CBCS SCHEME

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17MAT31

Third Semester B.E. Degree Examination, Feb./Mar.2022
Engineering Mathematics – III

Time: 3 hrs.

Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. Find a Fourier Series to represent $f(x) = x - x^2$ from $x = -\pi$ to $x = \pi$. Hence prove that $\frac{\pi^2}{12} = \frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} \ldots$ **(08 Marks)**

b. Obtain a Fourier series of $f(x) = \begin{cases} x, & 0 < x < 1 \\ 0, & 1 < x < 2 \end{cases}$. **(06 Marks)**

c. Find the half-range Fourier sine series of $f(x) = e^x$ in $0 < x < 1$. **(06 Marks)**

OR

2 a. Find the Fourier series expansion upto second harmonic using the following table of values:

x	0	$\frac{\pi}{3}$	$\frac{2\pi}{3}$	π	$\frac{4\pi}{3}$	$\frac{5\pi}{3}$	2π
y	1.0	1.4	1.9	1.7	1.5	1.2	1.0

(08 Marks)

b. Express $f(x) = (\pi - x)^2$ as a Fourier series of period 2π in the interval $0 < x < 2\pi$. **(06 Marks)**

c. Obtain the Half range cosine series of $f(x) = x^2$ in $0 \le x \le \pi$. **(06 Marks)**

Module-2

3 a. Find the Fourier transform of the function, $f(x) = \begin{cases} 1, & \text{for } |x| \le a \\ 0, & \text{for } |x| > a \end{cases}$ and hence evaluate $\int_0^\infty \frac{\sin ax}{x} dx$. **(08 Marks)**

b. Find the Fourier cosine transform of $f(x) = e^{-ax}$, $a > 0$ **(06 Marks)**

c. Solve $u_n + 3u_{n-1} - 4u_{n-2} = 0$ for $n \ge 2$ given $u_0 = 3$, $u_1 = -2$ using z-transform. **(06 Marks)**

OR

4 a. Find the Fourier sine transform of e^{-ax}, a>0, x>0 show that $\int_0^\infty \frac{x \sin mx}{a^2 + x^2} dx = \frac{\pi}{2} e^{-am}$, m>0. **(08 Marks)**

b. Find the z-transform of $\cosh\left(\frac{n\pi}{2} + \theta\right)$. **(06 Marks)**

c. Find the inverse z-transform of, $\frac{3z^2 + z}{(5z-1)(5z+2)}$. **(06 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-3

5 a. Find the correlation coefficient using the following table as values: (08 Marks)

x	65	66	67	67	68	69	70	72
y	67	68	65	68	72	72	69	71

b. Obtain an equation of the form $y = ax + b$ given that, (06 Marks)

x	0	5	10	15	20	25
y	12	15	17	22	24	30

c. Apply Regula-Falsi method to find the root of $xe^x = \cos x$ in four approximations with four decimals in (0, 1). (06 Marks)

OR

6 a. Obtain the regression line of y on x for the following table of values: (08 Marks)

x	1	2	3	4	5	6	7	8	9
y	9	8	10	12	11	13	14	16	15

b. Fit a parabola $y = a + bx + cx^2$ to the following data: (06 Marks)

x	20	40	60	80	100	120
y	5.5	9.1	14.9	22.8	33.3	46

c. Find the root of the equation $x^4 - x - 9 = 0$ by Newton-Raphson method in three approximations with three decimal places. (Take $x_0 = 2$) (06 Marks)

Module-4

7 a. Use Newton's forward interpolation formula to find y(8) from the table of values, (08 Marks)

x	0	5	10	15	20	25
y(x)	7	11	14	18	24	32

b. Determine y at x = 1 using Newton's general interpolation formula given that, (06 Marks)

x	-4	-1	0	2	5
y(x)	1245	33	5	9	1335

c. Evaluate $\int_0^6 \frac{dx}{1+x^2}$ using Weddle's rule with h = 1. (06 Marks)

