 \\ 1 & 4 & 7 & 30 \\ 1 & 1 & 1 & \lambda \end{bmatrix} \sim \begin{bmatrix} 1 & 2 & 3 & 14 \\ 0 & 2 & 4 & 16 \\ 0 & 0 & 0 & 2\lambda - 12 \end{bmatrix}$

To be consistent Rank of augmented matrix $(\rho(A/B))$ and Rank of A matrix should be equal.

$\rho(A/B) = \rho(A) = 2\lambda - 12 = 0 \Rightarrow \lambda = 6$

**42.  Ans: 0.94 (Range: 0.94 - 0.94)**

**Sol:** To increase the reliability of systems, redundancy is added. The technique here is to "back up" components with additional components.

The resulting reliability is the probability of the first component working plus the probability of the backup (or parallel) component working multiplied by the probability of needing the backup component. Therefore,

$\begin{pmatrix} \text{Probability of first} \\ \text{component working} \end{pmatrix} + \begin{pmatrix} \text{Probability of second} \\ \text{component working} \end{pmatrix} \times \begin{pmatrix} \text{Probability of needing} \\ \text{second component} \end{pmatrix}$

$= [0.9 + 0.9 (1-0.9)] \times [0.8 + 0.8(1-0.8)] \times 0.99$

$= 0.94$

**43. Ans: 0    [Range: 0 to 0]**

**Sol:**
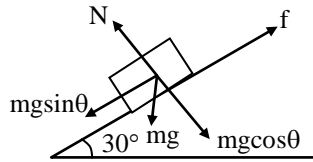


For motion along the incline

Maximum Frictional Force,

$f_{max} = \mu N = \mu mg\cos\theta$

$= 0.2 \times 2 \times 10 \times \dfrac{\sqrt{3}}{2} = 3.464$ N

Net force down the incline $= mg\sin\theta$

$= 2 \times 10 \times \sin 30 = 10$ N

Since, net force down the incline is greater than $f_{max}$, so no force is needed to move the block down i.e. it will move by itself.

**44. Ans: 1017    (Range: 1012 to 1022)**

**Sol:**

| Life in Weeks, $X_i$ | Probability, $p_i$ | $p_i X_i$ |
|---|---|---|
| 0.5 | 0.10 | 0.050 |
| 1.5 | 0.15 | 0.225 |
| 2.5 | 0.25 | 0.625 |
| 3.5 | 0.20 | 0.700 |
| 4.5 | 0.30 | 1.350 |
| **Total = 2.950** | | |

Mean life of the bulbs is 2.95 weeks

Expected number of failures during the

week $= \dfrac{\text{No. of bulbs}}{\text{Mean Life}} = \dfrac{1000}{2.95} = 339$

Weekly replacement cost = Expected no. of failures × cost of replacement for bulb

$= 339 \times 3 = 1017$

**45. Ans: 40    (Range: 40 to 40)**

**Sol:** For option P, Total annual cost (Rs in lakhs / year)

$= \dfrac{12}{100} \times 150 + 6 + 16 = 40$

For option Q, total annual cost (Rs. in lakhs / year)

$= \dfrac{12}{100} \times 120 + 8 + 20 = 42.4$

Therefore, Option P is better and answer is 40.

**46. Ans: 1.95 (Range 1.93 to 1.97)**

**Sol:** Given,

$h_0 = 4$ mm,    $h_1 = 4(1 - 0.3) = 2.8$ mm

$b = 500$ mm,    $\mu = 0.08$,    $R = 200$ mm

$L = \sqrt{R\,\Delta h} = \sqrt{200 \times 1.2} = 15.5$

$F_{avg} = \dfrac{2}{\sqrt{3}} \sigma_y (b\,L)\left(1 + \dfrac{\mu L}{4h}\right)$

$F_{avg} = \dfrac{2}{\sqrt{3}} \times 200 \times (500 \times 15.5)\left(1 + \dfrac{0.08 \times 15.5}{4 \times 3.4}\right)$

$\left[\because h = \dfrac{h_0 + h_1}{2} = \dfrac{4 + 2.8}{2} = 3.4\right]$

$= 1.95$ MN

**47.  Ans: (C)**

**Sol:** Number of ways we can distribute 5 red balls into 3 numbered boxes

$$= C(3-1+5, 5) = 21$$

Similarly we can distribute 5 white balls in 21 ways and 5 blue balls in 21 ways.

