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Important Questions *for* GATE 2022

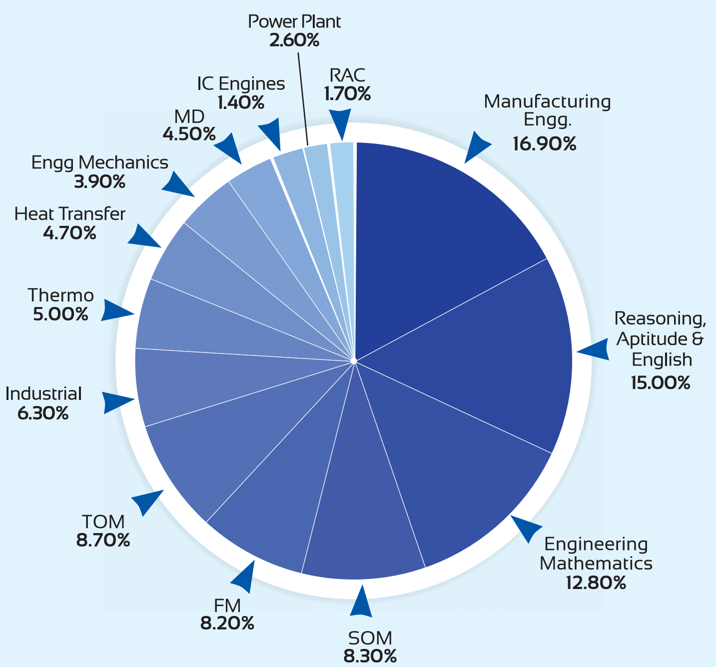
MECHANICAL ENGINEERING

Day 8 of 8

Q.176 - Q.200 (Out of 200 Questions)

Power Plant + Engineering Materials + Strength of Materials

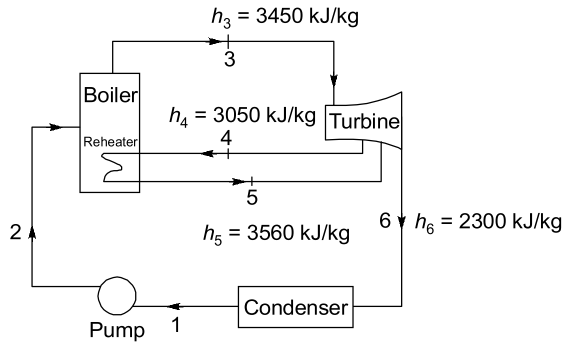
SUBJECT-WISE WEIGHTAGE ANALYSIS OF GATE SYLLABUS



Subject	Average % (last 5 yrs)
Manufacturing Engineering	16.90%
Reasoning, Aptitude & English	15.00%
Engineering Mathematics	12.80%
Strength of Materials	8.30%
Theory of Machines	8.70%
Fluid Mechanics & Hydraulic Machines	8.20%
Industrial Engineering	6.30%
Thermodynamics	5.00%
Heat Transfer	4.70%
Engineering Mechanics	3.90%
Machine Design	4.50%
Internal Combustion Engines	1.40%
Power Plant Engineering	2.60%
Refrigeration & Air Conditioning	1.70%
Total	**100%**

Power Plant + Engineering Materials + Strength of Materials

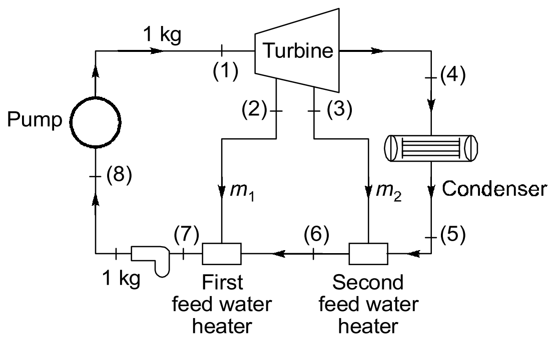
Q.176 A steam power plant operates on a theoretical reheat cycle as shown below. Steam enters high pressure turbine at 150 bar and 550°C (h_3 = 3450 kJ/kg) and expands upto 40 bar (h_4 = 3050 kJ/kg). It is reheated at constant pressure to 550°C (h_5 = 3560 kJ/kg) and expands through the low pressure turbine to a condenser at 0.1 bar (h_6 = 2300 kJ/kg).
Also given, h_{f1} (at 0.1 bar) = 191.8 kJ/kg.
Thermal efficiency (in %) and steam rate (kg/kWh) of the plant neglecting pump work are, respectively



(a) 44.05 and 4.34
(b) 48.10 and 5.12
(c) 42.10 and 3.10
(d) 44.05 and 2.17

Q.177 In order to control the temperature of steam in a steam generator, a spray type desuperheater is used. It is fed with water at 60°C. Steam at 90 bar and 500°C with flow rate 300 tons/hr enters the desuperheater. Neglect any pressure drop due to mixing and heat loss to the surrounding. Also given
h_g (at 90 bar and 500°C) = 3386.1 kJ/kg
h_f (at 60°C) = 251.11 kJ/kg
h_g (at 90 bar and 450°C) = 3256.6 kJ/kg
Amount of water that must be sprayed to maintain steam at 450°C is __________ kg/s.
[Correct upto 1 decimal place]

Q.178 A steam power plant operates on regenerative steam cycle as shown in figure.