OR

8 a. Find f(4) using Newton's Backward interpolation formula given that,

x	0	1	2	3
y = f(x)	1	2	1	10

(08 Marks)

b. Apply Lagrange's interpolation formula to find y (x = 10) given that,

x	5	6	9	11
y(x)	12	13	14	16

(06 Marks)

c. Apply Simpson's $\frac{1}{3}^{rd}$ formula to evaluate $\int_0^{120} V(t)dt$ given that,

t	0	12	24	36	48	60	72	84	96	108	120
V(t)	0	3.60	10.08	18.90	21.60	18.54	10.26	5.40	4.5	5.4	9.0

(06 Marks)

Module-5

9 a. Verify Green's theorem in the plane for $\oint_C (3x^2 - 8y^2)dx + (4y - 6xy)dy$, where C is the boundary of the region defined by $x = 0$, $y = 0$, $x + y = 1$. (08 Marks)

b. Evaluate $\oint_C \vec{F}.\vec{dr}$ by Stoke's theorem with $\vec{F} = y^2\hat{i} + x^2\hat{j} - (x + z)\hat{k}$ and C is the boundary of the triangle with vertices at, (0, 0, 0), (1, 0, 0) and (1, 1, 0). (06 Marks)

c. Show that the geodesies on a plane are straight lines. (06 Marks)

OR

10 a. Find $\iint_S \vec{F}.\vec{dS}$, where $F = (2x + 3z)\hat{i} - (xz + y)\hat{j} + (y^2 + 2z)\hat{k}$ and S is the surface of the sphere having center at (3, -1, 2) and radius 3. (Use Gauss divergence theorem). (08 Marks)

b. Derive Euler's equation with usual notations as, $\frac{\partial f}{\partial y} - \frac{d}{dx}\left(\frac{\partial f}{\partial y'}\right) = 0$. (06 Marks)

c. Find the extremals of the functional,

$$\int_{x_0}^{x_1} \left(\frac{y'^2}{x^3}\right) dx.$$ (06 Marks)

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17MATDIP31

Third Semester B.E. Degree Examination, Feb./Mar. 2022
Additional Mathematics – I

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Find a unit vector normal to the vectors $\vec{a} = 2\hat{i} + 2\hat{j} - \hat{k}$ and $\vec{b} = 6\hat{i} - 3\hat{j} + 2\hat{k}$. Also find the sine of the angle between them. **(08 Marks)**

b. Express $\dfrac{1+2i}{1-3i}$ in the form of a + ib. **(06 Marks)**

c. Express $\sqrt{3} + i$ in the polar form and hence find its modulus and amplitude. **(06 Marks)**

OR

2 a. Simplify $\dfrac{(\cos 3\theta + i\sin 3\theta)^4 (\cos 4\theta - i\sin 4\theta)^5}{(\cos 4\theta + i\sin 4\theta)^3 (\cos 5\theta + i\sin 5\theta)^{-4}}$. **(08 Marks)**

b. If $\vec{a} = 3\hat{i} - 7\hat{j} + 2\hat{k}$, $\vec{b} = 2\hat{i} - 5\hat{j} + 10\hat{k}$. Find $(\vec{a} + \vec{b}) \times (\vec{a} - \vec{b})$. **(06 Marks)**

c. Prove that the vectors $\hat{i} - 2\hat{j} + 3\hat{k}$, $-2\hat{i} + 3\hat{j} - 4\hat{k}$ and $\hat{i} - 3\hat{j} + 5\hat{k}$ are co-planar. **(06 Marks)**

Module-2

3 a. If $y = e^{a\sin^{-1}x}$ then prove that $(1-x^2)y_{n+2} - (2n+1)xy_{n+1} - (n^2 + a^2)y_n = 0$. **(08 Marks)**

b. Find the angle between the curves $r = \dfrac{a}{1+\cos\theta}$ and $r = \dfrac{b}{1-\cos\theta}$. **(06 Marks)**

c. If $u = \log\left(\dfrac{x^4 + y^4}{x + y}\right)$ then show that $x\dfrac{\partial u}{\partial x} + y\dfrac{\partial u}{\partial y} = 3$. **(06 Marks)**

