GATE 2016 – A Brief Analysis

(Based on student test experiences in the stream of ME on 30th January, 2016 – (Forenoon Session)

Section wise analysis of the paper

Section Classification	1 Mark	2 Marks	Total No of Questions
Engineering Mathematics	5	5	10
Engineering Mechanics	2	2	4
Strength of Materials	4	4	8
Design of Machine Elements	0	1	1
Theory of Machines	1	2	3
Vibrations	1	1	2
Fluid Mechanics	3	4	7
Thermal Science	2	3	5
Heat Transfer	2	2	4
Manufacturing Science	4	4	8
Industrial Engineering	1	2	3
Verbal Ability	3	0	3
Numerical Ability	2	5	7
	30	35	65

Type of Questions asked from each section

Engineering Mechanics	Questions came from friction, equilibrium equations, trusses.
Strength of materials	Questions came from simple stress and strain, stress – strain graph, deflection of beam, Hardness test, Torsion of circular shaft, Bending stress, Helical spring, Moment of Inertia.
Machine design	Questions came from failure theory
Theory of machines	Questions came from Gear train, Gyroscope, fly wheel, rotating masses.
Vibrations	Questions came from Resonance, single degree of freedom of free vibration.
Fluid mechanics	Questions came from boundary layer, flow through pipe, turbulent flow, stability of floating bodies, turbine, manometry,
Thermal Science	Questions came from work done in non flow process, thermodynamic relation, and thermodynamic system, Vapour compression cycle, regeneration vapour cycle.
Heat transfer	Questions came from radiation, unsteady heat conduction.
Manufacturing Science	Questions came from riser design, rolling, casting, welding, non traditional machining process, cutting tool.
Industrial Engineering	Questions came from LPP, Inventory

Questions from the Paper

General Aptitude

1. Despite the new medicine's ________ in treating diabetes, it is not ________ widely.
(A) effectiveness – prescribed (B) availability – used
(C) prescription – available (D) acceptance – proscribed

Key: (A)

2. If $q^{-a} = \frac{1}{r},\ r^{-b} = \frac{1}{s}$ and $s^{-c} = \frac{1}{q}$, then the value of a.b.c is ________.
(A) $(rqs)^{-1}$ (B) 0 (C) 1 (D) r + q + s

Key: (C)

Exp: $q^{-a} = \frac{1}{r},\ r^{-b} = \frac{1}{s},\ s^{-c} = \frac{1}{q}$

$q^{a} = r,\ r^{b} = s,\ s^{c} = q$

$r = q^{a} = \left(s^{c}\right)^{a} = s^{ac}$

$s = r^{b} = \left(s^{ac}\right)^{b} = s^{abc} \Rightarrow abc = 1$

3. Leela is older than her cousin Pavithra, Pavithra's brother shiva is older than Leela when Pavithra & Shiva are visiting Leela, all the three like to play chess together, Pavithra wins more often than Leela does.
Which is true on the basis of above statement?
(A) When Shiva plays chess with Leela and Pavithra, he often loses
(B) Leela is oldest of the three
(C) Shiva is better chess player than Pavithra
(D) Pavithra is the youngest of the three.

Key: (D)

4. Michel lives 10 km away from where I live, Ahmed lives 5 km and Susan lives 7 km away from where I live. Arun is farther away then Ahmed, but closer than Susan from where I live. From the information provided, what is one possible distance (in km) at which of I live from Arun
(A) 3.1 (B) 4.99 (C) 6.02 (D) 7.01

Key: (C)

5. Mount Everest is
(A) the highest peak in the world. (B) highest peak in the world
(C) one of highest peak in the world (D) one of the highest peak in the world.

Key: (A)

6. Policemen asked the victim of a theft, "What did you _______?"
(A) loose (B) lose (C) loss (D) louse

Key: (B)

Technical

1. An ideal gas undergoes a reversible process in which the pressure varies linearly with volume. The condition at the start (subscript 1) and at the end (subscript 2) of the process with usual notations are P_1 = 100 kPa, V_1 = 0.2 m^3 and P_2 = 200 kPa, V_2 = 0.1 m^3 and the gas constant R = 0.275 kJ/kg-K. The magnitude of work required for the process (in kJ) is ________.

Key: 22.5

Exp: Pressure varies linearly with volume.

