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15MAT31

Third Semester B.E. Degree Examination, July/August 2022
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. Find the Fourier series expansion of $f(x) = 2x - x^2$ in (0, 3). **(08 Marks)**

b. The turning moment T is given for a series of values of the Crank angle $\theta^\circ = 75^\circ$

θ°	0	30	60	90	120	150	180
T	0	5224	8097	7850	5499	2626	0

Obtain the first four terms in a series of sires to represent T. Also calculate T for $\theta = 75^\circ$. **(08 Marks)**

OR

2 a. Obtain Fourier series for the function f(x) given by

$$f(x) = \begin{cases} \pi + x & -\pi < x < 0 \\ \pi - x & 0 \le x < \pi \end{cases}. \quad \text{Hence deduce } \frac{\pi^2}{8} = \sum_{n=1}^{\infty} \frac{1}{(2n-1)^2}.$$ **(08 Marks)**

b. i) Define Half range Fourier sine series of f(x) **(02 Marks)**

ii) Find the half range Cosine series of $f(x) = x^2$ in the range $0 \le x \le \pi$. **(06 Marks)**

Module-2

3 a. Find the Fourier transform of $f(x) = \begin{cases} 1 & \text{for} |x| < 1 \\ 0 & \text{for} |x| > 1 \end{cases}$. Hence evaluate $\int_0^{\infty} \left(\frac{\sin x}{x}\right) dx$. **(06 Marks)**

b. Find the inverse sine transform of $F_s(\alpha) = \begin{cases} 1 & 0 \le \alpha < 1 \\ 2 & 1 \le \alpha < 2 \\ 0 & \alpha \ge 2 \end{cases}$ **(05 Marks)**

c. Find the inverse Z- transform of $\dfrac{2z^2 + 3z}{(z+2)(z-4)}$. **(05 Marks)**

OR

4 a. Find the Fourier Sine transform of $f(x) = e^{-|x|}$ and hence show that

$$\int_0^{\infty} \frac{x \sin mx}{1 + x^2} dx = \frac{\pi}{2} e^{-m}, m > 0.$$ **(06 Marks)**

b. Find the Z-transform of i) $\cosh n\theta$ ii) $\sinh n\theta$. **(05 Marks)**

c. Using the Z- transform, solve $u_{n+2} + u_n = 0$ given $u_0 = 1$, $u_1 = 2$. **(05 Marks)**

Module-3

5 a. Find the correlation coefficient between x and y

x	2	4	6	8	10
y	5	7	9	8	11

(06 Marks)

b. Fit the curve of the form $y = a + bx + cx^2$ to the following data :

x	0	1	2	3	4
y	-4	-1	4	11	20

(05 Marks)

c. Find the root of the equation $2x - \log_e x = 7$ using Regula-Falsi method. Carry out 3 iteration. (05 Marks)

OR

6 a. If θ is the angle between the two regression lines, show that $\tan\theta = \left(\frac{1-r^2}{r}\right)\left[\frac{\sigma_x\sigma_y}{\sigma_x^2+\sigma_y^2}\right]$.
Explain the significance when r = 0 and r = ±1. (06 Marks)

b. Use the method of least squares fit a curve of the form $y = a\,e^{bx}$ for the following data :

x	0	2	4	6	8
y	150	63	28	12	5.6

(05 Marks)

c. Find the real root of the equation $x^4 - x = 10$ by using Newton –Raphson method, carryout 3 iteration. (05 Marks)

Module-4

7 a. Find f(x), using Newton's interpolation formula

x	0	1	2	3	4
f(x)	-5	-10	-9	4	35

(06 Marks)

b. Find f(g) : Using Newton's divided difference formula

x	5	7	11	13	17
f(x)	150	392	1452	2366	5202

(05 Marks)

c. Evaluate, using Simpson's $\left(\frac{1}{3}\right)^{rd}$ rule for $\int_0^{\pi/2}\sqrt{\sin x}\,dx$ by taking 6 intervals. (05 Marks)

OR

8 a. A curve passing through the points (0, 18) (1, 10) (3, -18) and (6, 90). Find f(x), using Lagrange's interpolation formula. (05 Marks)

b. Evaluate, using Weddle's rule $\int_0^6 \frac{e^x}{1+x}dx$ by taking 7 ordinates. (05 Marks)

c. The area 'A' of a circle of diameter 'd' is given for the following values

d	80	85	90	95	100
A	5026	5674	6362	7088	7854

Calculate the area of a circle of diameter 105. (06 Marks)

Module-5

9 a. By using Green's theorem, evaluate $\int_C [(y - \sin x)dx + \cos x\, dy]$ where C is the plane triangle enclosed by the lines $y = 0$; $x = \frac{\pi}{2}$ and : $y = \frac{2}{\pi}x$. **(06 Marks)**

b. Apply Stoke's theorem evaluate

$\int_C (x + y)dx + (2x - z)dy + (y + z)dz$ where C is the boundary of the triangle with vertices (2, 0, 0) (0, 3, 0) and (0, 0,6). **(05 Marks)**

c. Find the curve on which the functional $\int_0^1 (y')^2 + 12xy\, dx$ with $y(0) = 0$ and $y(1) = 1$ can be extremized. **(05 Marks)**