By product rule, required number of ways

$$= (21)\ (21)\ (21) = 9261$$

**48.  Ans: 26.69     (Range 25.5 to 27.5)**

**Sol:** S = 30.5 mm,

d = 2 mm

Best wire size, $d = \dfrac{p}{2}\sec\left(\dfrac{\alpha}{2}\right)$

$$= \dfrac{3.5}{2}\sec 30^o = 2.02 \text{ mm} \approx 2 \text{ mm}$$

∴ The wire used is the best wire.

$$R_1 = 14.5642 \text{ mm},$$

$$R_2 = 13.7683 \text{ mm}$$

Micrometer reading, $M = S + (R_2 - R_1)$

$$= 30.5 + (13.7683 - 14.5642)$$

$$= 29.7041 \text{ mm}$$

Effective diameter = $M - \left(d + \dfrac{p}{2}\tan\left(\dfrac{\alpha}{2}\right)\right)$

$$= 29.7041 - \left(2 + \dfrac{3.5}{2}\tan 30^o\right)$$

$$= 26.69 \text{ mm}$$

**49.  Ans: 4.77     (Range 4.2 to 5.2)**

**Sol:** D = 30 mm,          P = 10 kW,

N = 500 rpm

$S_{yt} = S_{yc} = 400$ MPa,     FOS = 3

Torque transmitted (T) = $\dfrac{60\,P}{2\pi N}$

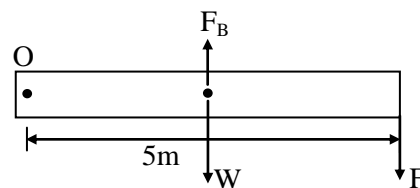$$= \dfrac{60 \times 10000}{2\pi \times 500}$$

T = 191.08 N-m

$$T = L \times W \times \tau \times \dfrac{D}{2}$$

$$T = L \times W \times \dfrac{D}{2} \times \dfrac{S_{yt}}{2 \times FOS}$$

$$W = \dfrac{2 \times 3 \times 191.08 \times 2 \times 1000}{40 \times 30 \times 400} = 4.77 \text{ mm}$$

**50.  Ans: 75     (Range: 75 to 75)**

**Sol:** The F.B.D of the timber block is shown as under:



For the timber block to float horizontally, we consider, $\Sigma M_o = 0$, i.e.,

$$F \times 5 + W \times \dfrac{5}{2} = F_B \times \dfrac{5}{2}$$

where W is the weight of the timber block and $F_B$ is the buoyancy force on the timber block.

Thus,

$$F = (F_B - W)\frac{1}{2} = (\gamma_{oil} \times 0.1^2 \times 5 - \gamma_{block} \times 0.1^2 \times 5) \times \frac{1}{2}$$

$$= (900 \times 10 \times 0.1^2 \times 5 - 600 \times 10 \times 0.1^2 \times 5) \times \frac{1}{2}$$

$$= 75 \text{ N}$$

**51.   Ans: (B)**

**Sol:** Given data:

Welding Process: I

   $V_1 = 60$ V          ;   $I_1 = 50$ A

   $N_1 = 150$ mm/min    ;   $\eta_2 = 90\% = 0.9$

Welding Process: II

   $V_2 = 60$ V          ;   $I_2 = ?$

   $N_2 = 120$ mm/min    ;   $\eta_2 = 88\% = 0.88$

(Heat input per unit length)$_1$ = (Heat input per unit length)$_2$
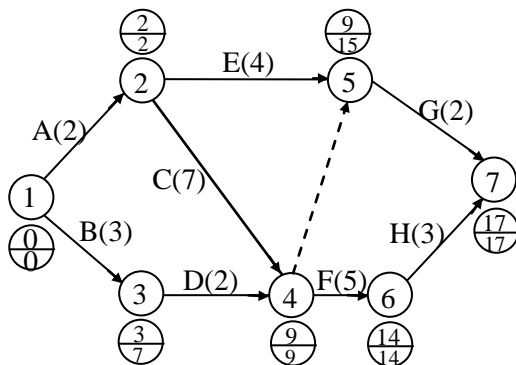
$$\frac{V_1 I_1}{N_1} \times \eta_1 = \frac{V_2 I_2}{N_2} \times \eta_2$$

$$\frac{60 \times 50}{150} \times 0.9 = \frac{60 \times I_2}{120} \times 0.88$$

$$\Rightarrow \ I_2 = 40.9 \text{ Amp}$$

**52.   Ans: (B)**

**Sol:**



**53.   Ans: 3028          (Range: 3020 to 3050)**

**Sol:** Given:

   $Q = 0.02\pi$ m$^3$/s,          $d_i = 0.2$ m,

   $d_o = 0.21$ m,               $H = 20$ m.

$$V = \frac{Q}{A} = \frac{4Q}{\pi d_i^2} = \frac{4 \times 0.02\pi}{\pi \times 0.2^2} = 2 \ \text{m/s}$$