P = a + bv.

$$P_1 = a + bv$$

$$\Rightarrow 100 = a + b\times 0.2 \quad -----(1)$$

$$P_2 = a + bv_2$$

$$\Rightarrow 200 = a + b\times 0.1 \quad -----(2)$$

Solving (1) & (2)

$$-100 = 0.1b \Rightarrow b = \frac{100}{0.1} = -1000$$

$$b = -1000$$

Substituting in any of the equations to get 'a'.

$$\Rightarrow 100 = a + (-1000\times 0.2) \Rightarrow \qquad a = 300$$

$$\therefore W = \int_1^2 p\,dv = \int_1^2 (a + bv)\,dv$$

$$= \int_1^2 (300 - 1000v)\,dv = 300(v_2 - v_1) - 1000\left(\frac{v_2^2 - v_1^2}{2}\right)$$

$$= 300(0.1 - 0.2) - 500\left(\frac{(0.1)^2 - (0.2)^2}{2}\right) = -30 - (-7.5) = -22.5\text{kJ}$$

$\therefore$ Magnitude of work required is 22.5 kJ.

2. For water 25°C, $dP_s/dT_s = 0.189\,\text{kPa/K}$ (p_s is the saturation pressure in kPa and T is the saturation temperature in K) and the specific volume of dry saturated vapour is 43.38 m^3/kg. Assume that the specific volume of liquid is negligible in comparison with that of vapour. Using the Clausius-Clapeyron equation, estimate the enthalpy of evaporation of water at $25°\text{C in}(\text{kJ/kg})$ is_____.

Key: 2443.24

Exp:
$$\frac{dP_s}{dT_s} = \frac{h_{fg}}{T_s(\nu_g - \nu_f)} \Rightarrow 0.189 = \frac{h_{fg}}{(25+273)(43.38-0)}$$

$$\Rightarrow h_{fg} = 2443.248\,\text{kJ/kg}$$

3. Oil (Kinematic Viscosity, $\nu_{oil} = 1\times10^{-5}\, m^2/s$) flows through a pipe of 0.5m diameter with a velocity of 10 m/s $\left(\text{kinematic viscosity}, \nu_w = 0.89\times10^{-6}\, m^2/s\right)$ is flowing through a model pipe of diameter 20 mm. For satisfying the dynamic similarity, the velocity of water (in m/s) is _____.

Key: 22.25

Exp: Dynamic similarity

$$(\text{Re})_{oil} = (\text{Re})_{water}$$

$$\left(\frac{ud}{\nu}\right)_{oil} = \left(\frac{ud}{\nu}\right)_{water}$$

$$\frac{0.5\times10}{1\times10^{-15}} = \frac{0.02\times u_{water}}{0.89\times10^{-6}}$$

$$u_{water} = 22.25\, m/s$$

4. A 300 mm thick slab is being cold rolled using roll of diameter 600 mm. If co-efficient of friction is 0.08, the maximum possible reduction (in mm) is _______.

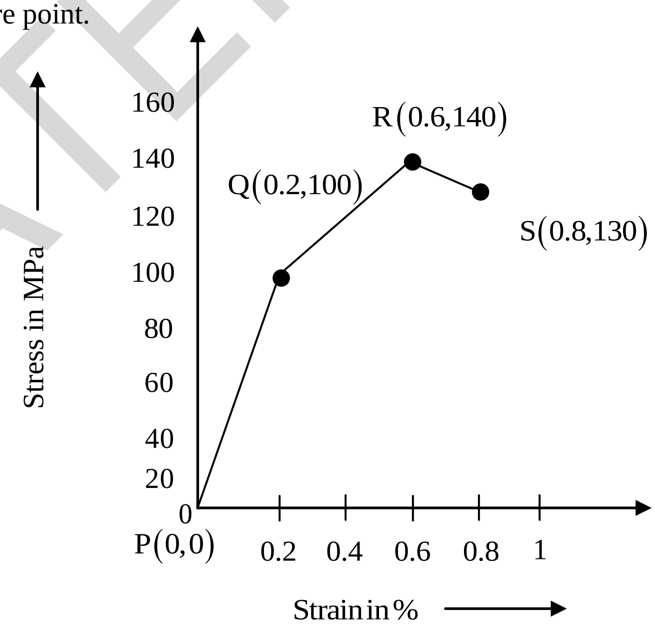
Key: 1.92

Exp: $(\Delta h)_{max} = \mu^2 R$

$$= (0.08)^2 \times 300$$

$$= 1.92\text{ mm}$$

5. A hypothetical engineering stress-strain curve shown in the figure has 3 straight lines PQ, QR, RS with co-ordinate P (0,0), Q(0.2, 100), R(0.6, 140) and S (0.8, 130). Q is the yield point, R is UTS point and S is fracture point.



