MADE EASY

GATE 2025

Mechanical Engineering

Memory based
Questions & Solutions

Exam held on
02/02/2025 (Forenoon Session)

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SECTION - A GENERAL APTITUDE

Q.1 If two unbiased coins flip together then what will be the probability for coming Head?

Ans. (3/4)

HH
HT
TH
TT

$$p = \frac{f \cdot C}{T \cdot C} = \frac{3}{4}$$

End of Solution

Q.2 HIDE : 19 – 28 – 7 – 11
CAGE : 8 – 2 –17 – 11
then HIGH is

(a) 8 – 17 – 1 – 2
(b) 19 – 28 – 17 – 19
(c) 13 – 3 – 1 – 2
(d) 17 – 19 – 13 – 17

Ans. (b)

H I D E → 19 28 7 11
C A G E → 8 2 17 11

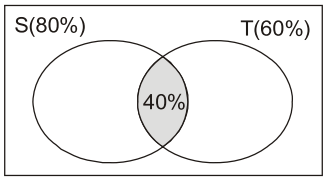
H I G H → 19 28 17 19

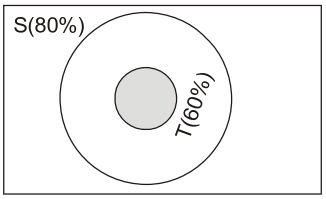
End of Solution

Q.3 Final year students are attending internships at company S and company T. The probability of a student interning at company S is 0.8 and the probability of a student interning at companyT is 0.6. The probability of a student interning at both companies is P.
Which of the following ranges is correct for P?

(a) $0.2 \le P \le 0.4$
(b) $0.4 \le P \le 0.6$
(c) $0.6 \le P \le 1.0$
(d) $0 \le P \le 0.2$

Ans. (b)





End of Solution

Q.4 Fish : Shoal : Lion : ?

(a) Forest
(b) School
(c) Series
(d) Pride

Ans. (d)

End of Solution

Q.5 Find the correct sentence.

(a) It is I who is responsible for this fiasco.
(b) It is I who are responsible for this fiasco.
(c) It is I who am responsible for this fiasco.
(d) It is myself who is responsible for this fiasco.

Ans. (c)

End of Solution

■■■■

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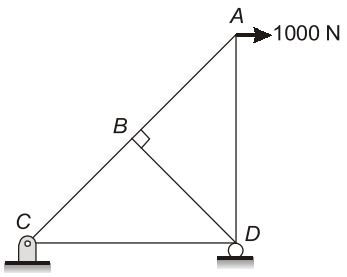
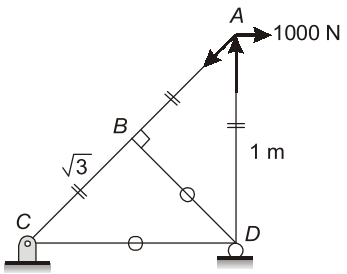
SECTION - B TECHNICAL

Q.1 Determine zero force member?



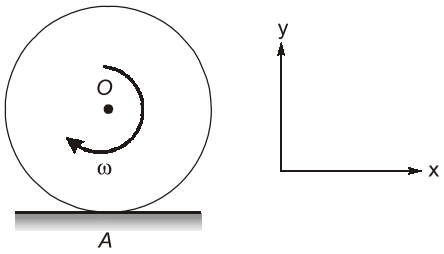
(a) BD
(b) AD
(c) BC
(d) BA

Ans. (a)



End of Solution

Q.2 The velocity of point A and O respectively.
(for pure rolling)



(a) $\omega r\hat{i},\ 0\hat{i}$
(b) $-\omega r\hat{i},\ 0$
(c) $\omega r\hat{i},\ \omega r\hat{j}$
(d) $0\hat{i},\ \omega r\hat{i}$

Ans. (d)

End of Solution

Q.3 Using Froude Number, $L_p / L_m = 100$. Velocity of Model is given by 1 m/s. Find velocity of prototype?

(a) 100 m/s (b) 0.1 m/s
(c) 10 m/s (d) 0.001 m/s

Ans. **(c)**

We know that

$$\text{Froude number} = \frac{V}{\sqrt{L_g}}$$

According to question

$$\frac{V_m}{\sqrt{L_m g}} = \frac{V_P}{\sqrt{L_P g}}$$

$$\frac{1}{\sqrt{L_m}} = \frac{V_P}{\sqrt{L_P}}$$

$$\sqrt{\frac{L_P}{L_m}} = V_P$$

$$\sqrt{100} = V_P$$

$$V_P = 10 \text{ m/s}$$

End of Solution

Q.4 The velocity vector for a flow is given by $\vec{V} = 3z\hat{i} + 0\hat{j} + Cx\hat{k}$. For an irotational flow. The value of C is _____

Ans. **(3)**

For irrotational flow, $\nabla \times \vec{V} = 0$

$$\omega_{xz} = \frac{1}{2}\left(\frac{\partial w}{\partial x} - \frac{\partial u}{\partial z}\right) = 0$$

$$\frac{1}{2}(c - 3) = 0$$

$$c = 3$$

End of Solution

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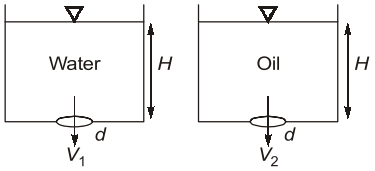
Q.5 Two tanks have holes at the bottom. In one tank there is water and in other engine oil. height of liquid is the same in both. Then relation between V_1 and V_2.



(a) $V_1 < V_2$
(b) $V_2 < V_1$
(c) $V_2 = V_1$
(d) Data insufficient to evaluate

Ans. **(c)**

$$V_1 = V_1$$

As Velocity $= \sqrt{2gh}$

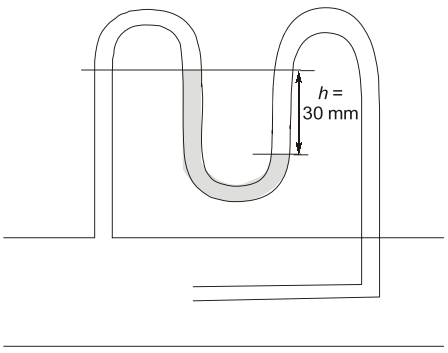
End of Solution

Q.6 Select correct option
For fully developed pipe flow
(a) compressibility becomes important when Mach number is less than 0.3
(b) for same maximum velocity, average velocity of turbulent flow is larger than that of laminar flow.
(c) friction factor is indepedent of surface roughness in laminar flow.
(d) in laminar flow, friction factor decreases with decrease in Reynolds number.

Ans. **(b, c)**
(b) For same maximum velocity average velocity of turbulent flow is larger than that of laminar flow because the velocity variation is parabolic in laminar regime while logarithmic in turbulent regime.
(c) Friction factor is in dependent of surface roughness in laminar flow.

