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15MAT31

Third Semester B.E. Degree Examination, Aug./Sept. 2020
Engineering Mathematics – III

Time: 3 hrs. Max. Marks: 80

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. Obtain the Fourier series of $f(x) = x(2\pi - x)$ in $0 \le x \le 2\pi$ and hence deduce that :

$$\frac{\pi^2}{8} = \frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \dots$$ **(08 Marks)**

b. Express y as a Fourier series upto the second harmonics given :

x	0	1	2	3	4	5
y	4	8	15	7	6	2

(08 Marks)

OR

2 a. Obtain the Fourier series for $f(x) = e^{-x}$ in the interval $0 < x < 2$. **(06 Marks)**

b. Expand the function $f(x) = x\sin x$ as a Fourier series in the interval $-\pi \le x \le \pi$. **(05 Marks)**

c. Expand $f(x) = 2x - 1$ as a cosine half range Fourier series in $0 \le x < 1$. **(05 Marks)**

Module-2

3 a. Find the Fourier transform of

$$f(x) = \begin{cases} 1-|x| & \text{for } |x| \le 1 \\ 0 & \text{for } |x| > 1 \end{cases}$$

And hence deduce that $\int_0^{10} \frac{\sin^2 t}{t^2} dt = \frac{\pi}{2}$ **(06 Marks)**

b. Find the Fourier cosine transform of

$$f(x) = \begin{cases} x & 0 < x < 2 \\ 0 & \text{else where} \end{cases}$$ **(05 Marks)**

c. Find the z – transform of : i) $\cos n\theta$ ii) $\sin n\theta$. **(05 Marks)**

OR

4 a. Obtain the Fourier transform of $f(x) = xe^{-|x|}$. **(06 Marks)**

b. If $u(z) = \frac{2z^2 + 3z}{(z+2)(z-4)}$, find the inverse z-transform. **(05 Marks)**

c. Solve the difference equation $y_{n+2} + 6y_{n+1} + 9y_n = 2^n$ with $y_0 = y_1 = 0$ using z – transforms. **(05 Marks)**

Module-3

5 a. Compute the co-efficient of correlation and equation of lines of regression for the data :

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

(06 Marks)

b. Fit a best fitting parabola $y = ax^2 + bx + c$ for the following data :

x	1	2	3	4	5
y	10	12	13	16	19

(05 Marks)

c. Use the Regula – Falsi method to find a real root of the equation $x^3 - 2x - 5 = 0$ correct to three decimal places. **(05 Marks)**

OR

6 a. Find the co-efficient of correlation for the following data :

x	10	14	18	22	26	30
y	18	12	24	6	30	36

(06 Marks)

b. Fit a least square geometric curve $y = ae^{bx}$ for the following data :

x	0	2	4
y	8.12	10	31.82

(05 Marks)

c. Use Newton – Raphson method to find a real root of the equation : $x \log_{10}^{x} = 1.2$ correct to four decimal places that is near to 2.5. **(05 Marks)**

Module-4

7 a. From the following table find the number of students who have obtained :

i) Less than 45 marks
ii) Between 40 and 45 marks.

Marks	30 – 40	40 – 50	50 – 60	60 – 70	70 – 80
Number of students	31	42	51	35	31

(06 Marks)

b. Find the Legrange's interpolation polynomial for the following values y(1) = 3, y(3) = 9, y(4) = 30 and y(6) = 132. **(05 Marks)**

c. Evaluate $\int_0^1 \frac{dx}{1+x}$ taking seven ordinates by applying Simpson's $\frac{3}{8}^{th}$ rule. **(05 Marks)**

OR

8 a. Give $u_{20} = 24.37$, $u_{22} = 49.28$, $u_{29} = 162.86$ and $u_{32} = 240.5$ find u_{28} by Newton's divided difference formula. **(06 Marks)**

b. Extrapolate for 25.4 given the data using Newton's backward formula :

x	19	20	21	22	23
y	91	100.25	110	120.25	131

(05 Marks)