The toughness of the material. (in MJ/m^3) is _______.

Key: 0.85

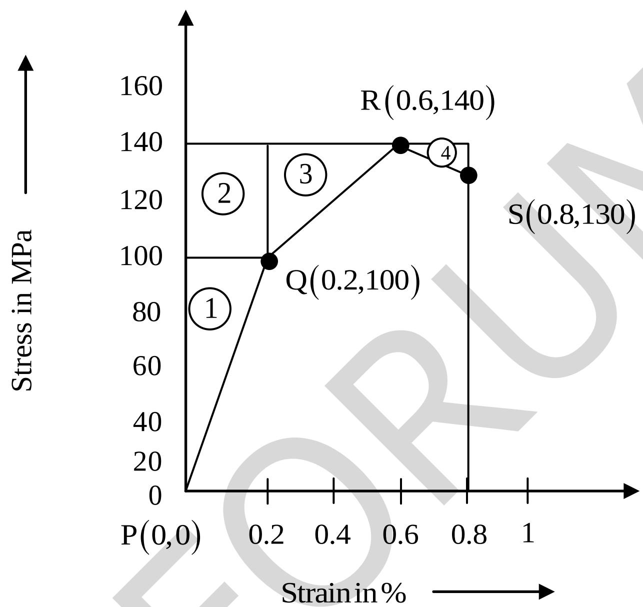
Exp: Toughness of material

Total area – [Area of 1 + Area of 2 + Area of 3 + Area of 4]

$$=\left(140\times\frac{0.8}{100}\right)-\left[\left\{\frac{1}{2}\times100\times\frac{0.2}{100}\right\}+\left\{40\times\frac{0.2}{100}\right\}+\left\{\frac{1}{2}\times40\times\frac{0.4}{100}\right\}+\left\{\frac{1}{2}\times10\times\frac{0.2}{100}\right\}\right]$$

$$=1.12-[0.1+0.08+0.08-0.01]$$

$$=0.85\,\mathrm{MJ/m^3}$$



6. A steel ball of 10 mm diameter at 1000 K is required to be cooled to 350 K by immersing it in a water environment at 300 K. The convective heat transfer coefficient is 1000 W/m^2-K. Thermal conductivity of steel is 40 W/m-K. The time constant for the cooling process τ is 16s. The time required (in-sec) to reach the final temperature is ______.

Key: 42.22

Exp: Given

d = 10 mm = 0.01 m

$$t_i=1000K; t=350K; t_\infty=300K; \quad k=40\,\frac{W}{mK}; h=1000\,\frac{W}{m^2K}; \tau_{th}=16s$$

$$\frac{t-t_\infty}{t_i-t_\infty}=e^{-\tau/\tau_{th}}$$

$$\ln\left(\frac{t-t_\infty}{t_i-t_\infty}\right)=-\tau/\tau_{th}$$

$$\ln\left(\frac{350-300}{1000-300}\right)=-\tau/16$$

$$\tau=42.22s$$

7. A cylindrical job with diameter of 200 mm and height of 100 mm is to be cast using modulus method of riser design. Assume that the bottom surface of cylindrical riser does not contribute as cooling surface. If the diameter of the riser is equal to its height, then the height of the riser (in mm) is

(A) 150 (B) 200 (C) 100 (D) 125.

Key: (A)

Exp: $d_c = 200\text{ mm}$ $d_r = h_r$ $C = \text{Casting}$

$h_c = 100\text{ mm}$ $h_r = ?$ $R = \text{Rises}$

$M_r = 1.2\,M_C$

$$\left(\frac{V}{S}\right)_r = 1.2\left(\frac{V}{S}\right)_C$$

$$\frac{\frac{\pi}{4}d_r^2 hr}{\pi d_r h_r + \frac{\pi}{4}d_r^2} = 1.2\ \frac{\frac{\pi}{4}d_c^2 h_c}{d_c h_c + \frac{\pi}{4}d_c^2 x^2}$$