End of Solution

Q.7 A pitot tube is used to measure the velocity of air flowing in wind tunnel which has density of 1.23 kg/m^3. The density of water is 1000 kg/m^3, SG of manometric fluid is 13.6, Meniscus height is 30 mm. The velocity of air in the wind tunnel is



Ans. (81.45)

Pitot tube

We kowon that, $V = \sqrt{2gh}$

$$h = x\left[\frac{\rho_m}{\rho_f} - 1\right]$$

$$h = \frac{30}{1000}\left[\frac{13600}{1.23} - 1\right] = 331.67 \text{ m}$$

$$V = \sqrt{2 \times 10 \times 331.67}$$

$$V = 81.45 \text{ m/s}$$

End of Solution

Q.8 A Pelton wheel turbine of mean diameter 6 m is working under maximum power condition and blades of wheel are frictionless if inlet velocity of jet is 126 m/sec then rotational speed of wheel is _____rpm.

Ans. (200.5)

We know that for maximum power condition,

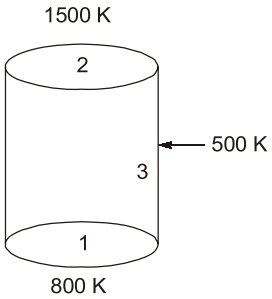
$$u = \frac{V_1}{2} = 63 \text{ m/s}$$

$$u = u_1 = u_2 = 63 = \frac{\pi DN}{60} = \frac{\pi \times 6 \times N}{60}$$

$$N = 200.5 \text{ rpm}$$

End of Solution

Q.9



$F_{12} = 0.2$

$Q_{13} = ?$

d = 5 m

h = 5 m

All are black surface. Find heat transfer from bottom to curve surface in ____ kW.

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Conventional Questions Practice Programme for ESE Mains 2025

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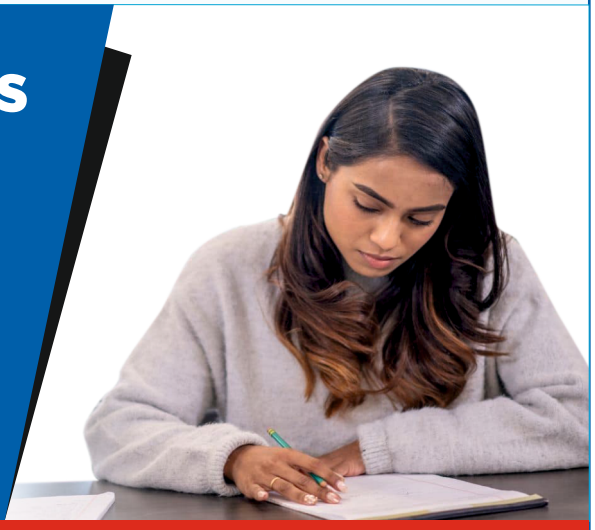

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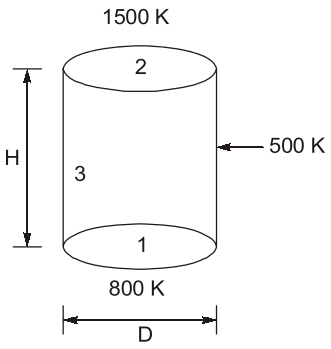
Ans. (309.141)

$D = H = 5$ m, $F_{13} = 0.8$, $F_{23} = 0.8$, $F_{13} + F_{11} + F_{12} = 1$

$$F_{12} = 1 - F_{13} = 1 - 0.8 = 0.2$$



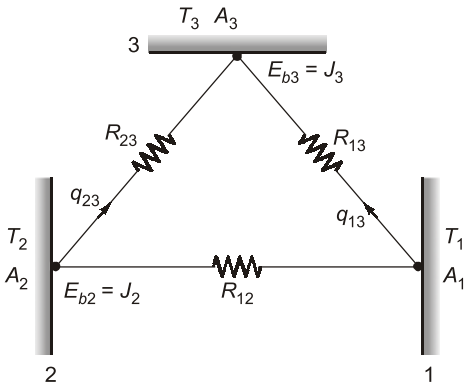
$$A_1 = A_2 = \frac{\pi}{4}D^2$$

$$A_3 = \pi DH$$

$$R_{12} = \frac{1}{A_1F_{12}} = \frac{1}{\frac{\pi D^2}{4}\times 0.2} = \frac{20}{\pi D^2}$$

$$R_{23} = \frac{1}{A_2F_{23}} = \frac{1}{\frac{\pi D^2}{4}\times 0.8} = \frac{5}{\pi D^2}$$

$$R_{13} = \frac{1}{A_1F_{13}} = \frac{1}{\frac{\pi D^2}{4}\times 0.8} = \frac{5}{\pi D^2}$$



$$q_{23} = \frac{E_{b2} - E_{b3}}{R_{23}} = \frac{\sigma\left(T_2^4 - T_3^4\right)}{\frac{5}{\pi D^2}}$$

$$= 5.67\times 10^{-8}\left(1500^4 - 500^4\right)\times\frac{\pi(5)^2}{5}$$

$$= 4453207.586 \text{ W}$$

$$= 4453.207 \text{ kW}$$

$$q_{13} = \frac{E_{b1} - E_{b3}}{R_{13}} = \frac{\sigma\left(T_1^4 - T_3^4\right)}{R_{13}}$$

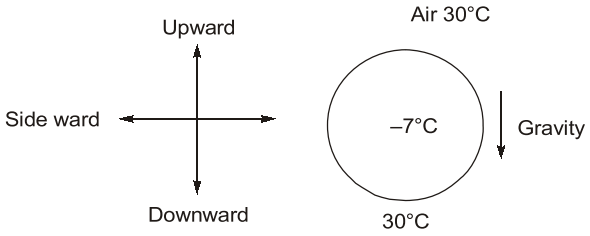
$$= \frac{5.67\times 10^{-8}\left(800^4 - 500^4\right)}{\frac{5}{\pi D^2}}$$

$$= \frac{5.67\times 10^{-8}\times\pi(5)^2\left(800^4 - 500^4\right)}{5}$$

$$q_{13} = 309141.6707 \text{ W} = 309.141 \text{ kW}$$

End of Solution

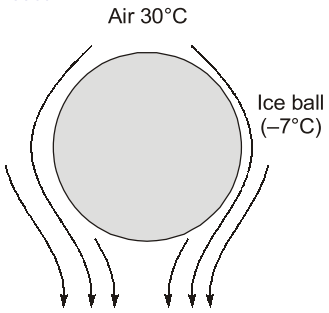
Q.10 Air at 30° flows over a spherical ice cube at –7°C expose to air with graity. What will be the air direction?



(a) No motion
(b) Downward
(c) Upward
(d) Sideward

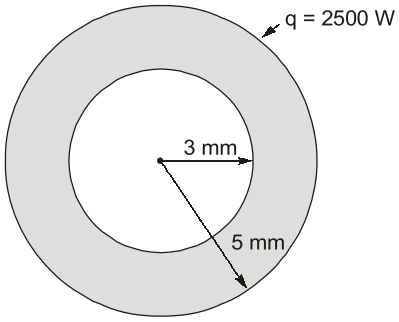
Ans. (b)

Air close to the Ice Ball will go in downward direction becouse of weight is more than Buoyant force because $T_{iceball}$ is less.