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Module-5

9 a. Verify Green's theorem for $\oint_C (xy + y^2)dx + x^2 dy$ where C is the closed curve of the region bounded by $y = x$ and $y = x^2$. **(06 Marks)**

b. Derive Euler's equation in the form $\frac{\partial f}{\partial y} - \frac{d}{dx}\left(\frac{\partial f}{\partial y^1}\right) = 0$. **(05 Marks)**

c. If $\vec{F} = xyi + yzj + zxk$ evaluate $\int_C \vec{F} \cdot d\vec{r}$ where C is the curve represented by $x = t$, $y = t^2$, $z = t^3$, $-1 \le t \le 1$. **(05 Marks)**

OR

10 a. Verify Green's theorem in the plane for $\int_C (x^2 + y^2)dx + 3x^2 y\, dy$ where C is the circle $x^2 + y^2 = 4$ traced in the positive sence. **(06 Marks)**

b. Evaluate $\int_C (xydx + xy^2 dy)$ by Stoke's theorem C is the square in the x-y plane with the vertices (1, 0), (–1, 0), (0, 1) and (0, 1). **(05 Marks)**

c. Prove that the geodesics on a plane are straight lines. **(05 Marks)**

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15MATDIP31

Third Semester B.E. Degree Examination, Aug./Sept.2020
Additional Mathematics – I

Time: 3 hrs. Max. Marks: 80

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. Express $\frac{5+2i}{5-2i}$ in the form $xi + iy$. **(06 Marks)**

b. Find the modulus and amplitude of $\frac{(1+i)^2}{3+i}$ **(05 Marks)**

c. If $\vec{a} = (3, -1, 4)$, $\vec{b} = (1, 2, 3)$, $\vec{c} = (4, 2, -1)$ find $\vec{a} \times (\vec{b} \times \vec{c})$ **(05 Marks)**

OR

2 a. Prove that $(1+\cos\theta+i\sin\theta)^n + (1+\cos\theta-i\sin\theta)^n = 2^{n+1}\cos^n\frac{\theta}{2}\cdot\cos\frac{n\theta}{2}$. **(06 Marks)**

b. Find the sine of angle between $\vec{a} = 2i - 2j + k$ and $\vec{b} = i - 2j + 2k$ **(05 Marks)**

c. Find the value of λ, so that the vector $\vec{a} = 2i - 3j + k$, $\vec{b} = i + 2j - 3k$ and $\vec{c} = j + \lambda k$ are coplanar. **(05 Marks)**

Module-2

3 a. If $y = \tan^{-1}x$, prove that
$(1+x^2)y_{n+2} + 2(n+1)xy_{n+1} + n(n+1)y_n = 0$ **(06 Marks)**

b. Find the angle between the radius vector and tangent to the curve $r = a(1 - \cos\theta)$ **(05 Marks)**

c. If $u = \sin^{-1}\left(\frac{x^3+y^3}{x+y}\right)$ prove that $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = 2\tan u$. **(05 Marks)**

OR

4 a. Find the pedal equation of the curve $r = 2(1 + \cos\theta)$ **(06 Marks)**

b. Find the total derivative of $u = x^3y^2$, where $x = e^t$, $y = \log t$. **(05 Marks)**

c. Obtain the Maclaurin's series expansion of the function $\sin x$. **(05 Marks)**

Module-3

5 a. Evaluate $\int_0^{\pi} x\cos^6 x\, dx$ **(06 Marks)**

b. Evaluate $\int_0^1\int_0^3 x^3y^3 dx\, dy$ **(05 Marks)**

c. Evaluate $\int_0^1\int_0^1\int_0^1 (x + y + z) dx\, dy\, dz$ **(05 Marks)**

OR

6 a. Evaluate $\int_0^{\pi/2} \sin^6 x \cos^5 x \, dx$ using Reduction formula. **(06 Marks)**

b. Evaluate $\int_0^1 \int_x^{\sqrt{x}} xy \, dy \, dx$ **(05 Marks)**

c. Evaluate $\int_0^1 \int_0^1 \int_0^y xyz \, dx \, dy \, dz$ **(05 Marks)**

Module-4

7 a. A particle moves along the curve $\vec{r} = (t^3 - 4t)i + (t^2 + 4t)j + (8t^2 - 3t^3)k$. Determine the velocity and acceleration at t = 2. **(06 Marks)**

b. Find the directional derivative of $\phi = x^2yz + 4xz^2$ at (1, –2, –1) in the direction of $2i - j - 2k$. **(05 Marks)**

c. Find the constants a and b, such that $\vec{F} = (axy + z^3)i + (3x^2 - z)j + (bxz^2 - y)k$ is irrotational. **(05 Marks)**