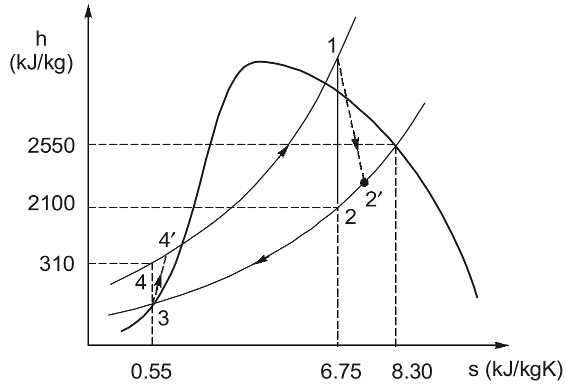


Given :
h_2 = 2679 kJ/kg, h_3 = 2365 kJ/kg, h_{f5} = 137.8 kJ/kg, h_{f6} = 467.1 kJ/kg and h_{f7} = 762.6 kJ.kg
Total mass of steam (m_1 + m_2) extracted from the two points of the turbine is __________ kg.
[Correct upto 2 decimal places]

Q.179 In an ideal Brayton cycle with 100% efficient regeneration, argon gas is compressed from 100 kPa and 25°C to 400 kPa, and then heated to 1200°C before entering the turbine. The highest temperature that argon can be heated in the regenerator is ________ °C. [Correct upto two decimal places]

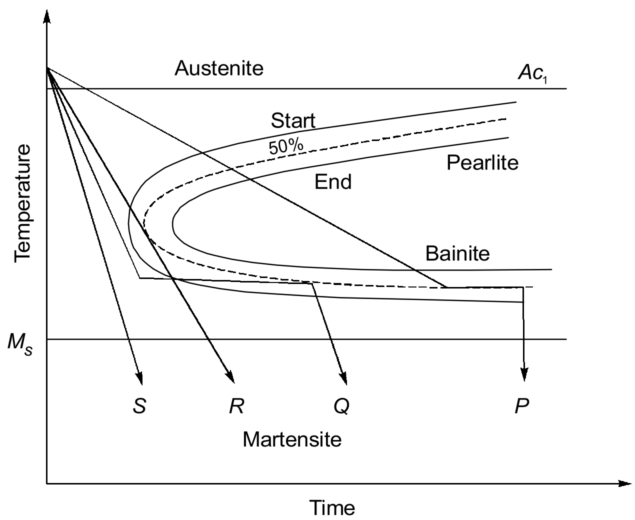
[Take $C_{p\text{-argon}}$ = 0.5203 kJ/kg-K, $C_{V\text{-argon}}$ = 0.3122 kJ/kg-K]

Q.180 The *h-s* diagram for a Rankine cycle is given below



Assuming pump work of 15 kJ/kg, the friction loss in the pump is ________ percent. [Correct upto 1 decimal place]

Q.181 Which of the following cooling curves (shown in schematic) in an eutectoid steel will produce 50% bainitic structure?



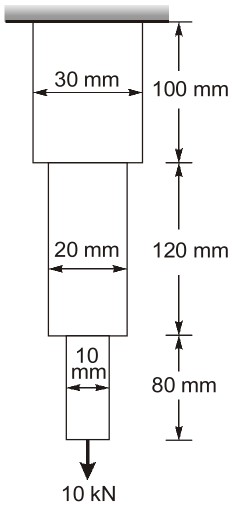
(a) *P*
(b) *Q*
(c) *R*
(d) *S*

Q.182 In metals subjected to cold working, strain hardening effect is due to:
(a) Twinning mechanism
(b) Dislocation mechanism
(c) Fracture mechanism
(d) Twisting mechanism

Q.183 The Mohr's circle for plane stress condition is a circle of radius R with its centre at $+\frac{R}{2}$ on σ-axis. The value of shear stress on the plane of pure shear stress will be _________ αR, where α is ________. [Correct upto 3 decimal places]

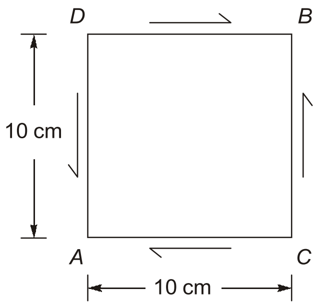
Q.184 What is the strain energy of the massless stepped bar as shown in the figure below?

[Take E = 200 GPa]



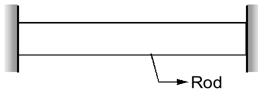
(a) 0.38 N-m
(b) 0.42 N-m
(c) 0.50 N-m
(d) 0.56 N-m

Q.185 In a pure shear condition, the maximum value of shear stress is observed to be 20 MPa for an element shown, subjected to above condition. The change in length of diagonal AB is ___ μm. [Take G = 80 GPa] [Correct upto 2 decimal places]