End of Solution

Q.11 Heat incident on the plate is 2500 W. 85% of heat is absorbed by the plate of 5 mm radius while 65% absorbed by the plate of 3 mm radius. Heat density absorbed by shaded area _____ W/mm^2.



Ans. (9.947)

Total incident heat is = 2500 W

5 m palte absorption = 85%

5 m plate sbrosption = 65%

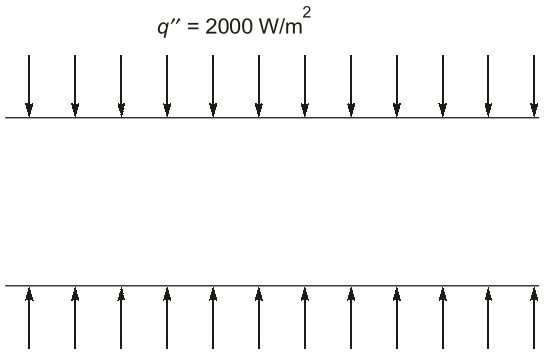
Absorption by shaded area = (85 – 65)% = 20%

$q_{absorbed\ (shaded)}$ = 2500 × 0.20 = 500 W

$$\text{Heat density} = \frac{500}{A_{shaded}} = \frac{500}{\pi\left(5^2 - 3^2\right)} = 9.947 \text{ W/mm}^2$$

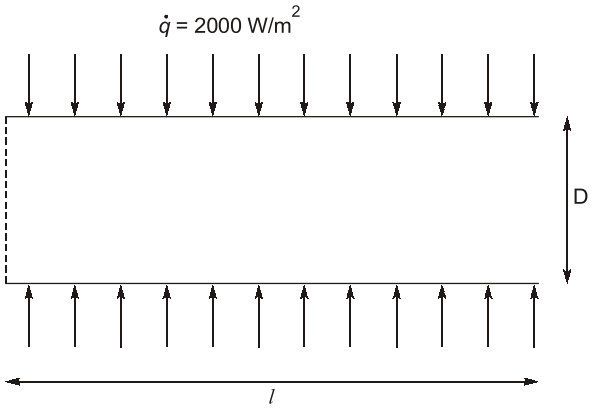
End of Solution

Q.12 Water is flowing through a pipe. The inlet and outlet temperature of water are 293 K and 353 K respectively. If mass flow rate of water is 0.01 kg/s and diameter of tube is 60 mm, then length of the tube if constant heat flux of 2000 W/m^2 is subjected to wall of the pipe.



Ans. (6.65)

Given: D = 60 mm = 0.060 meter, $T_{bm(\text{inlet})} = 293$ K, $T_{bm\ (\text{outlet})} = 353$ K, q″ = 2000 W/m^2, $\dot{m} = 0.01 \text{kg/s}$, $C_p = 4180$



Total rate of heat transfe:

$$q = q''(\pi DL) = \dot{m}C_p\left(T_{bm(outlet)} - T_{bm(inlet)}\right)$$

$$2000 \times \pi \times 0.060 \times l = 0.01 \times 4180 \times (353 - 293)$$

$$\Rightarrow \quad l = 6.6526 \text{ meter}$$

End of Solution

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Q.13 Efficiency of Otto cycle is 0.5. Specific heat ratio 1.4. Then compression ratio?

(a) (b)

(c) 5.6568 (d)

Ans. **(c)**

Given, $\eta_0 = 1 - \frac{1}{r^{\gamma-1}}$

$$0.5 = 1 - \frac{1}{(r)^{1.4-1}}$$

$$\frac{1}{r^{0.4}} = 1 - 0.5$$

$$r^{0.4} = \frac{1}{0.5} = 2$$

$$r = (2)^{1/0.4}$$

$$r = 2^{2.5}$$

$$r = 5.6568$$

End of Solution

Q.14 For a production system annual demand is 3000 units and the cost of placing one order is ₹150, the holding cost is 40% of unit price of inventory, and the items can be purchased in the lot as given below. Determine the best order size

Lot size	Price (₹/unit)
0 - 499	₹ 9/unit
500 - 999	₹ 8.5/unit
≥ 1000	₹ 8/unit

Ans. **(26050)**

D = 3000 unit, C_o = ₹150, C_h = 0.4C,

C = ₹8/unit

$$Q^* = \sqrt{\frac{2DC_0}{C_h}} = \sqrt{\frac{2\times 3000\times 150}{0.4\times 8}}$$

= 530.33 units/order (Not feasible)

C = ₹8.5/unit

$$Q^* = \sqrt{\frac{2DC_0}{C_h}} = 514.49 \text{ units/order (Feasible)}$$

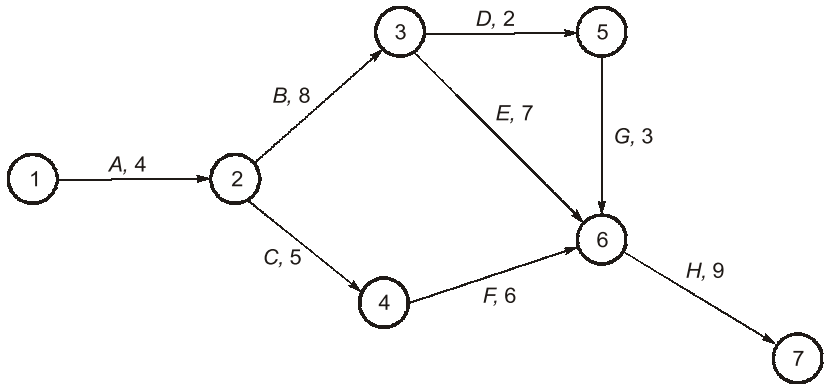
$$\text{T.C.} = D.C + \frac{D}{Q}C_0 + \frac{Q}{2}C_h$$

T.C.(514.49) = ₹27249.28

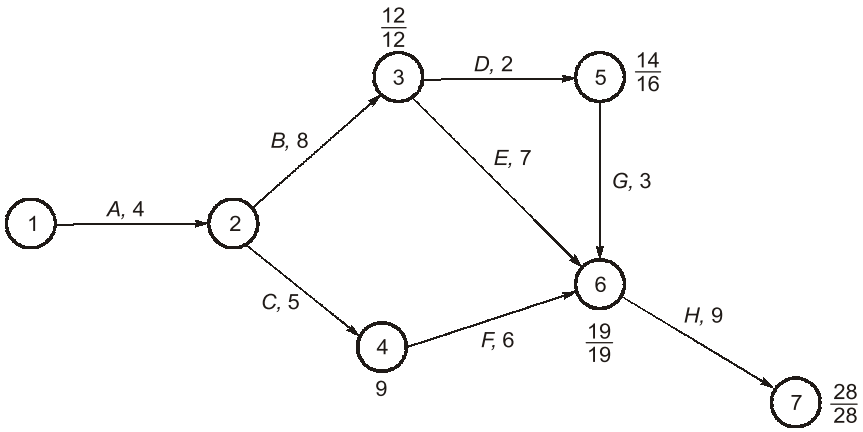
T.C.(1000) = ₹26050

End of Solution

Q.15 For the network diagram shown below, find the out the head events slack for activity D.