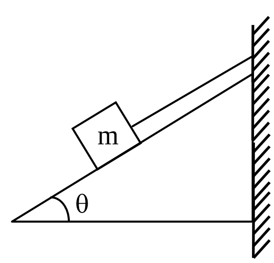
$$= \frac{dr^2 h_r}{4d_r h_r + d_r^2} = \frac{1.2d_c^2 h_c}{4d_c h_c + 2d_c^2}$$

$$= \frac{h_r^3}{4h_r^2 + h_r^2} = \frac{1.2\times(200)^2\times 100}{4\times 200\times 100 + 2\times 200^2}$$

$$= \frac{h_r}{5} = 1.2\times\frac{200\times 10}{4\times 100 + 2\times 200}$$

$$= h_r = 1.2\times 5\times\frac{200\times 100}{4\times 200} = 125\times 1.2 = 150$$

8. A block of mass m rests on an inclined plane and is attached by a string to the wall as shown in the figure. The coefficient of static friction between plane and the block is 0.25. The string can withstand a maximum force of 20 N. The maximum value of mass (m) for which the string will not break and the block will be in static equilibrium is _______ kg.



Take $\cos\theta = 0.8$ and $\sin\theta = 0.6$

Acceleration due to gravity g = 10 m/s^2

Key: 5

Exp: $F = \mu R = \mu\, mg\cos\theta$

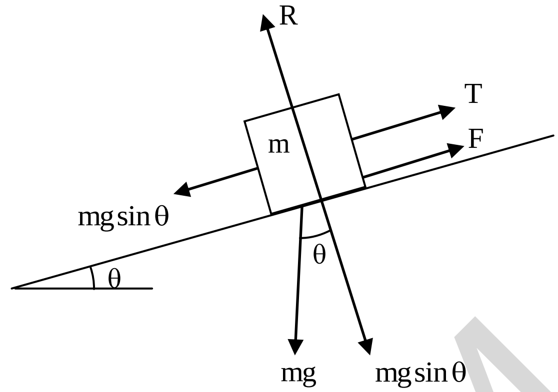
$= 0.25 \times m \times 10 \times 0.8$

$= 2m$

For equilibrium,

$T + F = mg\sin\theta$

$\Rightarrow 20 + 2m = m \times 10 \times 0.6 \Rightarrow m = 5\,kg$



9. A fluid (Prandtl No. Pr = 1) at 500 K flow over a flat plate of 1.5 m length maintained at 300K and the velocity of the fluid is 10 m/s. Assuming kinetic viscosity $(\nu) = 30 \times 10^{-6}\, m^2/s$, the thermal boundary layer thickness (in mm) at 0.5m from the leading edge is ____.

Key: 6.124

Exp: Pr = 1

$$Re_x = \frac{ux}{\nu} = \frac{10 \times 0.5}{30 \times 10^{-6}}$$

$$= 166666.67$$

$$= 1.67 \times 10^5$$

Hydrodynamic boundary layer thickness

$$\delta_{h_x} = \frac{5x}{\sqrt{Re_x}} = \frac{5 \times 0.5}{\sqrt{1.67 \times 10^5}}$$

$$= 6.124 \times 10^{-3}\, m$$

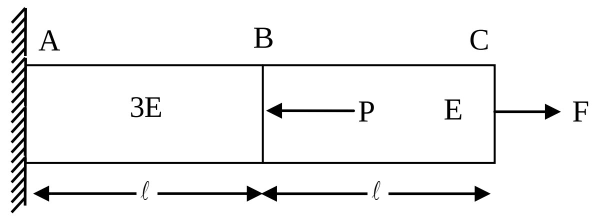
If Pr = 1

$$\delta_{h_x} = \delta_{T_x} = 6.124 \times 10^{-3}\, m$$

$$= 6.124\, mm$$

$\therefore$ Thermal boundary layer thickness = 6.124 mm.

10. A horizontal bar with a constant cross section is subjected to a loading as shown in the figure. The Young's modulus for the section AB and BC are 3E and E respectively.



For the deflection C to be zero, the ratio of P/F is _____.