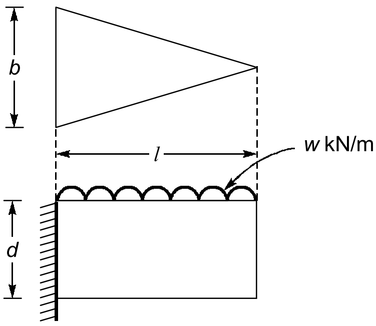


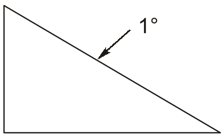
Q.186 A cantilever of length 3 m carries two point loads of 2 kN at free end and 4 kN at the distance of 1 m from the free end. The deflection at the free end is __________ mm. [Correct upto 2 decimal places]
[Take $E = 2 \times 10^5$ N/mm^2 and $I = 10^8$ mm^4]

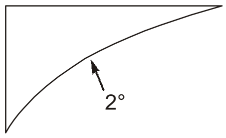
Q.187 A metal rod 2.4 m long is placed between and perpendicular to two vertical walls 2.43 m apart as shown in figure. The temperature of the rod is raised until the rod is fixed between the walls and has a compressive stress of 21 MN/m². The rod is restrained from bending. The rise in temperature is ____________°C. [Take E = 105 GN/m², α = 11.8 × 10^{-5} °C]
[Correct upto 1 decimal place]

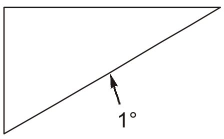


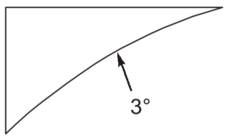
Q.188 A cantilever with constant depth and linearly varying width as shown in figure is subjected to uniformly distributed load. The longitudinal variation of bending stress considering only the bottom fibre will be



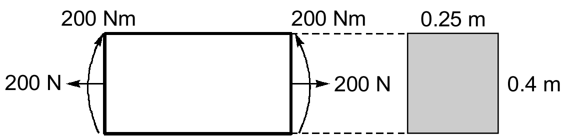
(a) 

(b) 

(c) 

(d) 

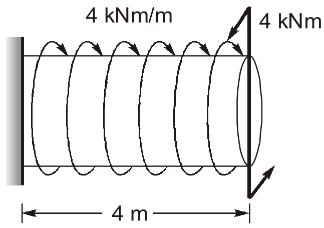
Q.189 A rectangular cross section beam of width 0.25 m and depth 0.4 m is subjected to a bending moment of 200 Nm and a uniform axial load of 200 N as shown in figure. The distance from top surface where normal stress will be zero is



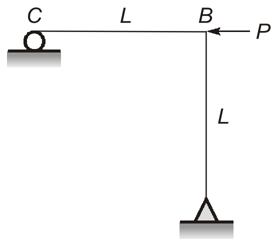
(a) 0.2134 m
(b) 0.1866 m
(c) 0.0134 m
(d) 0.2 m

Q.190 A thin cylinder of diameter 500 mm is subjected to internal fluid pressure of 6 MPa. If yield stress of cylinder is 280 MPa, Poisson's ratio 0.3 and factor of safety is 2, according to maximum principal strain theory, minimum thickness of the cylinder is ____________mm.
[Correct upto 1 decimal place]

Q.191 A solid circular shaft of diameter 100 mm is loaded with a uniformly distributed torque of 4 kN-m/m and a concentrated torque of 4 kN-m at free end as shown in figure. The distance of point of maximum angular twist from fixed end is ________ m.

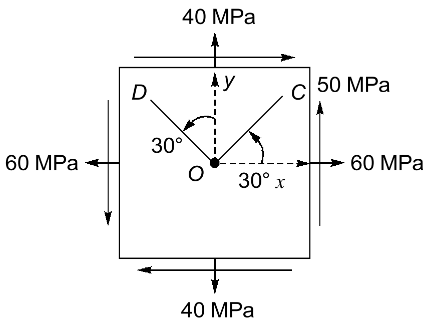


Q.192 A frame as shown in figure is subjected to a horizontal force P. Consider only bending effects, the horizontal displacement of point B is



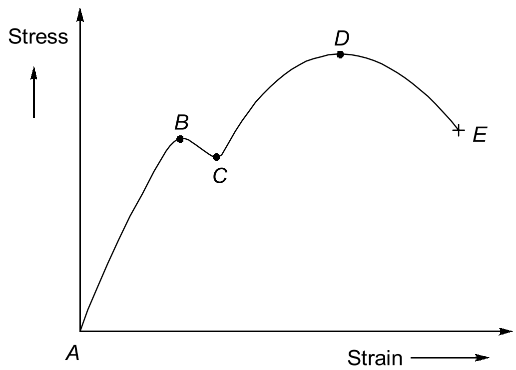
(a) $\dfrac{PL^3}{3EI}$
(b) $\dfrac{4PL^3}{3EI}$
(c) $\dfrac{2PL^3}{3EI}$
(d) $\dfrac{3PL^3}{2EI}$

Q.193 A square plate of size 1 m × 1 m is loaded as shown in figure. O is the center of the plate. OC and OD plane are 30° to x and y direction respectively before the loading. For Young's modulus 150 GPa and shear modulus 60 GPa, the change in angle between planes OC and OD after the application of stress will be ________ × 10^{-3} radians. [Correct upto 2 decimal places]



Q.194 The diagram shown below refers to the stress-strain curve for a mild steel specimen.