OR

4 a. Using Maclaurin's series expand $\sin x$ upto the term containing x^5. **(08 Marks)**

b. Find the pedal equation of the curve $r^m \cos m\theta = a^m$. **(06 Marks)**

c. If $u = x + y + z$, $v = y + z$, $w = z$ then find $\dfrac{\partial(u,v,w)}{\partial(x,y,z)}$. **(06 Marks)**

Module-3

5 a. Obtain a reduction formula for $\int_0^{\pi/2} \cos^n x \, dx (n > 0)$. **(08 Marks)**

b. Evaluate $\int_0^1 \dfrac{x^6}{\sqrt{1-x^2}} dx$ by taking $x = \sin\theta$. **(06 Marks)**

c. Evaluate $\int_0^1\int_0^1\int_0^1 (x^2 + y^2 + z^2) dxdydz$. **(06 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

6 a. Obtain a reduction formula for $\int_0^{\pi/2} \sin^n x\, dx\ (n > 0)$ **(08 Marks)**

b. Evaluate $\int_0^{\pi/2} \cos^4 \theta\, d\theta$ using reduction formula. **(06 Marks)**

c. Evaluate $\int_0^1 \int_0^2 xy\, dy\, dx$. **(06 Marks)**

Module-4

7 a. A particle moves along the curve $x = t^3 + 1$, $y = t^2$, $z = 2t + 3$ where t is the time. Find the components of its velocity and acceleration at $t = 1$ in the direction $\hat{i} + \hat{j} + 3\hat{k}$. **(08 Marks)**

b. Find the directional derivative of $\phi = x^2yz + 4xz^2$ at the point (1, –2, 1) in the direction of the vector $2\hat{i} - \hat{j} + 2\hat{k}$. **(06 Marks)**

c. Show that $\vec{F} = \dfrac{xi + yj}{x^2 + y^2}$ is solenoidal. **(06 Marks)**

OR

8 a. Find $\text{div}\vec{F}$ and $\text{crul}\vec{F}$, where $\vec{F} = (3x^2 - 3yz)\hat{i} + (3y^2 - 3xz)\hat{j} + (3z^2 - xy)\hat{k}$. **(08 Marks)**

b. If $\vec{F} = (3x^2y - z)\hat{i} + (xz^3 + y^4)\hat{j} - 2x^3z^2\hat{k}$, find grad $(\text{div}\vec{F})$ at (2, –1, 0). **(06 Marks)**

c. Find the constants a, b, c such that the vector, $\vec{F} = (x + y + az)\hat{i} + (bx + 2y - z)\hat{j} + (x + cy + 2z)\hat{k}$ is irrotational. **(06 Marks)**

Module-5

9 a. Solve : $(x^2 - y^2)dx - xy\, dy = 0$. **(08 Marks)**

b. Solve : $(1 + y^2)dx = (\tan^{-1}y - x)dy$. **(06 Marks)**

c. Solve : $(x^2 + y^2 + 1)dx + 2xy\, dy = 0$. **(06 Marks)**

OR

10 a. Solve : $x^2y\, dx - (x^3 + y^3)dy = 0$. **(08 Marks)**

b. Solve : $\left\{y\left(1 + \frac{1}{x}\right) + \cos y\right\}dx + (x + \log x - x \sin y)dy = 0$. **(06 Marks)**

c. Solve : $(x+1)\dfrac{dy}{dx} - ye^{3x}(x+1)^2 \dfrac{dy}{dx} + \dfrac{y}{x} = 1$. **(06 Marks)**

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CBCS SCHEME

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17ME32

Third Semester B.E. Degree Examination, Feb./Mar. 2022
Materials Science

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. What is Atomic Packing Factor? Calculate APF for Body Centred Cubic (BCC). **(08 Marks)**
b. Briefly discuss the point type crystal imperfect ions. **(04 Marks)**
c. Sketch and explain the Stress – Strain Curve for mild steel. **(08 Marks)**