Key: 3

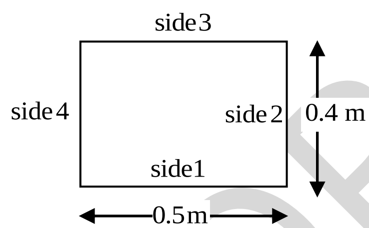
Exp: Since deflection of C is zero

$$\Rightarrow \delta\ell_{AB} = \delta\ell_{BC}$$

$$\frac{P\ell}{3E \times A} = \frac{F\ell}{E \times A}$$

$$P/F = 3$$

11. An infinitely long furnace of 0.5m × 0.4 m cross-section is shown in the figure below. Consider all surfaces of the furnace to be black. The top and bottom walls are maintained at temperatures $T_1 = T_3 = 927^oC$ and the side walls are at temperature $T_2 = T_4 = 527^oC$. The view factor F_{1-2} is 0.26. The net radiation heat loss or gain on side 1 is _______ W/m



Key: 12265.34

Exp: $\sigma = 5.67 \times 10^{-8}\ W/m^2K^4$

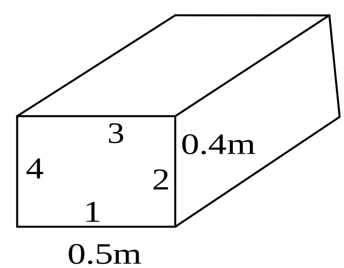
$T_1 = 927 + 273 = 1200K$

$T_2 = 527 + 273 = 800K$

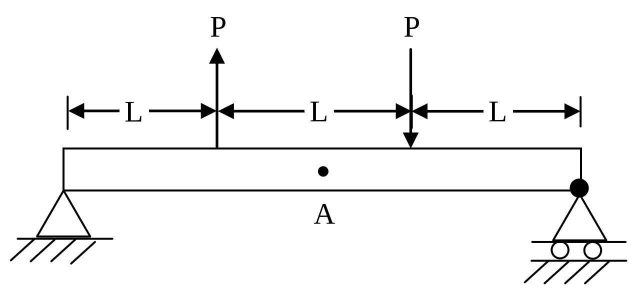
$$Q_{1-2} = \sigma A_1 F_{1-2}\left(T_1^4 - T_2^4\right)$$

$$= 5.67 \times 10^{-8} \times (0.5 \times 1) \times 0.26\left(1200^4 - 800^4\right)$$

$$= 12265.344\ W/m$$

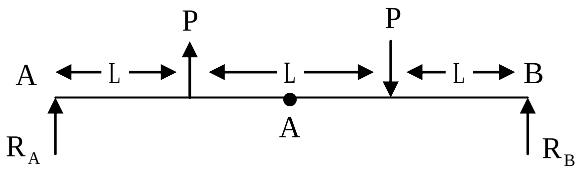


12. A simply supported beam of length 3L is subjected to the loading shown in the Figure. It is given that P = 1N, L= 1 m and Young's modulus = 200 GPa, The cross-sectional is a square with dimension 10 mm×10mm. The bending stress in (Pa) at the point A located at the top surface of the beam at a distance of 1.5 L, from the left end is___.



Key: 0

Exp:



Taking moment about B

$\Sigma M_B = 0 \Rightarrow R_A \times 3L + P \times 2L - PL = 0 \Rightarrow R_A = -P/3$

$\Sigma F_y = 0 \Rightarrow R_B + R_A = 0 \Rightarrow R_B = P/3$

Taking moment about A

$\Sigma M_A = 0$

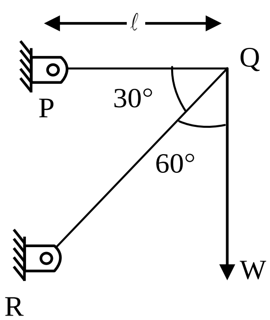
$R_A \times 1.5L + 0.5PL = M_A$ $\quad$ (Assuming M_A anticlockwise)

$\Rightarrow -\frac{P}{3} \times 1.5 + 0.5PL = M_A$

$\Rightarrow M_A = 0$

we know, $\frac{M}{I} = \frac{\sigma_b}{y} \Rightarrow \sigma_b$ (Bending stress) $= 0$ $\quad$ since, $M_A = 0$

13. A two member truss PQR is supporting a load W. The axial forces in member PQ and QR are respectively.



(A) 2W tensile and $\sqrt{3}$W compressive

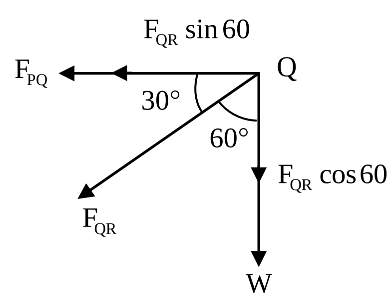
(B) $\sqrt{3}$W tensile and 2W compressive