OR

8 a. Find the angle between the tangents to the curve $x = t^2 + 1$, $y = 4t - 3$, $z = 2t^2 - 6t$ at t = 1 and t = 2. **(06 Marks)**

b. Find $\text{div}\vec{F}$ and $\text{curl}\vec{F}$ where $\vec{F} = (3x^2 - 3yz)i + (3y^2 - 3xz)j + (3z^2 - 3xy)k$ **(05 Marks)**

c. Find 'a' for which $\vec{F} = (x + 3y)i + (y - 2z)j + (x + az)k$ is solenoidal. **(05 Marks)**

Module-5

9 a. Solve $\frac{dy}{dx} = 1 + \frac{y}{x} + \left(\frac{y}{x}\right)^2$ **(06 Marks)**

b. Solve $x^2 \frac{dy}{dx} = 3x^2 - 2xy + 1$ **(05 Marks)**

c. Solve $(x^2 + y)dx + (y^3 + x)dy = 0$ **(05 Marks)**

OR

10 a. Solve $\frac{dy}{dx} = e^{x-y} + x^2e^{-y}$ **(06 Marks)**

b. Solve $x \frac{dy}{dx} = y + x\cos^2\left(\frac{y}{x}\right)$ **(05 Marks)**

c. Solve $(x^4 + y^2)dy = 4x^3y \, dx$ **(05 Marks)**

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CBCS SCHEME

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15ME32

Third Semester B.E. Degree Examination, Aug./Sept.2020
Material Science

Time: 3 hrs. Max. Marks: 80

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. With neat sketch , explain line defects in crystal imperfections. **(06 Marks)**

b. State and explain Fick's first law of diffusion. **(04 Marks)**

c. With neat sketch, explain plastic deformation of single crystal by slip and twinning. **(06 Marks)**

OR

2 a. What is Fatigue? Draw the SN curve for :
i) a material that displays a fatigue limit.
ii) a material that does not display a fatigue limit. **(08 Marks)**

b. Define Creep deformation. Explain the different stages of creep with neat sketch. **(08 Marks)**

Module-2

3 a. Explain the Interstitial and Substitutional solid solution with at least two examples. **(06 Marks)**

b. With neat sketch explain Cored structure and Homogenization. **(04 Marks)**

c. Two metals A & B having melting points of 800^0C and 1100^0C respectively form an eutectic alloys at 500^0C, with an eutectic composition of 65% B and 35% A. They have unlimited liquid solubilities. The solid solubility of B in A are 12% at Eutectic temp and 6% at room temperature. The solid solubilities of A in B are 10% at Eutectic temperature and 5% at room temperature. Draw the complete phase diagram and label all the fields. Determine the number , type and relative amount phases present at room temperature for an alloy 30% B and 70% A. **(06 Marks)**

OR

4 a. Draw the Iron – Carbon equilibrium diagram, indicating all temperatures, compositions and phases. Briefly explain uses of this diagram. **(08 Marks)**

b. What is a Plain Carbon Steel? Discuss the transformation of eutectoid steel with slow cooling. **(08 Marks)**

Module-3

5 a. Draw CCT diagram and explain briefly for plain carbon eutectoid steel. **(08 Marks)**

b. With neat sketch, explain Recovery , Recrystalization and grain growth effect on mechanical properties of metal, when cold work metal heated into temperature range of recrystalization. **(08 Marks)**

OR

6 a. Give the concept of Hardenability? What are the factors affecting hardenability? **(06 Marks)**

b. With neat sketch, explain carburizing process. **(06 Marks)**

c. Explain the composition , properties and uses of Malleable iron , steel. **(04 Marks)**

Module-4

7 a. Define the polymeric materials and its applications : (04 Marks)
i) Plastics ii) Elastomers.
b. With neat sketch, explain Injection molding process for thermoplastics. (08 Marks)
c. Write a note on Mechanical behavior of Ceramics. (04 Marks)

OR

8 a. Define Ceramic Material. Describe two methods for preparing ceramic raw materials for processing. (08 Marks)
b. What are the properties and applications of Piezo electric material? (04 Marks)
c. What are characteristics and properties of Shape memory alloys? (04 Marks)