OR

2 a. Explain the importance of Offset yield strength, with a neat sketch. **(05 Marks)**
b. Discuss the various types of fractures in brief. **(08 Marks)**
c. Derive the expression for Stress - relaxation. **(07 Marks)**

Module-2

3 a. Discuss the mechanism of Solidification in pure metals and alloys. **(08 Marks)**
b. Define Solid Solution and explain the various types of solid solutions. **(07 Marks)**
c. List out and briefly explain Hume – Rothary rules. **(05 Marks)**

OR

4 a. What is Gibb's Phase rule and discuss the various terms involved in it? **(07 Marks)**
b. Write the general steps involved in the construction of a binary equilibrium diagram between two metals. **(06 Marks)**
c. State the Lever Rule and briefly explain the importance. **(07 Marks)**

Module-3

5 a. What is Heat treatment? What is the purpose of Heat treatment? **(08 Marks)**
b. Discuss the various types of Annealing in brief. **(05 Marks)**
c. Write briefly the Composition , Properties and Applications of Grey Cast Iron. **(07 Marks)**

OR

6 a. What are the various Surface Heat treatment methods and explain Nitriding in brief. **(08 Marks)**
b. Discuss the properties and uses of S.G. Iron. **(06 Marks)**
c. Explain the principle of Induction hardening in brief. **(06 Marks)**

Module-4

7 a. What is Ceramic? Discuss the Mechanical and Electrical behavior of Ceramics. **(08 Marks)**
b. What is Smart Material? Discuss the various applications of Smart Material. **(05 Marks)**
c. Explain the importance of Ceramic materials in our day to day applications. **(07 Marks)**

OR

8 a. Define Shape Memory Alloys and list out various applications of Shape Memory Alloys. **(06 Marks)**
b. With a neat sketch, explain the processing of plastic through Injection molding. **(07 Marks)**
c. Discuss the various steps involved in the processing of Ceramics. **(07 Marks)**

Module-5

9 a. What is Composite Materials? Explain briefly the classification of composites. **(06 Marks)**

b. Discuss the Foundry techniques involved in the production of Metal Matrix Composites. **(06 Marks)**

c. Explain the Filament Winding process, with a neat sketch. **(08 Marks)**

OR

10 a. Derive the equation for Young's modulus of a Composite through i) Iso – Strain and ii) Iso – Stress condition. **(14 Marks)**

b. A Composite material is made by using 10% by volume of Kevlar fiber and 90% epoxy matrix. If the elastic moduli of Kevlar is 130 GN/m^2 and epoxy is 4 GN/m^2, calculate the

i) Young's modulus in fibre direction.

ii) Young's modulus in transverse direction.

iii) Fraction of load carried by the fibers. **(06 Marks)**

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CBCS SCHEME

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Third Semester B.E. Degree Examination, Feb./Mar. 2022
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. *Answer any FIVE full questions, choosing ONE full question from each module.*
2. *Use of thermodynamics data handbook is permitted.*
3. *Assume suitable missing data.*

Module-1

1 a. Define intensive property, cyclic process, thermodynamic equilibrium, ice point, thermocouple. Also differentiate between open system, closed system and isolated system. **(10 Marks)**

b. The temperature 'T' on a thermometer scale is defined interms of a property 'P' by the relation $T = a \ln P + b$ where a and b are constants. Experiments give values of P as 1.86 and 6.81 at ice point and steam point respectively. Evaluate the temperature 'T' on the celsius scale corresponding to a reading of $P = 2.5$ on thermometer. **(10 Marks)**

OR

2 a. Explain with a neat sketch showing on P-V diagram the displacement work for different thermodynamic processes.
(i) Iso-baric process (ii) Iso-choric process
(iii) Isothermal process (iv) Polytropic process **(10 Marks)**

b. Gas from a bottle of compressed helium is used to inflate a balloon originally folded completely flat to a volume of $0.25\ m^3$. If the barometer reach 1.033 bar how much work is done by the system comprising Helium gas initially in the bottle, if the bottle is light and requires no stretching.