(C) $\sqrt{3}$ W compressive and 2W tensile

(D) 2W compressive and $\sqrt{3}$W tensile

Key: (B)

Exp: F.B.D of point Q



$\Sigma F_x = 0$

$\Rightarrow F_{PQ} + F_{QR} \sin 60 = 0$ ...... (1)

$\Sigma F_y = 0$

$\Rightarrow F_{QR} \cos 60 + W = 0$ ....(2)

$\Rightarrow F_{QR} = \frac{-W}{\cos 60} \Rightarrow F_{QR} = 2W$ (compressive)

From equation (1)

$F_{PQ} - 2W \sin 60 = 0$

$\Rightarrow F_{PQ} = 2W \times \frac{\sqrt{3}}{2} = \sqrt{3}W$ (Tensile)

14. In an orthogonal cutting process the tool used has rake angle of zero degree. The measured cutting force and thrust force are 500 N & 250 N, respectively. The coefficient of friction between tool and chip is___.

Key: 0.5

Exp: $\text{Tan}(\beta-\alpha)=\dfrac{F_t}{F_C}$

$$\text{Tan}(\beta-0)=\frac{250}{500}$$

$$\text{Tan}\beta=\frac{1}{2}=0.5$$

15. For a floating body, buoyant force acts at the
(A) Centroid of floating body,
(B) C.G of body
(C) Centroid of fluid vertically below the body
(D) Centroid of displaced fluid

Key: (D)

16. Consider two Hydraulic turbines having identical specific speed and effective head at inlet. If the speed ratio (N_1/N_2) of the two turbines is 2, then the ratio of respective power (P_1/P_2) is___.

Key: 8

Exp: $\dfrac{P_1}{P_2}=\left(\dfrac{N_1}{N_2}\right)^3=2^3=8$

17. The spring constant of a helical compression spring doesn't depend on
(A) Coil diameter (B) Material strength
(C) Number of active turns (D) Wire diameter

Key: (B)

Exp: For Helical compression spring.

Deflection, $\delta=\dfrac{64\,\omega R^3 n}{Gd^4}$

Stiffness, or spring constant $=\dfrac{W}{\delta}=\dfrac{W}{\dfrac{64\,WR^3n}{Gd^4}}=\dfrac{Gd^4}{64R^3n}$

From the above formula we can say that spring constant depends on coil diameter (D), wire diameter (d), No. of active turns (n) and modulus of rigidity (G) and is independent of material strength.

18. A single degree of freedom spring mass system with viscous damping has a spring constant of 10 kN/m. The system is excited by a sinusoidal force of amplitude 100 N. If the damping factor (ratio) is 0.25, the amplitude of steady state oscillation at resonance is ___mm.

Key: 20

Exp: $k = 10\times10^3\ \text{N}/\text{m}$

$A = 100\ \text{N}$

$\xi = 0.25$

$$\text{M.F} = \frac{1}{\left(\left(1-\left(\frac{\omega}{\omega_n}\right)^2\right)^2 + \left(2\xi.\frac{\omega}{\omega_n}\right)^2\right)^{1/2}} \Rightarrow \frac{A}{F_o/k} = \frac{1}{\left(\left(\left(1-\left(\frac{\omega}{\omega_n}\right)^2\right)^2 + \left(2\xi\frac{\omega}{\omega_n}\right)^2\right)\right)^{1/2}}$$

$$\Rightarrow A = \frac{100}{10\times10^3\times(2\times0.25)} = \frac{100}{5000} = 20\text{mm}$$

19. Max $z = 15x_1 + 20x_2$

Subject to

$12x_1 + 4x_2 \geq 36$

$12x_1 - 6x_2 \leq 24$

$x_1, x_2 \geq 0$

The above LPP has

(A) Infeasible solution, (B) Unbounded solution

(C) Alternative optimum solution (D) Degenerate solution

Key: (B)

