CBCS SCHEME

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17MAT31

Third Semester B.E. Degree Examination, July/August 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 the Fourier Series of $f(x) = \begin{cases} -\pi, & -\pi < x < 0 \\ x, & 0 < x < \pi \end{cases}$.

Hence deduce that $\frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \ldots\ldots = \frac{\pi^2}{8}$. **(08 Marks)**

b. Find the Fourier Half – range sine series of $f(x) = \begin{cases} x, & 0 < x < 1 \\ 2 - x, & 1 < x < 2 \end{cases}$. **(06 Marks)**

c. Express y as a Fourier Series upto first harmonics for the following table : **(06 Marks)**

X	0	1	2	3	4	5
Y	4	8	15	7	6	2

OR

2 a. Compute the first two harmonics of the Fourier Series of f(x) given the following table :

x :	0	$\pi/3$	$2\pi/3$	π	$4\pi/3$	$5\pi/3$	2π
f(x) :	1.0	1.4	1.9	1.7	1.5	1.2	1.0

(08 Marks)

b. Find the Fourier series of $f(x) = x^2 - 2$ when $-2 < x < 2$. **(06 Marks)**

c. Obtain the Fourier Cosine series for $f(x) = \begin{cases} \cos x, & 0 < x < \frac{\pi}{2} \\ 0, & \frac{\pi}{2} < x < \pi \end{cases}$. **(06 Marks)**

Module-2

3 a. Find the Infinite Fourier transform of

$f(x) = \begin{cases} 1, & |x| \le a \\ 0, & |x| > a \end{cases}$ and hence evaluate $\int_0^\infty \frac{\sin ax}{x} dx$. **(08 Marks)**

b. If the Fourier sine transform of f(x) is given by $F_s(\alpha) = \frac{\pi}{2} e^{-2\alpha}$, find the function f(x). **(06 Marks)**

c. Find the Z – transform of $3n - 4\sin\frac{n\pi}{4} + 5a$. **(06 Marks)**

OR

4 a. Find the Fourier Cosine transform of e^{-ax}, hence evaluate $\int_0^\infty \frac{\cos \lambda x}{x^2 + a^2} dx$. **(08 Marks)**

b. Find the inverse Z – transform of $\frac{5Z}{(2-z)(3z-1)}$. **(06 Marks)**

c. Solve $u_{n+2} - 5u_{n+1} + 6u_n = 1$, with $u_0 = 0$, $u_1 = 1$, by using Z – transform method. **(06 Marks)**

Module-3

5 a. Calculate the coefficient of correlation and obtain the lines of regression for the following data :

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

(08 Marks)

b. Fit a Parabola to the following data :

x :	1	2	3	4	5
y :	2	6	7	8	10

(06 Marks)

c. Use Newton – Raphson method to find a real root of equation $x \sin x + \cos x = 0$ near $x = \pi$, correct to four decimal places. **(06 Marks)**

OR

6 a. In a partially destroyed laboratory record of correlation data, the following results only are available : Variance of x is 9. Regression equations are $8x - 10y + 66 = 0$, $40x - 18y = 214$. Find i) the mean values of x and y ii) standard deviation of y iii) the coefficient of correlation between x and y. **(08 Marks)**

b. By the method of least squares, fit a straight line to the following data : as $y = ax + b$.

x :	1	2	3	4	5
y :	14	13	9	5	2

(06 Marks)

c. Compute the real root of the equation $x \log_{10} x - 1.2 = 0$, lying between 2.7 and 2.8 correct to four decimal places, using the method of false position. **(06 Marks)**

Module-4

7 a. Given $\sin 45^0 = 0.7071$, $\sin 50^0 = 0.7660$, $\sin 55^0 = 0.8192$, $\sin 60^0 = 0.8660$, find $\sin 57^0$ using an appropriate Interpolation formula.. **(08 Marks)**

b. A curve passes through the points (0, 18), (1, 10), (3, -18) and (6, 90). Find the polynomial f(x) using Lagrange's formula. **(06 Marks)**

c. Use Simpson's $\left(\frac{1}{3}\right)^{rd}$ rule to find $\int_0^{0.6} e^{-x^2}\,dx$ by taking seven ordinates. **(06 Marks)**