Ans. (2)



TES = 0 (Tail Event Slack)

HES = 2 (Head Event Slack)

$s_j = L_j - E_j$

$(TF)_D = 16 - 2 - 12 = 2$

By using, $(TF) = LFT - t_{ij} - EST$

End of Solution

Q.16 Demand data and the forecasted value for the last 10 periods is given below. Find the Mean forecast error and mean absolute division for the last 10 periods.

Period	1	2	3	4	5	6	7	8	9	10
Demand	425	415	420	430	427	418	422	416	426	421
Forecast	427	422	416	422	423	420	419	418	430	415

Ans. (0.8)

Period	1	2	3	4	5	6	7	8	9	10
Demand	425	415	420	430	427	418	422	416	426	421
Forecast	427	422	416	422	423	420	419	418	430	415
e_i	–2	–7	4	8	4	–2	3	–2	–4	6

$$e_i = D_i - F_i$$

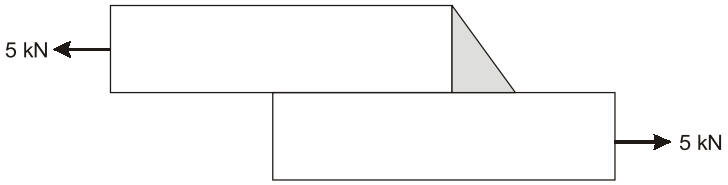
$$\sum |e_i| = 42$$

$$\text{MAD} = \frac{\sum |e_i|}{n} = \frac{42}{10} = 4.2 \qquad [\text{where } n \text{ is number of period}]$$

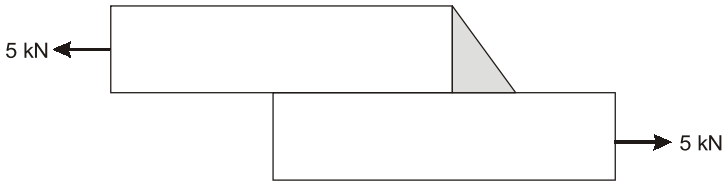
$$\text{Mean forecast error (MFE)} = \frac{\sum (e_i)}{n} = \frac{8}{10} = 0.8$$

End of Solution

Q.17 A lap joint one side welded subjected to transverse load of 5 kN, if S_{ys} = 150 MPa and FOS = 3, find out length of weld. Take plate thickness = 10 mm.



Ans. (14.14)



S_{ys} = 150 MPa, N = 3, l = ?

$$P = 0.707 \times t \times l_e \times \frac{S_{ys}}{N}$$

$$5000 = 0.707 \times 10 \times l \times \frac{150}{3}$$

$$l = 14.14 \text{ mm}$$

Now, if S_{yt} = 150 MPa (as given in some memory based questions)

$$P = 0.707 t\, l_e \tau_{per}$$

$$P = 0.707 t\, l \times \frac{S_{yt}}{2N} \quad (\because S_{ys} = \frac{S_{yt}}{2} \text{ and } l_e = l)$$

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$$5000 = 0.707 \times 10 \times l \times \frac{150}{2 \times 3}$$

$\therefore \quad l = 28.28$ mm

Ans: 14.14 mm if $S_{ys} = 150$ MPa
28.28 mm if $S_{yt} = 150$ MPa

End of Solution

Q.18 A helical gear is mounted on a shaft. Which one of the following bearing can't be used to support the shaft?

(a) straight roller bearings
(b) tapered roller bearings
(c) angular contact ball bearings
(d) double row ball bearings

Ans. (a)

In helical gears, straight roller bearing can't be used because it is suitable for only radial loads.

End of Solution

Q.19 For repeated fatigue stress condition determine maximum stress if endurance limit is equal to yield strength, ultimate strength is double of yield strength and FOS = 2.

(a) $\frac{S_e}{4}$
(b) $2S_e$
(c) $0.5S_e$
(d) S_e

Ans. (c)

For repeated fatigue stress condition, σ_{max} using soderberg equation,
if $\sigma_e = S_{yt}$; $S_{ut} = 2S_{yt}$; $N = 2$
For repeated fatiue stress condition,

$$\sigma_m = \sigma_a = \frac{\sigma_{max}}{2}$$

$$\frac{\sigma_m}{\sigma_{yt}} + \frac{\sigma_a}{\sigma_e} = \frac{1}{N}$$

$$\frac{\sigma_{max}}{2\sigma_e} + \frac{\sigma_{max}}{2\sigma_e} = \frac{1}{2}$$

$$\frac{\sigma_{max}}{2\sigma_e} + \frac{\sigma_{max}}{2\sigma_e} = \frac{1}{2}$$

$$\sigma_{max} = \frac{\sigma_e}{2}$$

End of Solution

Q.20 Ceramics and glass cutting can be done by which process

(a) Plasma arc
(b) Electromagnetic discharge
(c) Ultrasonic machining
(d) None

Ans. (c)

End of Solution

Q.21 If the height an d diameter of cylinder is equal and volume of cube and cylinder is same, then the ratio of solidification time of cube and cylinder is _____ Assume K is same for both and n = 2.

Ans. (0.85)

Solidification time:

$$V_{cy} = V_C$$

$$\frac{\pi}{4}d^2 \cdot h = a^3 \qquad (\because h = d)$$

$$\frac{\pi}{4}d^3 = a^3$$

$$\Rightarrow \left(\frac{a}{d}\right) = \left(\frac{\pi}{4}\right)^{1/3}$$

$$\frac{(t_s)_{cube}}{(t_s)_{cylinder}} = \frac{\left(\frac{V}{A}\right)_C^2}{\left(\frac{V}{A}\right)_{cy}^2} = \frac{\left(\frac{a}{6}\right)^2}{\left(\frac{d}{6}\right)^2} = \left(\frac{a}{d}\right)^2$$

$$= \left(\frac{\pi}{4}\right)^{2/3} = 0.85$$

End of Solution

Q.22 Rolling process (Metal forming)

Given : $\mu = 0.12$

Roller diameter, $D = 500$ mm,

Initial thickness, $t = 30$,

Final thickness, $t_f = 26$ mm

Find the maximum draft and given reduction is fisible or not _____.

Ans. (4)

$$\Delta h_{max} = \mu^2 R$$

$$= (0.12)^2 \times \frac{500}{2} = 3.6 \text{ mm}$$

Maximum possible reduction in single pass.

According to Question,

$$\Delta h = h_i - h_f$$

$$= 30 - 26 = 4 \text{ mm}$$

So not fisible.