Velocity of sound,

$$C = \sqrt{\frac{K}{\rho}} \text{ for pipe material as rigid.}$$

$$= \sqrt{\frac{2 \times 10^9}{10^3}} = 10^3 \sqrt{2} = 1414 \text{ m/s}$$

$P = \rho VC = 10^3 \times 2 \times 1414 = 2828$ kPa

The maximum pressure near the inlet would be equal to $= P + \rho gH$

$$= 2828(\text{kPa}) + \frac{10^3 \times 10 \times 20}{10^3}(\text{kPa})$$

$$= 3028 \text{ kPa}$$

Total float of E = (LFT)$_E$ − (EST)$_E$ − duration of activity E

$$= 15 - 2 - 4$$

$$= 9$$

**54.   Ans: 1.25          (Range: 1.2 to 1.30)**

**Sol:** Taking its dual we get

   minimize  $t = x' + 2z'$

$$10x' + 2z' \geq 11$$

$$x' - 2z' \geq 0$$

$$-x' + z' \geq -1 \ \Rightarrow x' - z' \leq 1$$
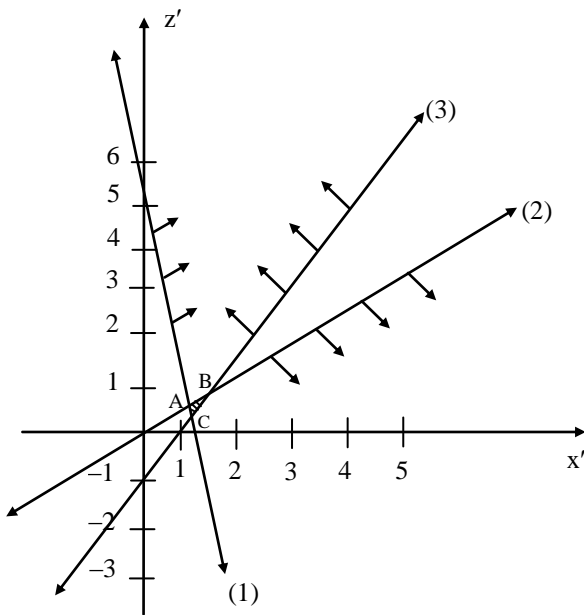
or $\dfrac{x'}{11/10} + \dfrac{z'}{11/2} \geq 1$ ......(1)

$x' = 2z'$ .......(2)

$\dfrac{x'}{1} + \dfrac{z'}{-1} \leq 1$ .......(3)

Plotting these three equations we get the following graph



Solving equation (1) & (2) we get, point A(1, 1/2)

Similarly solving equation (2) & (3), we get point B (2, 1)

And solving equation (1) & (3) we get point C(13/12, 1/12)

Putting these values in new objective function, i.e minimize t = x'+2z'

The values for point

A(1,1/2) = 1 + 2×1/2 = 2

B (2,1) = 2 + 2×1 = 4

C(13/12,1/12) = 13/12 + 2×1/12 = 1.25

The minimum value of dual is 1.25.

Therefore, the maximum value of w i.e. primal objective function is 1.25.

**55. Ans: (B)**

**Sol:** Total marbles = 10 + 30 + 20 + 15 = 75

P[both are white]

= P[first is white and second is white]

$= \dfrac{35}{75} \times \dfrac{35}{75} = \dfrac{4}{25}$

**56. Ans: (A)**

**Sol:** Vulgarity (n.) means offensive speech or conduct.

**57. Ans: (A)**

**58. Ans: (B)**

**59. Ans: (A)**

**Sol:** Cylinder volume = $\pi r^2 h$

$= \dfrac{22}{7} \times 10 \times 10 \times 14$

$= 4400 \text{ m}^3$

**60. Ans: (D)**

**Sol:** Speed = 10 kmph

$$= 10 \times \frac{5}{18} \, m/\sec = \frac{50}{18} \, m/\sec$$

Man walks 50 m in 18 sec.

**61. Ans: (D)**

**Sol:** Rate downstream = (24/2) kmph = 12 kmph.

Rate upstream = (24/4) kmph = 6 kmph.

Therefore, speed in still water

$$= 1/2* (12 + 6) = 9 \text{ kmph.}$$

**62. Ans: (B)**

**Sol:** Let principle be 4. Then amount $= 4 \times \frac{7}{4} = 7$

Interest = 7 - 4 = 3

Rate of interest $= \frac{3 \times 100}{4 \times 4} = 18\frac{3}{4}\%$

**63. Ans: (C)**

**Sol:** Net part filled in 1 hour

$$= \frac{1}{10} + \frac{1}{12} - \frac{1}{20} = \frac{6+5-3}{60}$$

$$= \frac{11-3}{60} = \frac{8}{60} = \frac{2}{15}$$

The tank will be full in $\frac{15}{2}$ hrs

$$= 7 \text{ hrs.30 min.}$$

**64. Ans: (A)**

**Sol:** Share of wealth that C gets (in Rs lakhs)

$$= 20$$

Tax = 40%

$\Rightarrow$ Wealth tax (in Rs lakhs) that C has to pay

$$= \frac{40}{100} \times 20 = 8$$

**65. Ans: (A)**

**Sol:** Note that an assumption is like a premise in that if it is wrong the argument is invalid, and if it is right it supports the conclusion. If the statement in (A) is correct, it supports the idea that point and shoot is not art, but if it is wrong, and choosing what to point the camera at involves art, then the argument is invalid. Hence, (A) is an assumption.