OR

8 a. Given f(40) = 184, f(50) = 204, f(60) = 226, f(70) = 250, f(80) = 276, f(90) = 304, find f(38) and f(85) using suitable Interpolation formulae. **(08 Marks)**

b. Use Newton's divided difference formula to find f(40), given the data :

x	0	2	3	6
f(x)	-4	2	14	158

(06 Marks)

c. Use Weddle's rule to compute the area bounded by the curve y = f(x), x - axis and the extreme ordinates from the following table : **(06 Marks)**

x :	0	1	2	3	4	5	6
y :	0	2	2.5	2.3	2	1.7	1.5

Module-5

9 a. Using Gauss – divergence theorem, evaluate $\int_s \vec{F}.d\vec{s}$, where $\vec{F} = 4x\hat{i} - 2y^2\hat{j} + z^2\hat{k}$ and s is the surface bounding the region $x^2 + y^2 = 4$, z = 0 and z = 3. **(08 Marks)**

b. Find the work done in moving a particle in the force field $\vec{F} = 3x^2\hat{i} + (2xz - y)\hat{j} + z\hat{k}$, along the Straight from (0, 0, 0) to (2, 1, 3). **(06 Marks)**

c. Find the extremal of the functional $I = \int_0^{\pi/2} (y^2 - y'^2 - 2\, y \sin x)\, dx$ under the end conditions $y = 0 = y(\pi/2) = 0$. **(06 Marks)**

OR

10 a. Verify Stoke's theorem for the vector field $\vec{F} = (2x - y)\hat{i} - yz^2\hat{j} - y^2z\hat{k}$ over the upper half surface $x^2 + y^2 + z^2 = 1$, bounded by its projection on the xy – plane. **(08 Marks)**

b. Find the Geodesics on a plane. **(06 Marks)**

c. A heavy cable hangs freely under gravity between two fixed points. Show that the shape of the cable is a catenary. **(06 Marks)**

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17MATDIP31

Third Semester B.E. Degree Examination, July/August 2022
Additional Mathematics – I

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. Find the modulus and amplitude of $1-i\sqrt{3}$ and hence express it in polar form. **(07 Marks)**

b. Express the following in the form $a+ib$ and also find the conjugate $\dfrac{1}{1-\cos\theta+i\sin\theta}$. **(07 Marks)**

c. Find the sine of the angle between $\vec{a}=2\hat{i}-2\hat{j}+\hat{k}$ and $\vec{b}=\hat{i}-2\hat{j}+2\hat{k}$. **(06 Marks)**

OR

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

b. Find $\vec{a}\cdot\left(\vec{b}\times\vec{c}\right)$, $\vec{b}\times\left(\vec{a}\times\vec{c}\right)$ and $\vec{c}\cdot\left(\vec{a}\times\vec{b}\right)$ where $\vec{a}=\hat{i}+\hat{j}-\hat{k}$, $\vec{b}=2\hat{i}-\hat{j}+2\hat{k}$, $\vec{c}=3\hat{i}-\hat{j}-\hat{k}$. **(06 Marks)**

c. Find the value of λ so that the points $A(-1,4,-3)$, $B(3,2,-5)$, $C(-3,8,-5)$ and $D(-3,\lambda,1)$ may lie on one plane. **(08 Marks)**

Module-2

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

b. Find the angle between the curves $r=a\cos\theta$, $2r=a$. **(06 Marks)**

c. Using Euler's theorem, prove that $xu_x+yu_y=2\tan u$, where $u=\sin^{-1}\left(\dfrac{x^3+y^3}{x+y}\right)$. **(06 Marks)**

OR

4 a. Obtain the Maclaurin's series expansion of the function $\sqrt{1+\sin 2x}$ upto x^4. **(08 Marks)**

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

c. If $u=\dfrac{yz}{x}$, $v=\dfrac{zx}{y}$, $w=\dfrac{xy}{z}$ show that $\dfrac{\partial(u,v,w)}{\partial(x,y,z)}=4$. **(06 Marks)**

Module-3

5 a. Obtain a reduction formula for $\int\sin^n x\,dx\ (n>0)$. **(08 Marks)**

b. Evaluate $\displaystyle\int_0^\infty\frac{x^2}{(1+x^6)^{\frac{7}{2}}}dx$. **(06 Marks)**

c. Evaluate $\displaystyle\int_0^1\int_{x^2}^{x}\left(x^2+3y+2\right)dy\,dx$. **(06 Marks)**