End of Solution

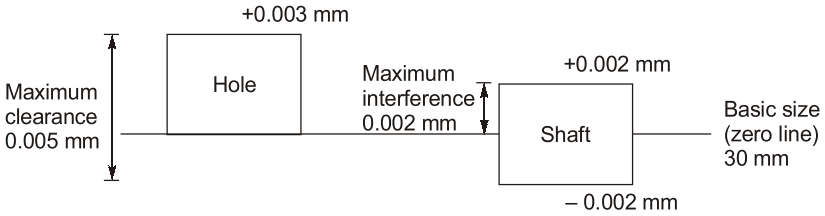
Q.23 A shaft and hole assembly having 30 mm basic size has following dimensions for the hole and shaft. Which of the following type of fit is obtained in the shaft and hole assembly?

$H = 30^{+0.003}_{0.000}$

$S = 30^{+0.002}_{-0.002}$

(a) Transition
(b) Interference
(c) loose fit
(d) Clearance fit

Ans. (a)



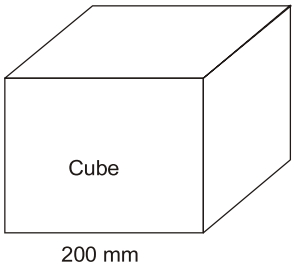
Type of fit = Transition

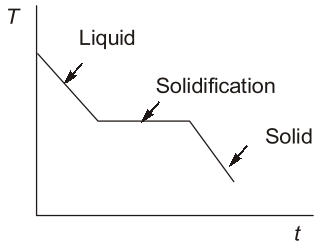
End of Solution

Q.24 A = 200 mm × 200 m × 200 mm
No compensation is given to shrinkage volumetric solidification and volumetric solid shrinkage 8% and liquid shrinkage 7%. Find edge length after solidification ?

Ans. (188.875)

Volumetric liquid shrinkage = 7%
Volumetric solid shrinkage = 8%





Volume of casting = (Volume of liquid metal) (1 – Shrinkage)
$= (200)^3 \times 0.93 \times 0.92$
$a^3 = 68,44,800\ mm^3$
$a = 189.868\ mm$

End of Solution

Q.25 CAD solid models can be constructed by using
(a) Bezlier curve
(b) Boundary representation
(c) Spline curve
(d) NURBS - Non uniform rotational B-splines

Ans. (b)

End of Solution

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Q.26 In a machining operation the following data is observed.
Diameter of W/P = 60 mm; Length of W/P = 400 mm
Cutting speed = 25 m/min; Feed = 0.2 mm/rev.; Tool life constant = 75;
Tool life exponent = 0.25; Tool change time = 3 min; Labour cost = Rs. 5/per min
Determine tool change cost per piece.

Ans. (3)

Given:
Diameter of workpiece = 60 mm; Length of workpiece = 400 mm
Cutting speed = 25 m/min; Feed = 0.2 mm/rev;
Tool life constant = 75; Tool life exponent = 0.25;
Tool change time = 3 min; Labour cost = Rs. 5 per min.

Tool change cost = z_1 × number of tool failures/piece × TCT

$\therefore$ z_1 = Rs. 5 per min.

$$\text{Number of tool failure/piece} = \frac{T_m}{T}$$

$$\therefore \quad \text{Machining time, } T_m = \frac{L}{f \times N} = \frac{400}{0.2 \times \left(\frac{1000v}{\pi D}\right)}$$

$$= \frac{400 \times \pi \times 60}{0.2 \times 1000 \times 25} = 15.0857 \text{ min}$$

$$\text{Tool life, } T = \left(\frac{c}{v}\right)^{1/n} = \left(\frac{75}{25}\right)^{1/0.25} = 81 \text{ min.}$$

$$\text{Number of tool failures piece} = \frac{15.0857}{81} = 0.1862$$

Tool change coster per piece = 5 × 0.1862 × 3
= Rs, 2.7936 $\simeq$ 3 per piece

End of Solution

Q.27 Match the following

Process		Technique	
P.	SLA	(1)	Injection of powder
Q.	FDM	(2)	Extrusion of melted polymer
R.	LOM	(3)	Liquid layer
S.	LENS	(4)	Sheet metal deposition

Codes:

	P	Q	R	S
(a)	1	2	4	3
(b)	3	2	4	1
(c)	2	1	3	4
(d)	4	2	3	1

Ans. (b)

End of Solution

Q.28 Match the following

List-I	List-II
A. Skim bob	(1) Rapid cooling
B. Chills	(2) To trap impurities
C. Inoculations	(3) To minimise heat transfer
D. Insulating material	(4) Control solidification rate

Codes:

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

Ans. (d)

A. Skim bob	(i) To trap impurities
B. Chills	(ii) Rapid cooling
C. Inoculations	(iii) Control solidification rate
D. Insulating material	(iv) To minimise heat transfer

End of Solution

Q.29 The process commonly used for fabricating tailored welded blank of dissimilar thickness of automatic application is _____.

(a) Friction welding (b) Laser welding
(c) Gas welding (d) Arc welding

Ans. (a, b)

End of Solution

Q.30 Maximum possible reduction in area in wire drawing of perfectly plastic material (without friction) is _____.

Ans. (63.2)

$$\sigma_d = \sigma_o \ln \frac{A_0}{A_f}$$

For maximum possible reduction, $\sigma_d = \sigma_o$

$$\therefore \quad \frac{A_0}{A_f} = e$$

$$\frac{A_0 - A_f}{A_0} = 1 - \frac{1}{e} = 0.632 \text{ or } 63.2\%$$

End of Solution

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Q.31 In which of the following processes, steel is heated to lowest temperature?

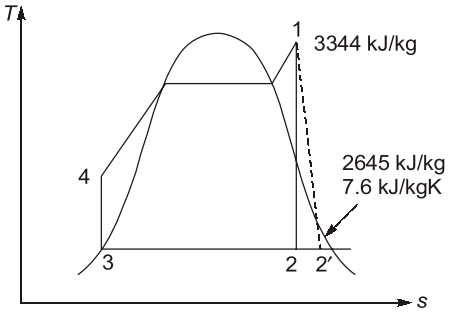
(a) Nitriding
(b) Cyaniding
(c) Carbonitriding
(d) Carburizing

Ans. (a)

End of Solution

Q.32 The condition of steam at inlet and outlet of the turbine is given below:
Super heated condition
h_1 = 3344 kJ/kg, S_1 = 6.5 kJ/kgK
At condenser pressure
S_f = 1.1 kJ/kgK, S_g = 7.6 kJ/kgK, h_f = 341 kJ/kg, h_g = 2645 kJ/kg
Mass flow rate = 102 kg/s
Isentropic efficiency = 0.9
Calculate the Turbine power in MW

Ans. (99.961)



$\eta_T = 0.9, \quad \dot{m} = 102$ kg/sec

$$S_1 = S_2$$
$$6.5 = 101 + x(7.6 - 1.1)$$
$$x = 0.83076$$
$$h_2 = 341 + 0.83076\,(2645 - 341)$$
$$= 2255.092$$
$$W_T = (h_1 - h_2)\eta_T = (3344 - 2255.092) \times 9$$
$$= 980.016 \text{ kJ/kg}$$
$$P = \dot{m} \times W_T = 102 \times 980.016$$
$$= 99961.726 \text{ K} = 99.961 \text{ MW}$$

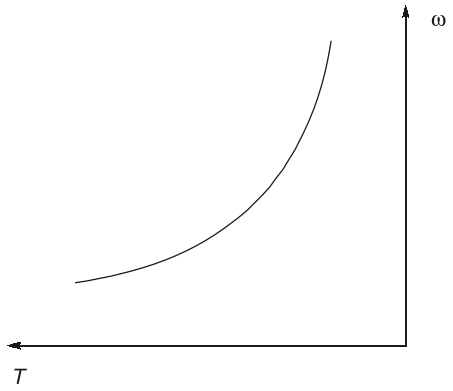
End of Solution

Q.33 On psychrometric chart, on the axis DBT is mantioned, in other axis, what is there.....