Module-5

9 a. Define Composite. Give brief classification of composites. (05 Marks)
b. With neat sketch, explain the production of MMC by any one of the process. (07 Marks)
c. What are advantages and disadvantages of composites? (04 Marks)

OR

10 a. Discuss the roles of matrix and reinforcement material in composite material. (08 Marks)
b. A continuous and aligned glass – fiber reinforced composite having a modulus of elasticity 30 GPa. If 40% of the volume occupied by glass fiber and 60% of the composite occupied by polyester resin with modulus elasticity 3.4 GPa. Determine modulus of elasticity of glass fiber. (08 Marks)

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15ME33

Third Semester B.E. Degree Examination, Aug./Sept.2020
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 80

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

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 thermodynamic equilibrium? Explain mechanical, chemical and thermal equilibrium. **(04 Marks)**

b. What are the similarities and dissimilarities between work and heat? **(04 Marks)**

c. The readings T_A and T_B of two Celsius thermometers A and B agree at ice and steam points, elsewhere the temperatures are related by $T_A = L + MT_B + NT_B^2$, where L, M and N are constants. When the two thermometer are immersed in a well stirred oil bath, A reads 51°C and B reads 50°C. Determine:

(i) What thermometer A reads when thermometer B reads 30°C?
(ii) What thermometer B reads when A reads 30°C?
(iii) Discuss the question which thermometer is correct.
Take ice point = 0°C and steam point = 100°C. **(08 Marks)**

OR

2 a. Define displacement work. Define an expression for displacement work for the case of polytropic process with PV^n = constant. **(05 Marks)**

b. Distinguish between following with an example for each:
(i) Intensive and extensive property
(ii) Point and path function **(04 Marks)**

c. A gaseous system undergoes three quasi-static process in sequence. The gas is initially at 5 bar, 0.01 m^3 is expanded at constant pressure. It is then further expanded according to the law $PV^{1.4}$ = constant to 2 bar, 0.025 m^3. The gas is then returned to its initial state following the process PV = constant. Show the process on PV diagram. Calculate the work interaction in each process and the network for the system. **(07 Marks)**

Module-2

3 a. Clearly write steady flow energy equation for an open system and explain the terms involved. **(04 Marks)**

b. Simplify steady flow energy equation for the following:
(i) Steam turbine (ii) Nozzle (iii) Boiler **(06 Marks)**

c. A gas undergoes a thermodynamic cycle consisting of the following process:
Process 1-2 : constant pressure P = 1.4 bars, $V_1 = 0.028\ m^3$, $W_{1-2} = 10.5$ kJ.
Process 2-3 : compression with PV = constant, $U_3 = U_2$.
Process 3-1: constant volume, $(U_1 - U_3) = -26.4$ kJ.
There are no significant changes in KE and PE. Sketch the cycle on P-V diagram. Calculate the network for the cycle in kJ. Calculate the net heat transfer for process 1-2, and show that $\sum_{cycle} Q = \sum_{cycle} W$. **(06 Marks)**

OR

4 a. State and prove that Kelvin-Planck and Clausius statements of second law of thermodynamics are equivalent. **(09 Marks)**

b. A reversible heat engine operating between two thermal reservoirs at 800°C and 30°C respectively. It drives a reversible refrigerator operating between −15°C and 30°C. The heat input to the heat engine is 1900 kJ and net work output from the combined plant (engine and the refrigerator both) is 290 kJ. Calculate the heat absorbed by the refrigerant and total heat transferred to 30°C reservoir. **(07 Marks)**

Module-3

5 a. Define the terms reversible and irreversible process. List the factors that makes a process irreversible. Explain them briefly. **(06 Marks)**

b. With the help of suitable sketches, explain reversible heat engine cycle. Show that the efficiency of reversible heat engine is independent of the nature of working substance and depends upon the temperature limits between which it is operating. **(10 Marks)**

OR

6 a. State and prove Clausius inequality. What is its significance? **(04 Marks)**

b. State and prove principle of increase of entropy. **(04 Marks)**

c. One kg of ice at −5°C is exposed to atmosphere which is at 20°C. The ice melts and comes into thermal equilibrium with atmosphere. Determine change in entropy of the universe. Take C_p of ice = 2.093 kJ/kgK as latent geat of fusion of ice = 333.3 kJ/kg. **(08 Marks)**