The region of Necking is given by

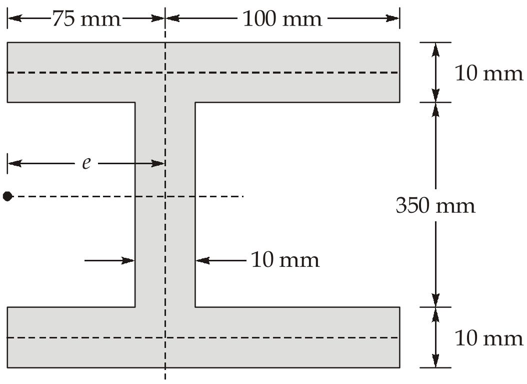


(a) AB
(b) BC
(c) CD
(d) DE

Q.195 A steel column, pinned at both ends, has a buckling load of 200 kN. If the column is restrained against lateral movement at its mid height, its buckling load will be

(a) 200 kN
(b) 283 kN
(c) 400 kN
(d) 800 kN

Q.196 For a given unsymmetrical I-section location of shear centre (e) is_____ mm. [Correct upto one decimal points.]



Multiple Select Questions (MSQ)

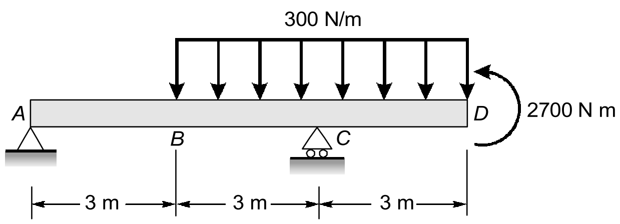
Q.197 Which of the following properties of solids is/are dependent on crystal imperfections?

(a) Yield stress
(b) Melting point
(c) Conductivity
(d) Ductility

Q.198 Percentages of various alloying elements present in different materials for high speed steels are

(a) 27% Cr, 3% Ni, 5% Mo, 0.25% C, 0.1% Pb
(b) 18% Cr, 8% Ni, 0.15% C, 0.2% Sn, 0.1% Pb
(c) 8% Mo, 4% Cr, 2% V, 6% W, 0.7% C
(d) 18% W, 4% Cr, 1% V, 5% Co, 0.7

Q.199 The shear force diagram changes its sign, for the given loading on beam *ABCD*, at



(a) point *B*
(b) point *C*
(c) mid point of *BC*
(d) a distance of 1.67 m from point *B* towards *C*

Q.200 The modulus of rigidity and the bulk modulus of a material are found as 70 GPa and 150 GPa respectively. Then,

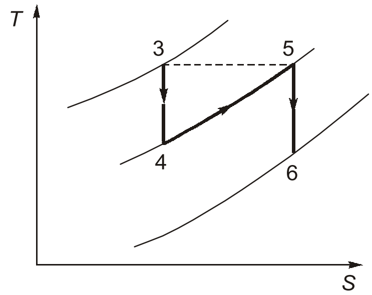
(a) Elasticity modulus is 200 GPa
(b) Poisson's ratio is 0.22
(c) Elasticity modulus is 182 GPa
(d) Poisons ratio is 0.3

■■■■

Detailed Explanations

176. (d)

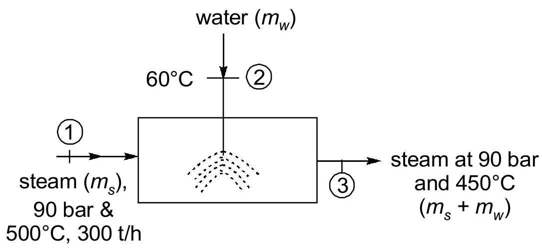
$$Q_s = (h_3 - h_{f_1}) + (h_5 - h_4) \quad \text{[Neglecting pump work, } h_{f_1} = h_2\text{]}$$
$$= (3450 - 191.8) + (3560 - 3050)$$
$$= 3768.2 \text{ kJ/kg}$$
$$W = (h_3 - h_4) + (h_5 - h_6)$$
$$= (3450 - 3050) + (3560 - 2300)$$
$$= 1660 \text{ kJ/kg}$$



$$\eta_{cycle} = \frac{W}{Q_s} = \frac{1660}{3768.2} = 44.05\%$$

$$\text{Steam rate} = \frac{3600}{W} = \frac{3600}{1660} = 2.17 \text{ kg/kWh}$$

177. 3.6 (3.5 to 3.6)



$$m_s h_1 + m_w h_2 = (m_s + m_w) h_3$$
$$m_w = \frac{m_s(h_1 - h_3)}{(h_3 - h_2)}$$
$$= \frac{300(3386.1 - 3256.6)}{(3256.6 - 251.11)} = 12.92 \text{ t/h}$$
$$= \frac{12.92 \times 1000}{3600} \text{ kg/s} = 3.588 \text{ kg/s} \simeq 3.6 \text{ kg/s}$$

178. 0.26 (0.25 to 0.27)

Energy balance for first feedwater heater

$$m_1 \times h_2 + (1 - m_1) h_{f6} = h_{f7}$$
$$\Rightarrow \quad m_1 \times 2679 + (1 - m_1) 467.1 = 762.6$$
$$\Rightarrow \quad m_1 = 0.1336 \text{ kg}$$