OR

6 a. Evaluate $\int_0^1 \int_0^y xy\,dx\,dy$. **(08 Marks)**

b. Evaluate $\int_0^{2a} x^2 \sqrt{2ax - x^2}\,dx$. **(06 Marks)**

c. Evaluate $\int_0^1 \int_0^2 \int_1^2 x^2yz\ dx\,dy\,dz$. **(06 Marks)**

Module-4

7 a. A particle moves along the curve $x = 1 - t^3$, $y = 1 + t^2$ and $z = 2t - 5$. Find the components of velocity and acceleration at $t = 1$ in the direction $2i + j + 2k$. **(08 Marks)**

b. Find the directional derivatives of $\phi = x^2yz + 4xz^2$ at $(1,-2,-1)$ along $2i - j - 2k$. **(06 Marks)**

c. Show that $\vec{F} = (y+z)i + (z+x)j + (x+y)k$ is irrotational. **(06 Marks)**

OR

8 a. If $\vec{F} = (x+y+z)\hat{i} + \hat{j} - (x+y)\hat{k}$, show that $\vec{F} \times \text{curl}\,\vec{F} = 0$. **(08 Marks)**

b. If $\phi(x,y,z) = x^3 + y^3 + z^3 - 3xyz$, find $\nabla\phi$, $|\nabla\phi|$ at $(1,-1,2)$. **(06 Marks)**

c. Find $\text{div}\,\vec{F}$ and $\text{curl}\,\vec{F}$ where $\vec{F} = (xz^3\hat{i} - 2x^2yz\hat{j} + 2yz^4\hat{k})$ at $(1,-1,1)$. **(06 Marks)**

Module-5

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

b. Solve $(x^2 + y)dx + (y^3 + x)dy = 0$. **(06 Marks)**

c. Solve $(5x^4 + 3x^2y^2 - 2xy^3)dx + (2x^3y - 3x^2y^2 - 5y^4)dy = 0$. **(06 Marks)**

OR

10 a. Solve $\frac{dy}{dx} + y\cot x = \sin x$. **(08 Marks)**

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

c. Solve $(x^2y - 2xy^2)dx - (x^3 - 3x^2y)dy = 0$. **(06 Marks)**

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17ME33

Third Semester B.E. Degree Examination, July/August 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 thermodynamic handbook is permitted.***

Module-1

1 a. Classify the following as open/closed/isolated system, i) Xerox machine ii) I-C engine iii) Thermo flask iv) Boiler v) Passenger getting out of train. **(05 Marks)**

b. Define the following with examples i) Property ii) Point function iii) Path function iv) Intensive property v) Extensive property. **(05 Marks)**

c. The temperature't' on a linear Celsius scale is related to thermometric property 'P' by the relation $T = A \ln P + B$, where A and B are constants the value of P at ice point and steam point are 1.47 and 5.2 respectively on celcius scale. Determine the temperature 't' corresponding to reading of P at 2.65? **(10 Marks)**

OR

2 a. Define work from thermodynamic point of view and derive the expression for work done in a polytropic process. **(08 Marks)**

b. What are the different types of work done? Derive expression for work done in stretching a wire. **(06 Marks)**

c. If a gas of volume $6000 cm^3$ and at a pressure 100KPa in compressed quasistatically according to $PV^2 = C$ until the volume becomes $2000 cm^3$. Determine final pressure and work transfer. **(06 Marks)**

Module-2

3 a. State 1^{th} law of thermodyanamics and show that enthalpy as a property of a system. **(08 Marks)**

b. Define specific heat at constant pressure and constant volume? Find the relation between C_p, C_v and R. **(06 Marks)**

c. Air is flowing in a 0.2m diameter pipe at a uniform velocity of 0.1m/s the temperature and pressure are 27°C and 150KPa respectively. Determine the mass flow rate of air assuming R = 0.287kJ/kg K. **(06 Marks)**

OR

4 a. Define the following i) Thermal reservoir ii) Source iii) Sink. **(06 Marks)**

b. With block diagram derive COP for refrigerator is less than COP of heat pump by unity. **(06 Marks)**

c. A reversible heat pump is used to maintain a temperature of 0°C in a refrigerator when it rejects heat to the surroundings at 25°C the heat removal rate is 1440kJ/min determine COP of the machine and work required? If the required input is supplied by a reversible engine which receiver heat from 380°C and rejects heat to atmosphere determine overall COP the system? **(08 Marks)**