Module-4

7 a. Briefly explain what is meant by
(i) Available energy
(ii) Unavailable energy
(iii) Dead state with respect to system. **(06 Marks)**

b. Derive Claperyon's equation. What are its uses and limitations? **(05 Marks)**

c. 2000 kJ/min of heat is supplied to a system at 500 K from a source at 1000 K. The temperature of the atmosphere is 27°C. Assuming the temperature of system and source remains constant during heat transfer, find:
(i) Change in entropy during heat transfer
(ii) The decrease in available energy after heat transfer. **(05 Marks)**

OR

8 a. Define the following terms as applied to a pure substance :
(i) Triple point
(ii) Critical point
(iii) Sub-cooled liquid state
(iv) Saturated liquid state
(v) Dryness fraction **(05 Marks)**

b. Explain with the help of diagram, how one could estimate the dryness fraction of steam using throttling calorimeter. What are limitations of this calorimeter? **(07 Marks)**

c. Select a point in a wet region and show the following processes starting from this common point on a h-s diagram for steam:
(i) Throttling of wet steam
(ii) Isobaric compression to superheated state
(iii) Isochoric heat addition till it becomes superheated steam
(iv) Isentropic compression till it becomes dry saturated. **(04 Marks)**

Module-5

9 a. Define the following terms:
   (i) Perfect and semi-perfect gas
   (ii) Specific humidity and relative humidity
   (iii) Dew point temperature and dew point depression **(06 Marks)**

b. Write down the Vander Waal's equation of state. How does it differ from ideal gas equation? **(04 Marks)**

c. 0.5 kg of Nitrogen is cooled in a rigid vessel from 227°C to 27°C. The initial pressure is 15 Bar. Calculate the final pressure and change in internal energy, changer in enthalpy and entropy. Assume that nitrogen behaves as an ideal gas with C_p = 1.042 kJ/kgK and C_v = 0.745 kJ/kgK. Also show the process on PV and TS diagram. **(06 Marks)**

OR

10 a. Explain the following:
   (i) Compressibility factor
   (ii) Law of corresponding states
   (iii) Psychrometric chart and its use **(10 Marks)**

b. Determine the specific volume of CO_2 at 200°C and 60 bar by using:
   (i) Ideal gas equation
   (ii) Compressibility chart
   Take compressibility factor Z = 0.96. **(06 Marks)**

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15ME/MA34

Third Semester B.E. Degree Examination, Aug./Sept.2020
Mechanics of Materials

Time: 3 hrs. Max. Marks: 80

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. Derive an expression for the total extension of the tapered circular bar of diameter d_1 and d_2, when it is subjected to an axial pull P. **(08 Marks)**

b. A stepped bar is subjected to an axial load is shown in Fig.Q.1(b). Determine the change in length of the bar. Take E = 200GPa for steel, E = 70GPa for Aluminium and E = 100GPa for copper. All dimensions are in mm. **(08 Marks)**

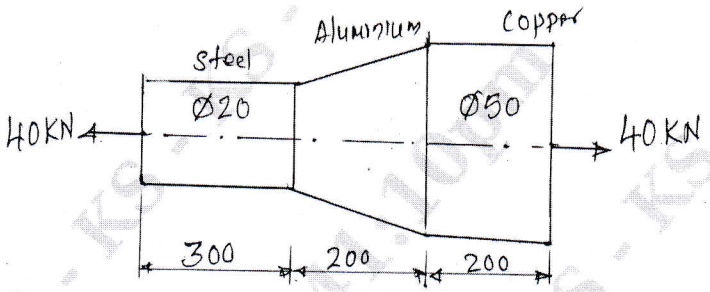

Fig.Q.1(b)

OR

2 a. Define:
i) Modulus of Elasticity
ii) Modulus of Rigidity
iii) Poisson's ratio
iv) Thermal stress. **(08 Marks)**

b. A steel rod of 20mm diameter and 300mm long is enclosed centrally inside a hollow copper tube of external diameter 30mm and internal diameter 25mm. The composite bar carries an axial load of 50kN. Take E_{steel} = 200GPa, E_{copper} = 100GPa. Determine:
i) Load carried by each material
ii) Stresses developed on each material. **(08 Marks)**