(a) Relative humidity (b) Specific humidity

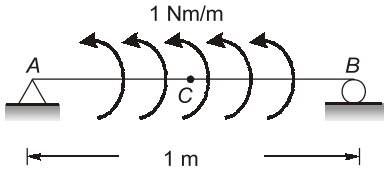
(c) WBT (d) DPT

Ans. (b)

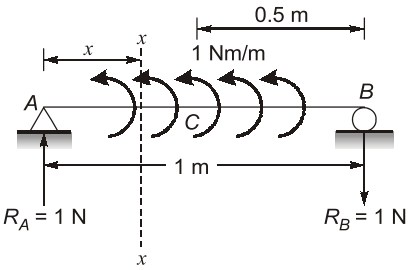


End of Solution

Q.34 1 Nm/m per m uniformly distributed bending moment over a 1 m beam with hinge at A and roller at B, is shown below. Bending momont at mid point will be



Ans. (0)



m = 1 N-m/m, L = 1 m, $(BM)_C$ = ?

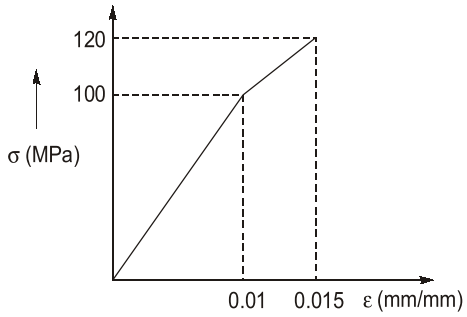
x = 0 to L

$$M_{x\text{-}x} = R_A\,(x) - mx$$
$$= m(x) - mx = 0$$

Hence, $(BM)_C = M_C$ = Zero

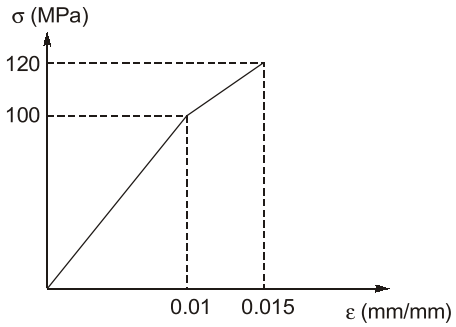
End of Solution

Q.35



Find the strain energy per unit volume?

Ans. (1.05)



$$\text{Modulus of resilience} = \frac{1}{2}\times 100\times 0.1 = 0.5\ \text{N–mm/m}^3 \text{ or MJ/m}^3$$

$$\text{Modulus of toughness} = 0.5 + (100 \times 0.005) + \frac{1}{2}\times 20\times 0.005$$

$$= 1.05\ \text{MJ/m}^3$$

End of Solution

Q.36 Yield stress in tension in case of Uniaxial loading is 200 MPa.
Then according to von mises theory, yield stress for pure shear will be
(a) (b)
(c) (d)

Ans. (115.4)

S_{yt} = 200 MPa.

$$S_{ys} = 0.577\ S_{yt} = 115.4\ \text{MPa}$$

End of Solution

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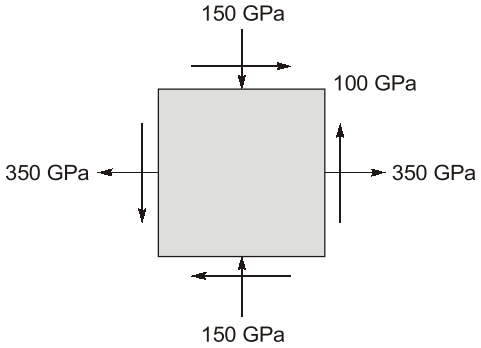
Q.37 A 2-D stress element is shown below. If the Poisson ratio is 0.27 then strain in z-direction if E = 200 GPa



Principle stress

Ans. (-0.27×10^{-3})

Given: ε_{zz} if σ_x = 350 GPa, σ_y = – 150 GPa

τ_{xy} = – 50 GPa, E = 200 GPa

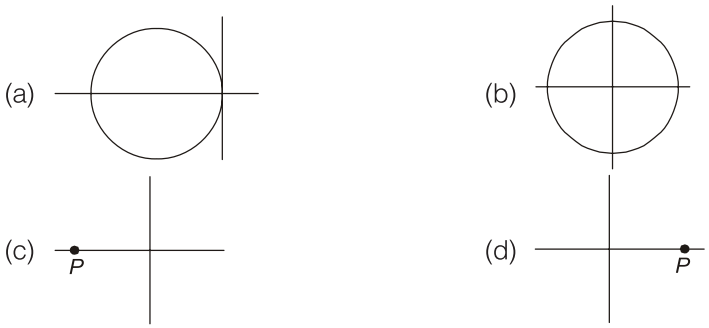
μ = 0.27

$$\varepsilon_z = \frac{1}{E}\left[\sigma_z - \mu\left(\sigma_x + \sigma_y\right)\right] = \frac{1}{200\times10^3}[0 - 0.27(350 - 150)]$$

$$\varepsilon_z = -0.27 \times 10^{-3}$$

End of Solution

Q.38 Mohr circle of a square plate under hydrostatic pressure is



Ans. (c)

Due to hydrostatic pressure, Mohr's circle becomes a point on -ve axis.

End of Solution

Q.39 A hydrogen gas having polytropic index 1.3 and γ = 1.4, if the work done on the gas is 400 kJ, then heat transfer is

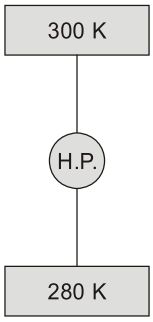
Ans. (100)

$$Q_{Poly} = W_{Poly} \times \frac{\gamma - n}{\gamma - 1} \qquad (\because \gamma = 1.4)$$

$$= 400 \times \frac{1.4 - 1.3}{1.4 - 1} = 100 \text{ kJ}$$

End of Solution

Q.40 A pump is working on reversed carnot cycle between temperature limit 300 K and 280 K, if heat lost through room is 15 kW, then power input is



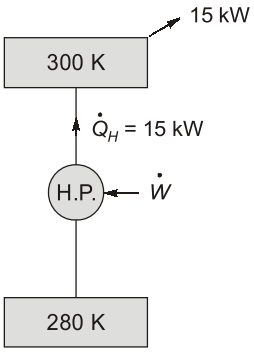
Ans. (1)

$$COP_{HP} = \frac{T_H}{T_H - T_L}$$

$$\frac{\dot{Q}_H}{\dot{W}} = \frac{300}{300 - 280}$$

$$\frac{15}{\dot{W}} = 15$$

$$\dot{W} = 1 \text{ kW}$$

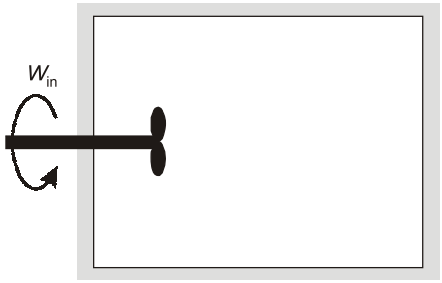


End of Solution

Q.41 A work is done on insulated rigid cylinder with the help of stirrer. Which of the following statement are correct?