OR

10 a. Derive the Euler's equation in the form $\frac{\partial f}{\partial y} - \frac{d}{dx}\left(\frac{\partial f}{\partial y'}\right) = 0$. **(06 Marks)**

b. Show that the geodesics on a plane are straight lines. **(05 Marks)**

c. Evaluate $\iint_S \vec{F} \cdot \hat{n}\, ds$ where $\vec{F} = 4xz\,\hat{i} + y^2\,\hat{j} + yz\,\hat{k}$ and S in the surface of the cube bounded by the planes $x = 0$, $x = 1$, $y = 0$, $y = 1$, $z = 0$, $z = 1$. **(05 Marks)**

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CBCS SCHEME

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15MATDIP31

Third Semester B.E. Degree Examination, July/August 2022

Additional Mathematics - I

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Express $\frac{(2-3i)(2+i)^2}{1+i}$ in the form of x + iy. **(06 Marks)**

b. If $x+\frac{1}{x} = 2\cos\alpha$ then prove that $x^n + \frac{1}{x^n} = 2\cos n\alpha$. **(05 Marks)**

c. Find the cosine of the angle between the vectors $\vec{a} = 5\hat{i} - \hat{j} + \hat{k}$ and $\vec{b} = 2\hat{i} - 3\hat{j} + 6\hat{k}$. **(05 Marks)**

OR

2 a. Find the Fourth roots of $1 - i\sqrt{3}$ and represent them on an Argand plane. **(06 Marks)**

b. Show that the vectors $\vec{a} = \hat{i} - 2\hat{j} + 3\hat{k}$, $\vec{b} = 2\hat{i} + \hat{j} + \hat{k}$ and $\vec{c} = 3\hat{i} + 4\hat{j} - \hat{k}$ are co-planar. **(05 Marks)**

c. Prove that $[\vec{a}+\vec{b}\ ,\ \vec{b}+\vec{c}\ ,\ \vec{c}+\vec{a}] = 2[\vec{a}, \vec{b}, \vec{c}]$. **(05 Marks)**

Module-2

3 a. Obtain the n^{th} derivative of $e^{ax}\cos(bx + c)$. **(06 Marks)**

b. Show that the curves $r = a(1+\cos\theta)$ and $r = a(1-\cos\theta)$ are orthogonal. **(05 Marks)**

c. If $u = x(1-y)$, $v = xy$ find the Jacobians $J = \frac{\partial(u,v)}{\partial(x,y)}$ and $J' = \frac{\partial(x,y)}{\partial(u,v)}$. **(05 Marks)**

OR

4 a. If $y = a\cos(\log x) + b\sin(\log x)$, prove that $x^2 y_{n+2} + (2n+1)xy_{n+1} + (n^2+1)y_n = 0$. **(06 Marks)**

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

c. If $z = xy^2 + x^2y$, where $x = at^2$, $y = 2at$. Find $\frac{dz}{dt}$. **(05 Marks)**

Module-3

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

b. Evaluate $\int_0^1\int_0^1 \frac{dxdy}{\sqrt{(1-x^2)(1-y^2)}}$. **(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 $\int_0^1 x^5(1-x^2)^{\frac{5}{2}} x.dx$. **(06 Marks)**

b. Evaluate $\int_0^{2a}\int_0^{\frac{x^2}{4a}} xy\ dy\, dx$. **(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 $\vec{r} = 2t^2\,\hat{i} + (t^2 - 4t)\hat{j} + (3t - 5)\hat{k}$. Find the components of velocity and acceleration at t = 2. **(06 Marks)**

b. Find the directional derivative of $\phi = x^2yz + 4xz^2$ at (1, -2, -1) along $\vec{a} = 2\hat{i} - \hat{j} - 2\hat{k}$. **(05 Marks)**

c. Find $\text{div}\,\vec{f}$ for $\vec{f} = \nabla(x^3 + y^3 + z^3 - 3xyz)$. **(05 Marks)**

OR

8 a. Find the unit tangent vector to the curve $\vec{r} = t^2\,\hat{i} + 2t\,\hat{j} - t^3\,\hat{k}$ at $t = \pm 1$. **(06 Marks)**

b. Find the unit normal vector to the surface xy + yz + zx = c at the point (-1, 2, 3). **(05 Marks)**

c. Show that $\vec{f} = (z + \sin y)\,\hat{i} + (x\cos y - z)\,\hat{j} + (x - y)\,\hat{k}$ is irrotational. **(05 Marks)**

Module-5

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

b. Solve $\frac{dy}{dx} + y\cot x = \text{Sin}\, x$. **(05 Marks)**

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

OR

10 a. Solve $\frac{dy}{dx} = (4x + y + 1)^2$. **(06 Marks)**

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

c. Solve $[y(1 + \frac{1}{x}) + \text{Cos}\, y]\,dx + (x + \log x - x\,\text{Sin}\, y)\,dy = 0$. **(05 Marks)**