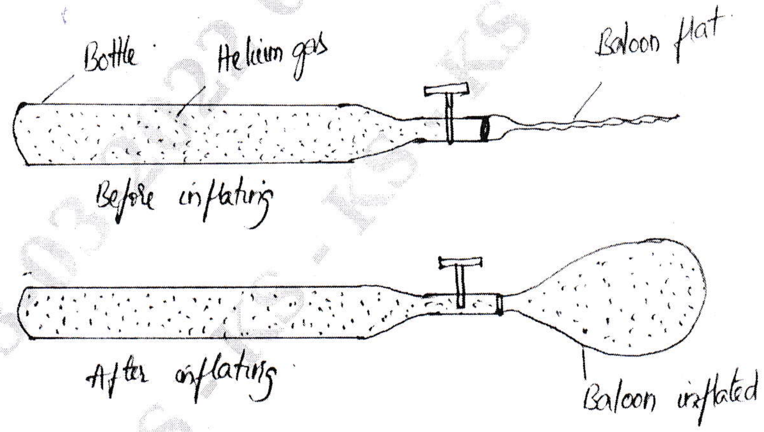

Fig.Q2(b) **(10 Marks)**

Module-2

3 a. Define internal energy. Show that internal energy is a property of a system. **(10 Marks)**

b. A steam turbine receives a flow of 22700 kg/hr of steam while the power input is 500 KW. The inlet and outlet velocities of steam are 75 m/sec and 300 m/sec respectively. The inlet pipe is 3 mts above the exhaust. Neglecting the heat loss from the turbine, find the change in enthalpy per kg of steam. **(10 Marks)**

OR

4 a. What is Carnot cycle? Showing P-V diagram, explain the working operation of Carnot cycle on four processes. **(10 Marks)**

b. A reversible engine operates between temperature limits T_1 and T_2 ($T_1 > T_2$). The energy rejected from the engine A is received by a second reversible engine B at the same temperature T_2. Second engine B rejects energy to a reservoir at a temperature T_3($T_2 > T_3$). Show that the intermediate temperature T_2 is

(i) The geometric mean of temperatures T_1 and T_3 if both the engines have same efficiency $(T_2 = \sqrt{T_1 T_3})$.

(ii) Arithmetic mean of temperature T_1 and T_3 if both engines have same work transfer $\left(T_2 = \dfrac{T_1 + T_3}{2}\right)$.

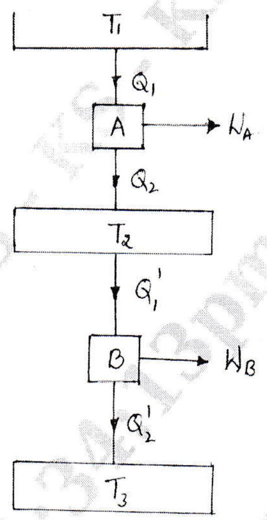

Fig.Q4(b) **(10 Marks)**

Module-3

5 a. Briefly explain reversible process and irreversible process, also mention conditions of reversibility and causes of irreversibility. **(10 Marks)**

b. Write the statement of Carnot theorem, and prove that reversible heat engine has higher efficiency than a regular heat engine $\eta_A > \eta_B$.

η_A = Efficiency of a reversible heat engine

η_B = Efficiency of a regular (any) heat engine **(10 Marks)**

OR

6 a. Define change in entropy. Show that entropy is a property of a system or a point function. **(10 Marks)**

b. A 30 kg of steel ball at 427°C is dropped in 150 kg of oil at 27°C, the specific heat of steel and oil are 0.5 kJ/kgK and 2.5 kJ/kgK respectively. Estimate the entropy change of steel, oil and that of the system containing oil and steel. **(10 Marks)**

Module-4

7 a. What is exergy and anergy, and irreversibility? Write the expression of irreversibility for:
(i) A non flow system (ii) Steady flow system **(10 Marks)**

b. Derive an expression for Maximum Work (W_{max}) in a steady flow system or control volume. **(10 Marks)**