Module-3

5 a. Define reversibility. Explain the factors that causes the irreversibility. **(08 Marks)**

b. State and prove Carnot's theorem. **(06 Marks)**

c. Two reversible engines A and B working on Carnot cycle operate in series such that engine 'A' receives that from source maintained at 600K and rejects heat to an intermediate sink maintained at T_2. Engine B receives heat rejected by engine 'A' through intermediate sink and rejects heat to a sink maintained at 300K. If both the engines have same efficiency determines the intermediate temperature T_2. **(06 Marks)**

OR

6 a. State Clausius theorem. Show that entropy as a property of a system. **(08 Marks)**

b. Find the change in entropy for the following process :
i) Constant volume process ii) Isothermal process. **(06 Marks)**

c. Find the entropy change of 5Kg of a perfect gas whose temperature varies from 150°C to 200°C during constant volume process the specific heat varies linearly with absolute temperature and is represented by relation $C_V = 0.45 + 0.009T$ kJ/.Kg K. **(06 Marks)**

Module-4

7 a. Define the following i) Available energy ii) Unavailable energy iii) Irreversibility iv) Second law of efficiency. **(10 Marks)**

b. A system at 800K receives heat at the rate of 4000kJ/min from a reservoir at 1200K. The temperature of the surrounding is 300K. Assuming that the temperature of the source and the system remain constant during heat transfer obtain i) the net change of entropy during heat transfer ii) Decrease in available energy after heat transfer. **(10 Marks)**

OR

8 a. Define the following : i) Triple point ii) Sublimation iii) Dryness fraction. **(06 Marks)**

b. With neat sketch, explain the working of throttling calorimeter. **(06 Marks)**

c. Determine dryness fraction of the steam sample when tested in a separating and throttling Calorimeter and the following data were noted
i) Pressure of steam sample is 15 bar
ii) Pressure of steam at exit is 1 bar
iii) Temperature of steam at exit if 150°C
iv) Water collected from separating calorimeter in 0.2 Kg/min
v) Discharge collected at exit is 10Kg/min. **(08 Marks)**

Module-5

9 a. Define the following : i) Avogadrd's law ii) Mass fraction iii) Mole fraction iv) Daltons law of partial pressure. **(10 Marks)**

b. A Gas is raised from 30°C to 120°C calculate
i) Molar specific heat at constant pressure
ii) Specific heat at constant pressure
iii) Specific heat at constant volume
iv) Change in enthalpy

Assume molecular weight of gas 40 Kg/Kg mol and gas follows the relation $C_P = \frac{5}{3}R$. **(10 Marks)**

OR

10 a. Derive an expression for the Vander Waal's constant 'a' and 'b' in terms of critical properties. **(08 Marks)**

b. Write a note on : i) Compressibility factor ii) compressibility chart. **(04 Marks)**

c. Determine the specific volume of hydrogen gas when its pressure is 60 bar and temperature is 100K by using i) compressibility chart ii) Vander Waal's equation. **(08 Marks)**

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Third Semester B.E. Degree Examination, July/August 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. Explain with neat sketch Stress-Strain diagram for ductile materials. **(06 Marks)**

b. Find the stresses in various segments of the circular bar shown in Fig.Q1(b). Also find total elongation. E = 195 GPa.

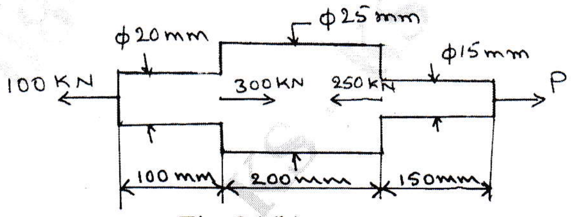

Fig.Q1(b) **(14 Marks)**

OR

2 a. At room temperature the gap between bar A and bar B shown in Fig.Q2(a) is 0.25mm. What are the stresses induced in the bars if the temperature rise is 35°C. Given that
$A_A = 1000\ mm^2$; $A_B = 800\ mm^2$; $E_A = 2\times10^5\ N/mm^2$; $E_B = 1\times10^5\ N/mm^2$
$\alpha_A = 12\times10^{-6}/°C$; $\alpha_B = 23\times10^{-6}/°C$; $L_A = 400$ mm ; $L_B = 300$ mm.