(a) Enthalpy and entropy both increases
(b) Enthalpy and entropy both decreases
(c) Enthalpy and entropy both remain constant
(d) Enthalpy remains constant but entropy increases

Ans. (a)



End of Solution

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2	27th Feb 2025	75 Qs	1 Hour	Part Syllabus Test	Basics of project Management, Information and communication technologies, Ethics and values in engineering profession, intellectual property rights, Role of science and technology in daily life, recent developments in applied sciences, basics of artificial intelligence and robotics
3	6th Mar 2025	75 Qs	1 Hour	Part Syllabus Test	Green Energy, Energy conversion principles, Climate change, Disaster Management, Basics of thermodynamics, Water resources and conservation processes, Basics of measurement and instrumentation, Human health and sanitation
4	13th Mar 2025	75 Qs	1 Hour	Part Syllabus Test	General Hindi
5	20th Mar 2025	75 Qs	1 Hour	Part Syllabus Test	Indian History, Indian Polity, Geography, GK & Miscellaneous and Current Affairs
6	27th Mar 2025	150 Qs	2 Hours	Full Syllabus Test	Full Syllabus Test (100 Qs. Engineering Aptitude + 25 Hindi + 25 General Studies)
7	3rd Apr 2025	150 Qs	2 Hours	Full Syllabus Test	Full Syllabus Test (100 Qs. Engineering Aptitude + 25 Hindi + 25 General Studies)
8	5th Apr 2025	150 Qs	2 Hours	Full Syllabus Test	Full Syllabus Test (100 Qs. Engineering Aptitude + 25 Hindi + 25 General Studies)
9	8th Apr 2025	150 Qs	2 Hours	Full Syllabus Test	Full Syllabus Test (100 Qs. Engineering Aptitude + 25 Hindi + 25 General Studies)
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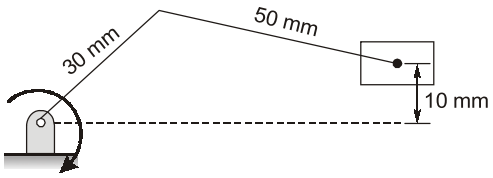
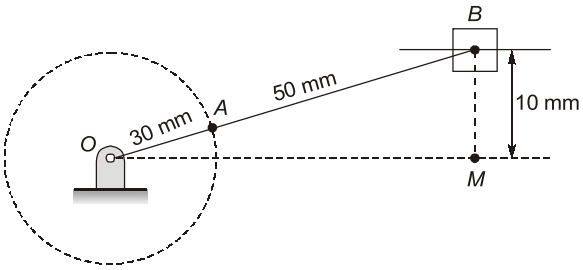
Q.42

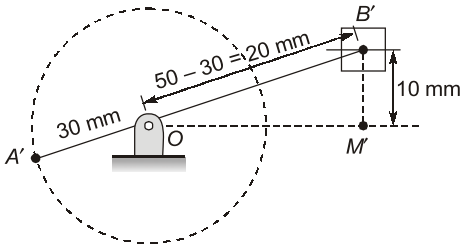


Find stroke length.

Ans. (62.0519)



$$OM = \sqrt{80^2 - 10^2}$$
$$= 79.3725 \text{ mm}$$



$$OM' = \sqrt{20^2 - 10^2} = 17.3205$$
$$\text{Stroke} = OM - OM' = 79.3725 - 17.3205$$
$$= 62.0519 \text{ mm}$$

End of Solution

Q.43 Velocity ratio, = 1 : 2

$\phi = 15°$, m = 10 mm, add = 10 mm

Minimum number of teeth required on the pinion is _____.

Ans. (25)

$$A_P = A_G = 1$$
$$\text{V.R.} = \frac{1}{2}$$
$$\Rightarrow \quad G = 2$$
$$t_{min} = ??$$
$$T_{min} = \frac{2A_G}{\sqrt{1 + \frac{1}{G}\left(\frac{1}{G} + 2\right)\sin^2\phi - 1}} = \frac{2 \times 1}{\sqrt{1 + \frac{1}{2}\left(\frac{1}{2} + 2\right)\sin^2 15° - 1}}$$

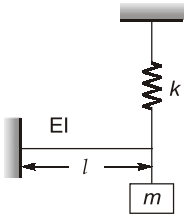
$$T_{min} = 48.750 = 49$$

$$t_{min} = \frac{T_{min}}{2} = \frac{49}{2} = 24.5 = 25$$

$$t_{min} = 25$$

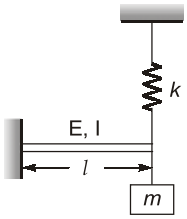
End of Solution

Q.44



Find ω_n of free oscillation?

Ans. $\left(\sqrt{\frac{3EI + Kl^3}{ml^3}}\right)$



First we are going to calculate bending stiffness of beam (K_{beam})

$$\text{Static deflection } (\Delta) = \frac{Wl^3}{3EI} = \frac{mgl^3}{3EI}$$

$$\sqrt{\frac{K_{beam}}{m}} = \sqrt{\frac{g}{\Delta}}$$

$$\frac{K_{beam}}{m} = \frac{g}{\frac{mgl^3}{3EI}}$$

$$K_{beam} = \frac{3EI}{l^3}$$

Equivalent stiffness, $K_{eq} = K_{beam} + K$

$$= \left(\frac{3EI}{l^3} + K\right)$$

$$\omega_n = \sqrt{\frac{K_{eq}}{m}} = \sqrt{\frac{\frac{3EI}{l^3} + K}{m}}$$

$$\omega_n = \sqrt{\frac{3EI + Kl^3}{ml^3}}$$

End of Solution

Q.45 If the damping factor or damping ratio is equal to $\frac{\omega_d}{\omega_n} = \xi$ then value of ξ is

Ans. (0.707)

$$\frac{\omega_d}{\omega_n} = \xi \text{ (given)}$$

$$\left(\sqrt{1-\xi^2}\right)\omega_n = \omega_d$$

$$\frac{\sqrt{1-\xi^2}\cdot\omega_n}{\omega_n} = \xi$$

$$\sqrt{1-\xi^2} = \xi$$

$$2\xi^2 = 1$$

$$\xi^2 = \frac{1}{2} = 0.5$$

$$\xi = 0.707$$

End of Solution

Q.46 The solution of the following differential equation :

$$x^2\frac{d^2y}{dx^2} + 3x\frac{dy}{dx} + y = 0$$

for the initial condition $y(1) = 0$, $\left(\frac{dy}{dx}\right)\Big|_{x=1} = 1$ is $y(2) = A \ln 2$, then the value of A is