OR

8 a. Define:
(i) Saturated temperature
(ii) Triple point
(iii) Dryness fraction
(iv) Critical point
(v) Superheated temperature.
Also draw neatly enthalpy-entropy (H-S) diagram showing all the details. **(10 Marks)**

b. What is calorimeter? Explain with a neat sketch the working operation of separating and throttling calorimeter. **(10 Marks)**

Module-5

9 Write Vander-Walls equation of state. Derive an expression for Vander-Walls constants in terms of critical constants as $a = \frac{27R^2t_C^2}{64p_C}$, $b = \frac{Rt_C}{8p_C}$. **(20 Marks)**

OR

10 a. Define:
(i) Dalton's law of partial pressure
(ii) Amagat's law of additive volumes
(iii) Compressibility factor
(iv) Law of corresponding states
(v) Dry bulb temperature, Wet bulb temperature Humidity **(10 Marks)**

b. Determine the mass of Nitrogen contained in a 35 m^3 vessel at 200 bar and 200 K by using :
(i) Ideal gas equation of state
(ii) The generalized compressibility chart. **(10 Marks)**

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CBCS SCHEME

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17ME34

Third Semester B.E. Degree Examination, Feb./Mar. 2022
Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

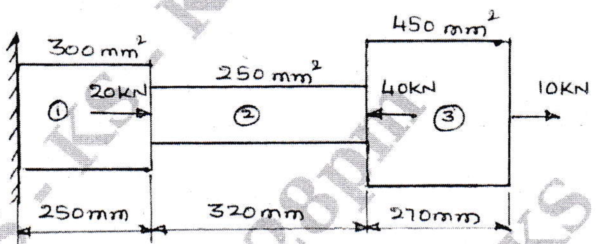
Module-1

1 a. State and explain Hooke's Law. **(02 Marks)**

b. A circular rod of length 'L' has its cross – section varying linearly from larger end diameter 'd_1' to smaller end diameter 'd_2' is subjected to an axial pull 'F'. Derive an expression for an extension of the rod. **(07 Marks)**

c. A stepped bar with three different portions has a fixed portion at one of its ends. The stepped bar is subjected to forces as shown in Fig. Q1(c). Determine the stresses and deformations induced in each portion. Also find the net deformation induced in the stepped bar. Take E = 200 GPa. **(11 Marks)**

Fig. Q1(c)



OR

2 a. Establish a relationship between Modulus of Elasticity (E), Modulus of Rigidity (G) and Poisson's ratio (γ). **(10 Marks)**

b. A compound bar is made of a central steel plate 60mm wide and 10mm thick to which copper plates 40mm wide by 5mm thick are connected rigidly on each side. The length of the bar at normal temperature is 1 meter. If the temperature is raised by 80°C, determine the stresses in each materials and the change in length. Take E_S = 200GPa , E_C = 100GPa , $\alpha_S = 12 \times 10^{-6}/°C$, $\alpha_C = 17 \times 10^{-6}/°C$. **(10 Marks)**

Module-2

3 a. Derive expressions for Normal and Tangential stresses on an inclined plane in a body under biaxial direct stress condition. **(06 Marks)**

b. A point in a body is subjected to tensile stresses 100MPa and 70MPa along two mutually perpendicular directions. The point is also subjected to shear stress of magnitude 50MPa. Determine i) Normal stress and shear stress acting on a plane which is at an angle of 120° with reference to the 100MPa stress plane.

ii) Magnitude of principal stresses and maximum and minimum shear stresses.

iii) Orientations of principal planes and maximum and minimum shear stress planes.

iv) Normal stress on the planes of maximum and minimum shear stresses.

v) Sketch the planes. **(14 Marks)**

OR

4 a. Stating the assumptions made, derive Lame's equations for thick cylinders. **(10 Marks)**

b. A cylindrical pressure vessel of 3m long and is having 1m internal diameter and 15mm thickness. Calculate the maximum intensity of shear stress induced and also the changes in the dimensions of the cylinder if it is subjected to an internal fluid pressure of $1.5 N/mm^2$. Take $E = 2 \times 10^5 N/mm^2$ and Poisson's ratio $\gamma = 0.3$. **(10 Marks)**