Module-2

3 a. Define or explain:
i) Principal plane
ii) Principal stresses
iii) Plane of maximum shear
iv) Maximum shear stress. **(08 Marks)**

b. The state of stress at a point in a strained material is shown in Fig.Q.3(b). Determine:
   i) Principal stresses and their planes
   ii) Maximum shear stress and its planes. **(08 Marks)**

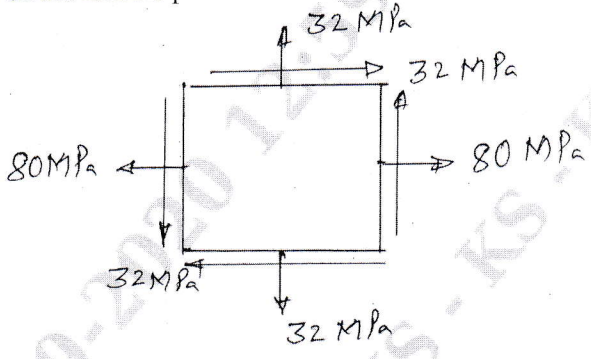

Fig.Q.3(b)

OR

4 a. Derive the expressions for circumferential and longitudinal stresses developed in thin cylinder subjected to internal pressure. **(06 Marks)**

b. A thick cylinder of internal diameter 200mm and external diameter 300mm is subjected to an internal pressure 14N/mm^2. Find the maximum hoop stress developed. Also plot the variation of hoop stress and radial pressure across the thickness of the cylinder. **(10 Marks)**

Module-3

5 a. Define:
   i) Shear force
   ii) Bending moment
   iii) Point of contra flexure. **(06 Marks)**

b. Draw the shear force and bending moment diagrams for the beam shown in Fig.Q.5(b). **(10 Marks)**

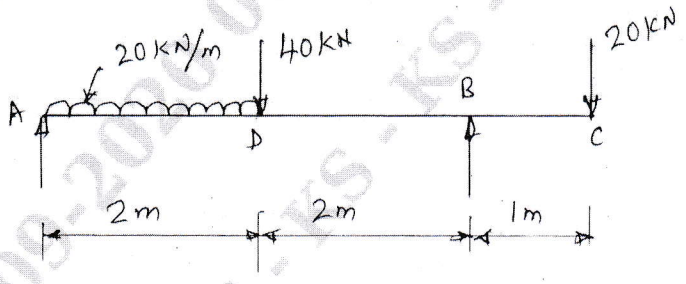

Fig.Q.5(b)

OR

6 a. Derive the relation $\frac{M}{I}=\frac{\sigma}{y}=\frac{E}{R}$ with usual notations. **(08 Marks)**

b. A beam of symmetric I-section consists of flanges of 100mm × 10mm and a web of 180mm × 5mm. The beam is used as simply supported subjected to udl of 10kN/m. The beam is 10m long. Determine the maximum bending stress and sketch the variation along the depth of the section. **(08 Marks)**

Module-4

7 a. Derive the torsion equation with usual notations. **(08 Marks)**

b. Find the diameter of the shaft required to transmit 60kW at 150rpm, if the maximum torque is 25% more than the mean torque. The maximum permissible shear stress is 60MPa. Also find the angle of twist for a length of 4m. Take G = 80GPa. **(08 Marks)**

OR

8 a. Derive an expression for buckling load in a column subjected to an axial compressive load, when both ends are fixed. **(08 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. Find the ratio of Euler's to Rankine's constants is 1/1600 and crushing strength as 550N/mm^2. **(08 Marks)**

Module-5

9 a. Define:

i) Strain energy

ii) Proof resilience

iii) Modulus of resistance. **(06 Marks)**

b. State Castigliano's first and second theorems. **(04 Marks)**

c. Calculate the strain energy stored in a bar 2m long, 50mm wide and 40mm thick when it is subjected to an tensile load of 60kN. Take E = 200GPa. **(06 Marks)**

OR

10 a. Determine the strain energy stored in a cantilever beam of length L subjected to a point load P at its free end and hence find the deflection of its free end. **(08 Marks)**

b. Explain maximum principal stress theory and maximum shear stress theory. **(08 Marks)**

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