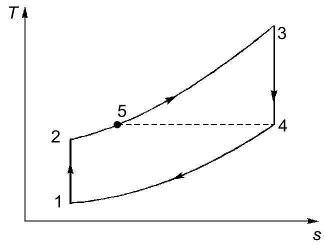
Energy balance for second feed water heater :

$$m_2 h_3 + (1 - m_1 - m_2) h_{f5} = (1 - m_1) h_{f6}$$
$$\Rightarrow \quad m_2 \times 2365 + (1 - 0.1336 - m_2) \times 137.8 = (1 - 0.1336) \times 467.1$$

$$\Rightarrow \quad m_2 = 0.1281 \text{ kg}$$

$$\text{Total mass} = m_1 + m_2 = 0.1336 + 0.1281 = 0.26 \text{ kg}$$

179. 572.88(572.60 to 572.90)



$$P_1 = 100 \text{ kPa} = P_4$$

$$P_3 = P_2 = 400 \text{ kPa}$$

$$\gamma = \frac{C_P}{C_V} = \frac{0.5203}{0.3122} = 1.667$$

$$T_1 = 298 \text{ K}, T_3 = 1473 \text{ K}$$

The maximum temperature to which argon can be heated in regenerator is equal to outlet temperature of turbine assuming 100% efficiency of regenerator.

$$\Rightarrow \quad \frac{T_3}{T_4} = \left(\frac{P_3}{P_4}\right)^{(\gamma-1)/\gamma}$$

$$\Rightarrow \quad \frac{1473}{T_4} = (4)^{0.667/1.667}$$

$$\Rightarrow \quad T_4 = T_5 = 845.875 \text{ K} = 572.875°\text{C} \simeq 572.88°$$

180. (33.3) (33 to 34)

$$s_1 = s_2$$

$$6.75 = 0.55 + x_2(8.30 - 0.55)$$

$$\Rightarrow \quad x_2 = 0.8$$

$$h_2 = h_f + x_2 h_{fg}$$

$$\Rightarrow \quad h_2 = h_3 + x_2\{h_g - h_3\}$$

$$\Rightarrow \quad h_2 = h_3(1 - x_2) + x_2 h_g$$

$$\Rightarrow \quad 2100 = h_3 \times 0.2 + 0.8 \times 2550$$

$$\Rightarrow \quad h_3 = 300 \text{ kJ/kg}$$

$$w_p = 15 \text{ kJ/kg} \qquad \text{[Given]}$$

$$h_4' = h_3 + w_p = 315 \text{ kJ/kg}$$

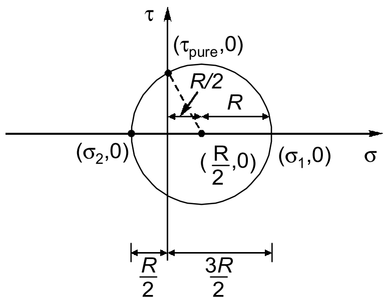
$$\eta_p = \frac{h_4 - h_3}{h_4' - h_3} = \frac{10}{15} \times 100 = 66.66\%$$

$$\text{Losses} = 33.33\%$$

181. (b)

182. (b)

183. 86.60 (0.866 to 0.866)



$$\Rightarrow \quad \sigma_1 = \frac{3R}{2},\ \sigma_2 = -\frac{R}{2}$$

$$\Rightarrow \quad (\tau)_{\text{on plane of pure shear}} = \sqrt{-\sigma_1 \times \sigma_2}$$

$$= \sqrt{-\left(\frac{-R}{2} \times \frac{3R}{2}\right)} = 0.866 \times R$$

Thus, $\alpha = 0.866$ MPa

Alternate solution:

From Mohr's circle

$$(\tau)_{\text{on plane of pure shear}} = \sqrt{R^2 - \left(\frac{R}{2}\right)^2}$$

$$= \sqrt{3}\frac{R}{2} = 0.866\,R$$

184. (a)

$$\text{Total strain energy} = \frac{1}{2}P_1\delta_1 + \frac{1}{2}P_2\delta_2 + \frac{1}{2}P_3\delta_3$$

$$= \frac{1}{2} \times P \times \frac{PL_1}{A_1E} + \frac{1}{2}P \times \frac{PL_2}{A_2E} + \frac{1}{2} \times P \times \frac{PL_3}{A_3E}$$

$$= \frac{P^2}{2E}\left[\frac{L_1}{A_1} + \frac{L_2}{A_2} + \frac{L_3}{A_3}\right]$$

$$= \frac{(10 \times 1000)^2}{2 \times 200 \times 10^9}\left[\frac{100 \times 4 \times 1000}{\pi \times (30)^2} + \frac{120 \times 4 \times 1000}{\pi \times (20)^2} + \frac{80 \times 4 \times 1000}{\pi \times (10)^2}\right]$$

$$= 0.3855 \text{ N-m}$$

185. 17.67 (17.60 to 17.70)

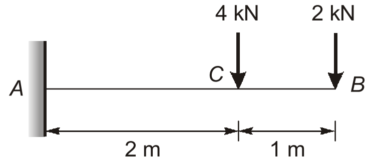
$$y = \frac{\tau}{G} = \frac{20}{80 \times 10^3} = 0.25 \times 10^{-3}$$

$$(\varepsilon)_{\text{at } \theta = 45°} = \frac{y}{2}\sin 90° = \frac{y}{2} = 0.125 \times 10^{-3}$$

$$\frac{\text{Change in length}}{\text{Original length}} = 0.125 \times 10^{-3}$$

$$\text{Change in length} = 0.125 \times 10^{-3} \times \sqrt{10^2 + 10^2} = 0.01767 \text{ mm} \simeq 17.67\,\mu\text{m}$$