Module-3

5 a. Establish a relationship between load intensity shear force and bending moment in a beam. **(04 Marks)**

b. Draw the shear force and bending moment diagrams for the beam loaded as shown in Fig. Q5(b). Locate the point of contra flexure if any. **(16 Marks)**

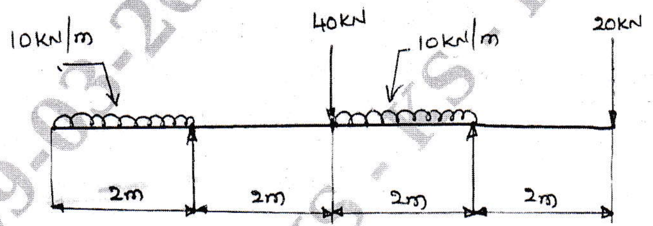


Fig. Q5(b)

OR

6 a. Stating the assumptions made, derive bending equation $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$ with usual notations. **(10 Marks)**

b. A simply supported beam of span 5m has a cross – section 150mm × 250mm. If the permissible stress is $10 N/mm^2$, find
   i) Maximum intensity of uniformly distributed load it can carry.
   ii) Maximum concentrated load P applied at 2m from one end it can carry. **(10 Marks)**

Module-4

7 a. Determine the diameter of solid shaft which will transmit 440KW at 280 rpm. The angle of twist must not exceed one degree per meter length and the maximum torsional shear stress is to be limited to $40 N/mm^2$. Take $G = 84 KN/mm^2$. **(08 Marks)**

b. A solid shaft transmits 250KW at 100 rpm. If the shear stress is not to exceed $75 N/mm^2$, what should be the diameter of the shaft? If this shaft is to be replaced by a hollow one whose internal diameter = 0.6 times outer diameter. Determine the size and the percentage saving in weight, the maximum shear stress being the same. **(12 Marks)**

OR

8 a. Derive an expression for Euler's Buckling load in a column with one end fixed and other end free. State the assumptions made in Euler's theory of columns. **(10 Marks)**

b. A hollow cast iron column whose outside diameter is 200mm and has a thickness of 20mm is 4.5m long and is fixed at both ends. Calculate the safe load by Rankine's formulae using a factor of safety of 2.5. Find the ratio of Euler's to Rankine's load. Take $E = 1 \times 10^5 N/mm^2$ and Rankine's constant $= \frac{1}{1600}$ for both ends pinned case and $\sigma_C = 550 N/mm^2$. **(10 Marks)**

Module-5

9 a. State and prove Castigliano's theorem II. **(08 Marks)**

b. Derive an expression for Strain energy due to torsion in shafts. **(04 Marks)**

c. A bar with circular cross – section as shown in Fig. Q9(c) is subjected to a load of 10KN. Determine the strain energy in the bar. Take $E = 2.1 \times 10^5\ N/mm^2$. **(08 Marks)**

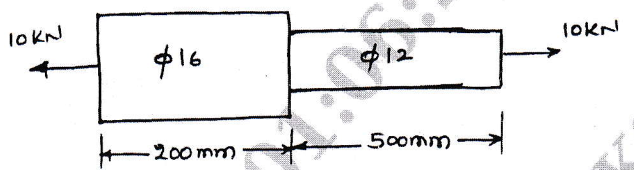


Fig. Q9(c)

OR

10 a. State the following theories of failure :
i) Maximum Principal Stress theory ii) Maximum Shear Stress theory. **(06 Marks)**

b. A bolt is subjected to an axial pull of 12KN together with a transverse shear force of 6KN. Determine the diameter of the bolt by using
i) Maximum Principal Stress theory ii) Maximum Shear Stress theory.
Take Elastic Limit in tension = $300N/mm^2$, Factor of safety = 3. **(14 Marks)**

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