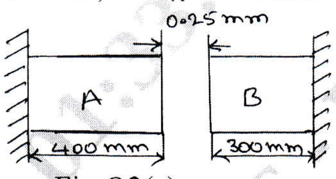

Fig.Q2(a) **(10 Marks)**

b. A bar of 20mm diameter is subjected to pull of 500 kN. The measured extension is 0.12mm on a gauge length of 250mm and the change in diameter is 0.00375 mm. Determine (i) Young's modulus (ii) Poisson's ratio (iii) Bulk modulus (iv) Modulus of rigidity (v) Change in volume. **(10 Marks)**

Module-2

3 a. A point in a strained material is subjected to a tensile stress of 500 N/mm^2 and 300 N/mm^2 in mutually perpendicular planes. Calculate the normal, tangential resultant stresses and its obliquity on a plane making an angle of 30° with the axis of the second stress. Also find maximum shear stress. **(10 Marks)**

b. A point subjected to a tensile stress of 60 N/mm^2 and a compressive stress of 40 N/mm^2 acting on a two mutually perpendicular planes and a shear stress of 10 N/mm^2. Determine principal and maximum shear stress by Mohr's circles method. **(10 Marks)**

OR

4 a. A thin cylindrical shell of one metre diameter and 3m long has a metal thickness of 10mm. It is subjected to an internal fluid pressure of 3 MPa. Determine (i) Circumferential stress (ii) Longitudinal stress (iii) Circumferential strain (iv) Longitudinal strain (v) Volumetric strain. **(10 Marks)**

b. A thick cylindrical pipe of outside diameter 300mm and internal diameter 200mm is subjected to an internal fluid pressure of 20 N/mm^2 and external fluid pressure of 5 N/mm^2. Determine the maximum hoop stress developed. Draw the variation of hoop stress and radial stress across the thickness indicating the values at every 25mm interval. **(10 Marks)**

Module-3

5 a. Explain the different types of beams. **(05 Marks)**

b. Find the reactions at the fixed end and draw SFD and BMD for the beam shown in Fig.Q5(b). Locate point of contraflexure.

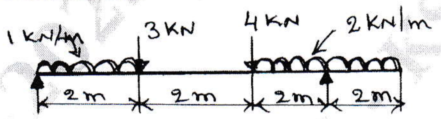

Fig.Q5(b) **(15 Marks)**

OR

6 a. Calculate the maximum stress induced in a cast iron pipe of external diameter 40 mm and internal diameter 20mm, length 4m when the pipe is supported at its ends and carry a point load of 80 N at its centre. **(10 Marks)**

b. A simply supported beam of span 5m has a cross section of 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. Write the assumptions made in pure torsion and derive the torsional equation

$$\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$$ **(12 Marks)**

b. A solid shaft rotating at 1000 rpm transmit 50 kW. Maximum torque is 20% more than the mean torque. Material of the shaft has the allowable shear stress of 50 MPa and modulus of rigidity 80 GPa. Angle of twist in the shaft should not exceed one degree in one metre length. Determine diameter of shaft. **(08 Marks)**

OR

8 a. Derive an expression for crippling load for a column when both of its ends are hinged. **(10 Marks)**

b. Find the Euler's crippling load for a hollow cylindrical steel column of 40 mm external diameter and 4mm thick. The length of the column is 2.5m and hinged at both ends. Also compute the Rankine's crippling load using constants 335 MPa and $\frac{1}{7500}$.

Take E = 205 GPa. **(10 Marks)**

Module-5

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

b. A rectangular block of 1m long, 0.5m wide and 0.25m thick is subjected to a shear stress of 100 N/mm^2. Determine

(i) Strain energy stored in the block (ii) Local strain energy per unit volume.

Take G = 80 GPa. **(06 Marks)**

c. A cantilever beam of length L carries uniformly distributed load W per unit length over its entire length. Determine (i) Strain energy stored in the beam (ii) If W = 10 kN/m, L = 2m and EI = 2×10^5 N/mm^2, determine strain energy stored in the beam. **(06 Marks)**

OR

10 a. Explain Maximum Principal stress theory and Maximum Shear stress theory. **(06 Marks)**

b. A plate of steel is subjected to stress σ_x = 150 N/mm^2 ; σ_y = 100 N/mm^2 and τ_{xy} = 50 N/mm^2. Yield stress of the material is 353 MPa. Find factor of safety using
(i) Maximum principal stress theory
(ii) Maximum shear stress theory. **(08 Marks)**

c. A load of 200 N falls through a height of 25mm on to a collar rigidly attached to the lower end of a vertical bar 2m long and 300mm^2 cross sectional area. The upper end of the vertical bar is fixed. Determine
(i) Maximum instantaneous stress induced in the vertical bar.
(ii) Strain energy stored in the vertical rod. **(06 Marks)**

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