186. 1.83 (1.80 to 1.86)



Distance $AC = a = 2 \text{ m} = 2000 \text{ mm}$

$\therefore \quad W_1 = 2 \text{ kN} = 2000 \text{ N}$

$W_2 = 4 \text{ kN} = 4000 \text{ N}$

Let y_1 = Deflection at the free end due to load 2 kN alone

y_2 = Deflection at the free end due to load 4 kN alone

$$y_1 = \frac{W_1 L^3}{3EI} = \frac{2000 \times 3000^3}{3 \times 2 \times 10^5 \times 10^8} = 0.9 \text{ mm}$$

and
$$y_2 = \frac{W_2 a^3}{3EI} + \frac{W_2 a^2}{2EI}(L - a)$$

$$= \frac{4000 \times 2000^3}{3 \times 2 \times 10^5 \times 10^8} + \frac{4000 \times 2000^2}{2 \times 2 \times 10^5 \times 10^8}(3000 - 2000)$$

$$= 0.53 + 0.4 = 0.93 \text{ mm}$$

Total deflection at the free end = $y_1 + y_2 = 0.93 + 0.9 = 1.83$ mm

187. 107.59 (105 to 109)

Expansion required for the rod to just fix itself between the walls.

$$= (2.43 - 2.4) = 0.03 \text{ m}$$

Increase in length, $\delta l = 0.03$

$\therefore$ Temperature rise required

$$t_1 = \frac{0.03}{11.8 \times 10^{-5} \times 2.4} = 105.9\ °\text{C}$$

Strain required for a stress of 21 MN/m^2.

$$\frac{\sigma}{E} = \frac{21 \times 10^6}{105 \times 10^9} = 200 \times 10^{-6}$$

Let the temperature rise required for this strain = t_2

$$\text{Strain} = \alpha t_2$$

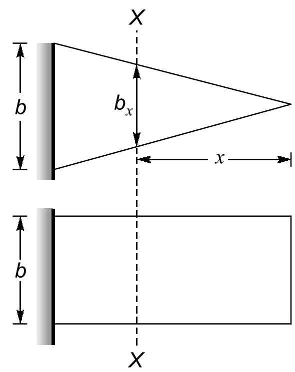
$$t_2 = \frac{\text{Strain}}{\alpha}$$

$$t_2 = \frac{200 \times 10^{-6}}{11.8 \times 10^{-5}} = 1.694\ °\text{C}$$

$\therefore$ Total temperature rise required = $t_1 + t_2 = 105.9 + 1.694$

$$= 107.59°\text{C} \simeq 107.6°\text{C}$$

188. (c)



Maximum bending stress at any section x-x.

$$b_x = \frac{b}{l}x$$

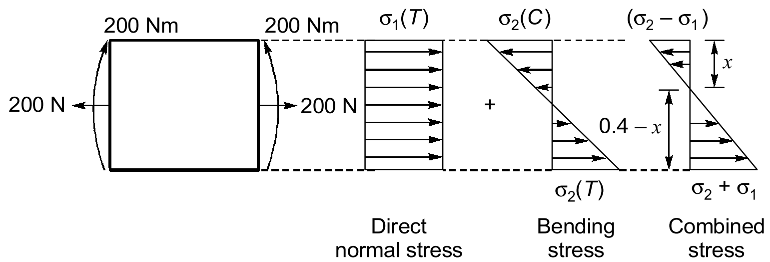
$$I_x = \frac{b_x d^3}{12}$$

$$\therefore \quad (\sigma_{max})_x = \frac{M}{I_x} y_{max} = \frac{\frac{wx^2}{2} \cdot \frac{d}{2}}{\left(\frac{b_x d^3}{12}\right)}$$

$$\therefore \quad (\sigma_{max})_x = \frac{3wx^2}{b_x d^2} = \frac{3wlx}{bd^2}$$

$$\therefore \quad (\sigma_{max})_x \propto x$$

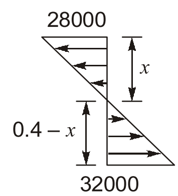
189. (b)



$$\text{Direct normal stress } \sigma_1 = \frac{200}{0.4 \times 0.25} = 2000 \text{ N/m}^2$$

$$\text{Bending stress } \sigma_2 = \frac{M}{I} \cdot y_{max} = \frac{200}{\left(\frac{0.25 \times 0.4^3}{12}\right)} \times 0.2$$

$$= 30000 \text{ N/m}^2$$



The distance from top surface at which normal stress is zero be x.

$$\frac{x}{28000} = \frac{0.4 - x}{32000}$$

$$\therefore \quad x = (0.4 - x)\frac{7}{8}$$

$$\therefore \quad x = 0.1866 \text{ m}$$

190. 9.1 (9.0 to 9.3)