Ans. (1/2)

$$\frac{x^2d^2y}{dx^2} + 3x\frac{dy}{dx} + y = 0$$

$$(D(D-1) + 3D + 1)y = 0$$

$$(D^2 - D + 3D + 1)y = 0$$

$$(D^2 + 2D + 1)y = 0$$

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

AE: $(m + 1)^2 = 0$

$$m = -1, 1$$

$$y = (C_1 + C_2t)e^{-t}$$

$$y = (C_1 + C_2 \ln x)e^{-\ln x}$$

$$y = (C_1 + C_2 \ln x)e^{\ln\left(\frac{1}{x}\right)}$$

$$y = (C_1 + C_2 \ln x)\frac{1}{x}$$

At n = 1, y = 0

$$0 = (C_1 + C_2 \ln 1)\frac{1}{1}$$

$$0 = C_1 + 0$$

$$C_1 = 0$$

$$y = \frac{C_1}{x} + \frac{C_2 \ln}{x}$$

$$\frac{dy}{dx} = -\frac{C_1}{x^2} + C_2 \frac{x\left(\frac{1}{x}\right) - \ln x}{x^2} = \frac{-C_1 + C_2(1 - \ln x)}{x^2}$$

At $x = 1$, $\frac{dy}{dx} = 1$

$$1 = 0 + \frac{C_2 + (1 - \ln 1)}{1} = C_2$$

Now, $$y = \frac{C_1}{x} + \frac{C_2 \ln x}{x}$$

$$y = \frac{\ln x}{x}$$

At $x = 2$, $y = A \ln 2$

$$A \ln 2 = \frac{\ln 2}{2}$$

$$A = \frac{1}{2}$$

End of Solution

Q.47 If A and B are symmetric matrix with same order, then

(a) $A^T = A^{-1}$ (b) $AB = BA$

(c) $(AB)^T = B^T A^T$ (d) $A = A^{-1}$

Ans. **(c)**

A and B are symmetrix

$A^T = A$, $B^T = B$

End of Solution

Q.48 If $f(x) = 2x^3 - 9x^2 + 12x$; $x \in [0, 3]$ the minimum value of $f(x)$ is

(a) 4 (b) 9

(c) 0 (d) 5

Ans. **(c)**

$$f(x) = 2x^3 - 9x^2 + 12x$$

$$f'(x) = 6x^3 - 18x + 12 = 6(x^2 - 3x + 2) = 0$$

$$= 6(x - 1)(x - 2) = 0$$

$x = 1$, $x = 2$; $f''(x) = 12x - 18$

$$f''(x)\big|_{x=1} = 12 \times 1 - 18 = -6 < 0$$

$x = 1$ maxima point,

$$f''(x)\big|_{x=2} = 12x - 18 = 6 > 0$$

$x = 2$ minima, $f(x) = 2x^3 - 9x^2 + 12x$

$$f(x)\big|_{x=0} = 0$$

$$f(x)\big|_{x=1} = 2(D^3 - 9(1)^2 + 12 \times 1 = 2 - 9 + 12) = 5$$

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Total	**150**	**150**	

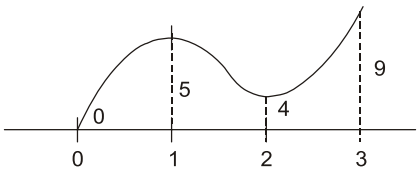
Test Series Schedule

Test No.	Activate Date	Total Marks	Total Questions	Total Time
1	11th Feb 2025	150 Marks	150 Qs	2 Hours
2	14th Feb 2025	150 Marks	150 Qs	2 Hours
3	18th Feb 2025	150 Marks	150 Qs	2 Hours
4	21st Feb 2025	150 Marks	150 Qs	2 Hours
5	25th Feb 2025	150 Marks	150 Qs	2 Hours
6	28th Feb 2025	150 Marks	150 Qs	2 Hours
7	4th Mar 2025	150 Marks	150 Qs	2 Hours
8	7th Mar 2025	150 Marks	150 Qs	2 Hours
9	11th Mar 2025	150 Marks	150 Qs	2 Hours
10	14th Mar 2025	150 Marks	150 Qs	2 Hours

Fee: ₹500/-

$$f(x)\big|_{x=2} = 2(2)^3 - 9(2)^2 + 12 \times 2 = 4$$

$$f(x)\big|_{x=3} = 2(3)^3 - 9(3)^2 + 12 \times 3 = 9$$



So, minimum value = 0

End of Solution

Q.49 If $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0,\ 0 \le x \le 1,\ 0 \le y \le 1$

(a) $u = \sin x \,.\, \sin y$
(b) $u = e^x.\ \sin y$
(c) $u = \cos x \,.\, \cos y$
(d) $u = e^{x+y}$

Ans. (b)

$\nabla^2 U = 0 \Rightarrow$ Laplace equation

By option

$$u = e^x \sin y$$

$$\frac{d^2U}{dx} = e^x \sin y$$

$$\frac{d^2U}{dx^2} = e^x \sin y$$

$$\frac{d^2U}{dx^2} + \frac{d^2U}{dy^2} = e^x \sin y + e^x(-\sin y)$$

$$= 0$$

End of Solution

Q.50 If $\bar{V} = 3z\hat{i} + Cx\hat{k}$ has irrotational flow, then the value of C is _____.

Ans. (3)

$$\bar{V} = 3z\hat{i} + Cx\hat{k}$$

curl $\bar{V} = 0 \Rightarrow$ For irrotational

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 3z & 0 & Cx \end{vmatrix} = i(0) + J(C-3) + \hat{k}(0) = 0$$

$$C = 3$$

End of Solution

Q.51 For the given set of values :

x	0	0.25	0.5	0.75	1
y	0.9	2.0	1.5	1.8	0.4

By using Simpson's 1/3 rule, the approximate integral value is _____.

Ans. (1.625)

$$\int_0^1 f(x)dx = \frac{1}{3}\left[(y_0+y_x)+4(y_1+y_3+y_5+.....)+2(y_2+y_4+y_6.....)\right]$$

$$= \frac{0.25}{3}\left[(0.9+0.9)+4(2+1.8)+2(1.5)\right]$$

$$= \frac{1}{4\times 3}\left[1.3+4\times 3.8+3\right] = \frac{19.5}{12} = 1.625$$

End of Solution

Q.52 For the given expression

$$\oint \frac{z^3}{(z^2+4)+(z^2-4)} = 2\pi\imath n$$

the values of n is _____.

Ans. (0)

Poles: $(z^2 - 4)\ (z^2 + 4) = 0$

$z = \pm 2, \pm 2i$

All the poles are lies outstack the closed curve.

End of Solution

■■■■

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