Exp: Max $z = 15x_1 + 20x_2$

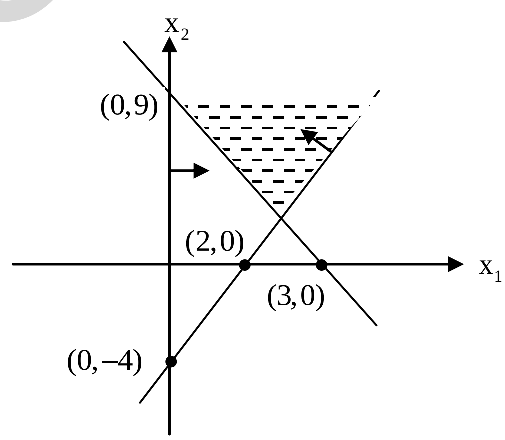
Subject to

$12x_1 + 4x_2 \geq 36$

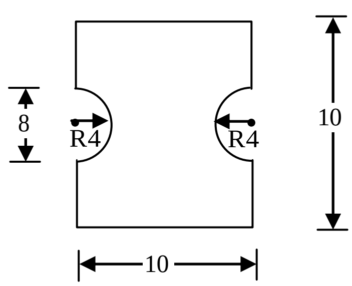
$12x_1 - 6x_2 \leq 24$

$x_1, x_2 \geq 0$

Since, there is no limitation of boundary for the feasible region therefore, the LPP has unbounded solution.



20. The figure shows Cross-section of a beam subjected to bending. The are moment of inertia (in mm^4) of this cross-section about its base is ____.



Key: 1875.63

Exp: By using parallel axis theorem

Area moment of inertia about its base

$$=\left\{\frac{10\times10^{3}}{12}+\left(10\times10\times5^{2}\right)\right\}-\left\{\left(\frac{\pi}{64}\times8^{4}\right)+\pi\times4^{2}\times5^{2}\right\}$$

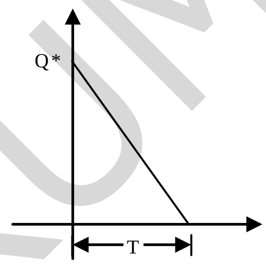
$$=3333.33-1457.69=1875.63\,\text{mm}^{4}$$

21. The annual demand for an item is 10,000 units. The unit cost is Rs.100 and inventory carrying charges is 14.4 % of unit cost per annum. The cost of one procurement is Rs 2000.
The time between two consecutive orders to meet the above demand is ___ month(s).

Key: 2

Exp: D= 10,000, Cu = Rs 100, C_h= 0.144×Cu, C_o=Rs 2,000.

$$Q^{*}=\sqrt{\frac{2DC_0}{C_h}}=\sqrt{\frac{2\times10,000\times2000}{0.144\times100}}=1666.67\,\text{units}$$

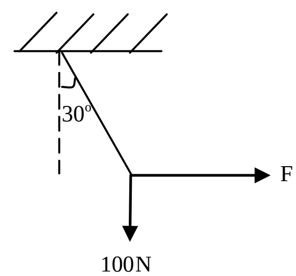


$$\text{We know } T=\frac{Q^{*}}{D}=\frac{1666.67}{10,000}=0.1667\,\text{years} = 2 \text{ months}$$

22. The Non traditional machining process that essentially, requires vacuum is
(A) Electron beam machining
(B) Electro-chemical machining
(C) Electro chemical discharge machining
(D) Electrical discharge machining.

Key: (A)

23. A rigid ball of weight 100 N is suspended with the help of a string. The ball is pulled by a horizontal force F such that the string makes and angle 30^{o} with the vertical. The magnitude of force F (in N) is __.

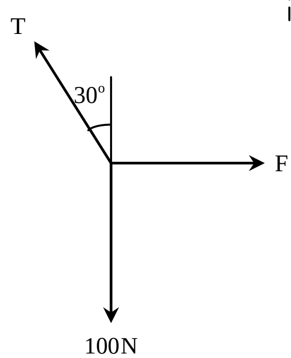


Key: 57.735

Exp: Applying Lami's theorem

$$\frac{T}{\sin 90}=\frac{100}{\sin(90+30)}=\frac{F}{\sin(180-30)}$$

$$F=57.735\,\text{N}$$



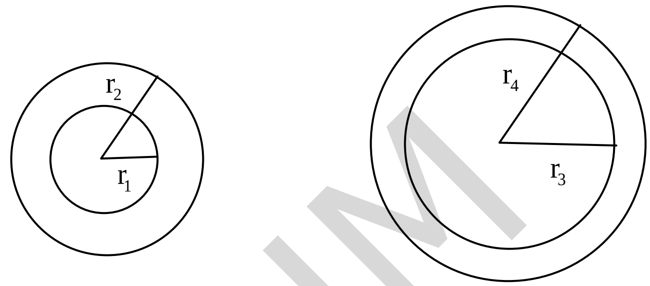
24. Which of the following statement are true regarding Heat and work?
(i) Boundary phenomena (ii) Exact differential (iii) Path function
(A) Both (i) & (ii), (B) Both (i) & (iii),
(C) Both (ii) & (iii) (D) Only (iii).