According to maximum principal strain theory,

$$\frac{\sigma_1}{E} - \mu\frac{\sigma_2}{E} \leq \frac{\sigma_y / FOS}{E}$$

$$\therefore \quad \sigma_1 - \mu\sigma_2 \leq \frac{\sigma_y}{FOS}$$

Here,
$$\sigma_1 = \sigma_h = \text{Circumferential stress} = \frac{pd}{2t}$$

$$\sigma_2 = \sigma_L = \text{Longitudinal stress} = \frac{pd}{4t}$$

$$\therefore \quad \frac{pd}{2t} - \frac{\mu pd}{4t} \leq \frac{\sigma_y}{FOS}$$

$$\therefore \quad t \geq \frac{FOS}{\sigma_y}\left[\frac{pd}{2} - \frac{\mu pd}{4}\right]$$

$$t \geq \frac{2}{280}\left[\frac{6\times 500}{2} - \frac{0.3\times 6\times 500}{4}\right]$$

$$t \geq 9.1071 \text{ mm}$$

191. 3(3 to 3)

$$\Sigma\text{Torque} = 0$$

$$T_R - (4 \times 4) + 4 = 0$$

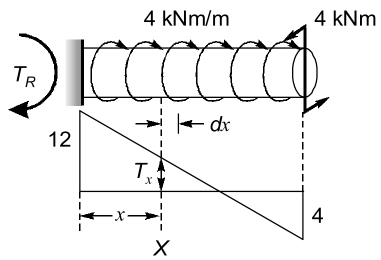
$$T_R = 12 \text{ kNm}$$

Consider an element of length 'dx' at any section x – x at x distance from fixed end.

∴ Angle of twist of element

$$\theta_x = \int_0^x \frac{T_x . dx}{G . I_P} = \int_0^x \frac{(12 - 4x)\,dx}{G I_P}$$

$$= \frac{(12x - 2x^2)}{G I_P}$$



Torque diagram

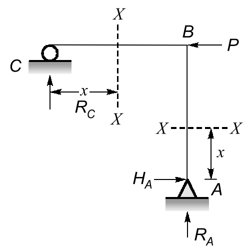
For maximum angular twist

$$\frac{d\theta_x}{dx} = 0$$

$$\frac{12 - 4x}{G I_P} = 0$$

$$x = 3 \text{ m}$$

192. (c)



$$\Sigma F_V = 0; \qquad R_A + R_C = 0$$

$$\Sigma F_H = 0; \qquad H_A = P$$

$$\Sigma M_C = 0; \qquad H_A L + R_A L = 0$$

$$R_A = -H_A = -P$$

Now
$$\Delta_{B_H} = \frac{\partial U}{\partial P} = \frac{\partial U_{BC}}{\partial P} + \frac{\partial U_{AB}}{\partial P}$$

$$U_{BC} = \int_0^L \frac{Mx_{AB}^2\,dx}{2EI} = \int_0^L \frac{(R_C.x)^2\,dx}{2EI}$$

$$= \int_0^L \frac{P^2x^2dx}{2EI} = \frac{P^2L^3}{6EI}$$

$$U_{AB} = \int_0^L \frac{Mx_{AB}^2\,dx}{2EI} = \int_0^L \frac{(H_A.x)^2\,dx}{2EI}$$

$$= \int_0^L \frac{P^2x^2dx}{2EI} = \frac{P^2L^3}{6EI}$$

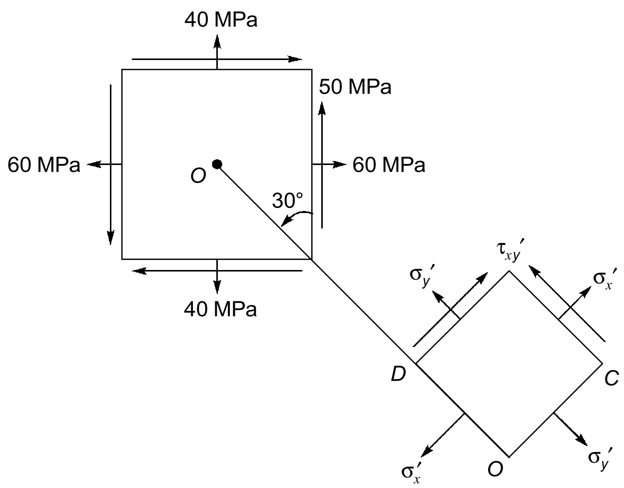
$\therefore$
$$\Delta_{B_H} = \frac{\partial}{\partial P}\left(\frac{2P^2L^3}{6EI}\right) = \frac{2PL^3}{3EI}$$

193. 0.272 (0.260 to 0.280)

$$\sigma_x = 60 \text{ MPa}$$

$$\sigma_y = 40 \text{ MPa}$$

$$\tau_{xy} = 50 \text{ MPa}$$



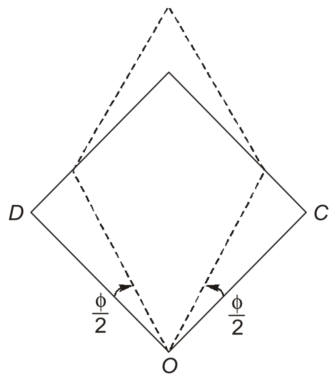
$$\tau'_{xy} = -\left(\frac{\sigma_x - \sigma_y}{2}\right)\sin 2\theta + \tau_{xy}\cos 2\theta$$

$$= -\left(\frac{60-40}{2}\right)\sin 60° + 50\cos 60°$$

$$= -5\sqrt{3} + 25$$

$$= 16.3397 \text{ MPa}$$

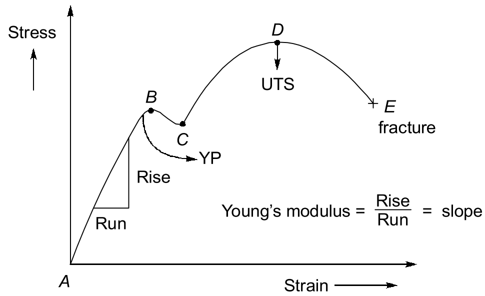
Change in angle between OC and OD



$$\phi = \frac{\tau'_{xy}}{G}$$

$$\therefore \quad \phi = \frac{16.3397}{60 \times 10^3} = 0.2723 \times 10^{-3}$$

194. (d)



Necking starts from ultimate tensile strength and ends at the point of failure of specimen.

195. (d)

When both ends are hinged, the buckling load is given by

$$P_{\text{critical}} = \frac{\pi^2 EI}{L^2}$$

$$\Rightarrow \quad 200 = \frac{\pi^2 EI}{L^2}$$

When the lateral movement at the mid height is restrained, then buckling load

$$\text{Buckling load} = \frac{\pi^2 EI}{L_1^2} \qquad \left(\text{where, } L = \frac{L}{2}\right)$$

$$= \frac{4\pi^2 EI}{L^2}$$

$$= 4 \times 200 = 800 \text{ N}$$

196. (9.50) (9.0 to 9.9)

Given: $b_1 = 100$ mm, $b_2 = 75$ mm, $t_f = 10$ mm, $h = 360$ mm

$$\text{Position of shear centre, } e = \frac{h^2 t_f \left(b_1^2 - b_2^2\right)}{4I_z}$$

$$I_z = I_{web} + 2I_{flange}$$

$$= \frac{10 \times 350^3}{12} + 2\left[\frac{175 \times 10^3}{12} + 175 \times 10\left(\frac{350}{2} + 5\right)^2\right]$$

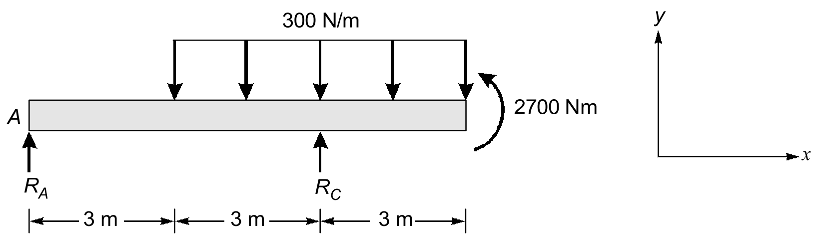
$$= 1.492 \times 10^8 \text{ mm}^4$$

$$e = \frac{360^2 \times 10 \times \left(100^2 - 75^2\right)}{4 \times 1.492 \times 10^8} = 9.50 \text{ mm}$$

197. (a, c, d)

198. (c, d)

199. (b, c)



$$\sum M_A = 0$$

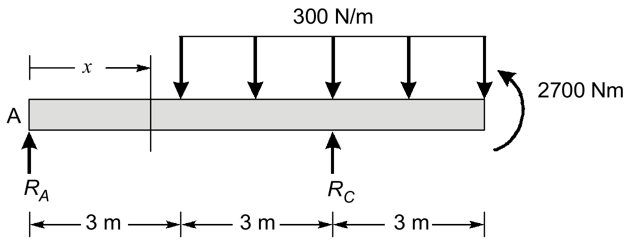
$\Rightarrow$ $300 (6) (3 + 3) - R_C (6) - 2700 = 0$

$\Rightarrow$ $R_C = 1350$ N

$$\sum F_y = 0$$

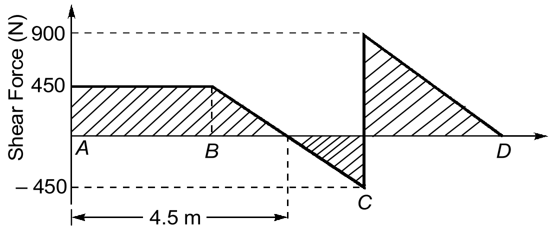
$\Rightarrow$ $R_A + R_C = 300 (6)$

$\Rightarrow$ $R_A = 450$ N



$V = 450$ N ; $0 \le x < 3\text{m}$

$$V = [450 - 300\,(x - 3)]\ \text{N} \quad ; \quad 3\ \text{m} \le x < 6\ \text{m}$$
$$V = [450 - 300\,(x - 3) + 1350]\ \text{N} \quad ; \quad 6\ \text{m} \le x < 9\ \text{m}$$



200. **(c, d)**

Given: G = 70 GPa, K = 150 GPa

$$E = 2G(1 + \mu) = 3K(1 - 2\mu)$$

$$\frac{3K}{2G} = \frac{(1+\mu)}{(1-2\mu)}$$

$$\frac{3\times 150}{2\times 70} = \left(\frac{1+\mu}{1-2\mu}\right)$$

$$450 - 900\,\mu = 140 + 140\,\mu$$

$$\mu = \frac{450-140}{900+140} = 0.298$$

$$E = 2G(1 + \mu) = 2 \times 70(1 + 0.3)$$
$$= 182\ \text{GPa}$$

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