Key: (B)

25. Jominy test is used to find
(A) Young's Modulus (B) Hardenability
(C) Yield stress (D) Thermal conductivity

Key: (B)

26. The cross-section of two hollow bars made of same material and concentric circles are shown in the figure. It is given that $r_3 > r_1$ and $r_4 > r_2$ and that of area of cross-section are same. J_1 and J_2 are torsional rigidity of the bars left and right respectively. The ratio of J_2 / J_1 is



(A) >1 (B) <0.5 (C) =1 (D) between 0.5&1.

Key: (A)

Exp: $\text{Torsional rigidity}(J) = \text{shear modulus} \times \text{polar moment of inertia}$

$$\frac{J_2}{J_1} = \frac{G_1 \times \frac{\pi}{2}\left(r_4^4 - r_3^4\right)}{G_2 \times \frac{\pi}{2}\left(r_2^4 - r_1^4\right)} = \frac{r_4^4 - r_3^4}{r_2^4 - r_1^4} \quad \left(\because G_1 = G_2\right) \quad \text{\_\_\_\_\_(i)}$$

Area of C/S is same

$$\Rightarrow \pi\left(r_2^2 - r_1^2\right) = \pi\left(r_4^2 - r_3^2\right)$$

$$\Rightarrow r_2^2 - r_1^2 = r_4^2 - r_3^2 \qquad \text{\_\_\_\_\_\_}(ii)$$

From equation (1)

$$\frac{J_2}{J_1} = \frac{\left(r_4^2 + r_3^2\right)\left(r_4^2 - r_3^2\right)}{\left(r_2^2 + r_1^2\right)\left(r_2^2 - r_1^2\right)} = \frac{\left(r_4^2 + r_3^2\right)}{\left(r_2^2 + r_1^2\right)}$$

$$\text{but } r_4^2 + r_3^2 > r_2^2 + r_1^2 \qquad \text{since, } r_3 > r_1 \text{ and } r_4 > r_2$$

$$\Rightarrow \frac{J_2}{J_1} > 1$$

27. The part of a gating system which regulates the rate of pouring of molten metal is___.
(A) Pouring basin (B) Runner (C) Choke (D) Ingate

Key: (C)

28. A Cantilever beam having square cross-section of side a is subjected to an end load. If a is increased by 19%, the tip deflection decreased approximately by
(A) 19% (B) 29% (C) 41% (D) 50%

Key: (D)

Exp: $\delta = \frac{p\ell^3}{3EI} \Rightarrow \delta\alpha\frac{1}{I} \Rightarrow \delta\alpha\frac{1}{a^4}$

$\frac{\delta_1}{\delta_2} = \frac{a_2^4}{a_1^4}$ where, $a_2 = 1.19a$,

$\Rightarrow \frac{\delta_1}{\delta_2} = (1.19)^4 \Rightarrow \delta_2 = \frac{\delta_1}{(1.19)^4} = 0.5\delta_1$

So, deflection decrease by 50%

29. The instantaneous stream wise velocity of a turbulent flow is given as follows $u(x,y,z,t) = \bar{U}(x,y,z) + U'(x,y,z,t)$.

The time average of fluctuating velocity $v'(x,y,z,t)$ is

(A) $\frac{U'}{2}$ (B) $\frac{-\bar{U}}{2}$ (C) 0 (D) $\frac{\bar{U}}{2}$

Key: (C)

Exp: Instantaneous velocity $= u(x,y,z,t) = \bar{U}(x,y,z) + u'(x,y,z,t)$

Time average of fluctuating velocity should be zero.

30. Under optimal condition of the process the temperature experienced by a copper work piece in fusion welding, brazing and soldering are such that

(A) $T_{welding} > T_{soldering} > T_{brazing}$ (B) $T_{Soldering} > T_{Welding} > T_{Brazing}$

(C) $T_{brazing} > T_{welding} > T_{soldering}$ (D) $T_{welding} > T_{brazing} > T_{soldering}$

Key: C