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CBCS SCHEME

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15ME33

Third Semester B.E. Degree Examination, July/August 2022
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note : 1. *Answer any FIVE full questions, choosing ONE full question from each module.*
2. *Use of Thermodynamic data handbook is allowed.*

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. Distinguish between :
i) Open system and Closed system ii) Macroscopic and Microscopic approaches
iii) Intensive and Extensive properties iv) Diathermic and Adiabatic walls. **(08 Marks)**

b. A platinum wire is used as resistance thermometer. The wire resistance were found to be 10Ω and 16Ω at ice point and steam point on Celsius scale and 30Ω at sulphur boiling point of 444.6°C. Find the constants 'a' and 'b' in the equation. $R = R_0(1 + at + bt^2)$, where 't' is in °C. Also find the resistance of the wire at 500°C. **(08 Marks)**

OR

2 a. Show that work is a path function. **(04 Marks)**

b. Derive an expression for the workdone by a system, undergoing a polytropic process $PV^n = C$. **(04 Marks)**

c. To a closed system 150 kJ of work is done on it. If the initial volume is $0.6m^3$ and pressure of system varies as follows : $P = (8 - 4V)$, where P is pressure in bar and V is volume in m^3. Determine the final volume and pressure of the system. **(08 Marks)**

Module-2

3 a. State the 1st law of Thermodynamics for cyclic process and show that internal energy is a property of a system. **(06 Marks)**

b. A perfect gas flows through a Nozzle where it expands in a reversible adiabatic manner. The inlet conditions are 22bar, 500°C and 38m/s. At exit the pressure is 2 bar. Determine the exit velocity and exit area. If the flow rate is 4kg/S. Take R = 0.190 kJ/kg K and $\gamma = 1.35$. **(10 Marks)**

OR

4 a. State the Kelvin – Planck and Clausius statements of the Second law of Thermodynamics and prove their equivalence. **(08 Marks)**

b. A reversible heat engine operates between two reservoirs at temperature of 600° C and 40°C. The engine drives a reversible refrigerator which operates between at temperature of 40°C and -20°C. The heat transfer to the heat engine is 2000 kJ and the net work output of the combined engine refrigerator plant is 360 kJ.
i) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C.
ii) Reconsider (i) given that the efficiency of the heat engine and the Cop of the refrigerator are each 40% of their maximum possible values. **(08 Marks)**

Module-3

5 a. Explain the various causes of Irreversibility. (04 Marks)

b. Write any four remarks on Carnot's engine. (04 Marks)

c. Two Carnot refrigerators A and B operate in series. The refrigerator A absorbs energy at the rate of 1kJ/S from a body at temperature 300K and rejects energy as heat to a body at a temperature T. The refrigerator B absorbs the same quantity of energy which is rejected by the refrigerator A from the body at temperature T and rejects energy as heat to a body at temperature 1000K. If both the refrigerators have the same C.O.P, calculate
i) The temperature T of the body ii) The C.O.P of the refrigerators and
iii) The rate at which energy is rejected as heat to the body at temperature 1000K. (08 Marks)

OR

6 a. State and prove Clausius in equality. (08 Marks)

b. Air at 20°C and 1.05 bar occupies $0.025m^3$. The air is heated at constant volume until the pressure is 4.5bar and then cooled at constant pressure back to original temperature. Calculate i) The net heat flow from the air ii) The net entropy change. Sketch the process on T – S diagram. (08 Marks)

Module-4

7 a. Explain "Useful Work", Maximum useful work and Irreversibility. (06 Marks)

b. Two kg of air at 500KPa, 80°C expands adiabatically in a closed system until its volume is doubled and its temperature becomes equal to that of the surroundings which is at 100KPa and 5°C. For this process determine i) The maximum work ii) the change in availability and iii) The irreversibility. For air take C_V = 0.718kJ/kg K and R = 0.287kJ/kg K. (10 Marks)

OR

8 a. With a neat sketch, explain Combined Separating and Throttling Calorimeter. (08 Marks)

b. A vessel of volume $0.05m^3$ contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of water present is 9kg. Find the pressure , the mass , specific volume, the enthalpy, entropy and internal energy. (08 Marks)

Module-5

9 a. Explain i) Dalton's law of partial pressure ii) Amagat's law of additive volume. (04 Marks)

b. Derive an expression for specific humidity of moist air. (04 Marks)

c. Define the following : i) Dry bulb temperature ii) Wet bulb temperature
iii) Relative humidity iv) Specific humidity. (08 Marks)

OR

10 a. Derive Vander Waal's constants interms of Critical properties. (08 Marks)

b. Explain the following :
i) Compressibility factor ii) Law of Corresponding States
iii) Generalized compressibility chart iv) Reducing properties. (08 Marks)

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CBCS SCHEME

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15ME34

Third Semester B.E. Degree Examination, July/August 2022
Mechanics of Materials

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Derive an expression for deformation of uniformly tapering rectangular bar. **(08 Marks)**

b. A compound bar consists of a 40mm diameter steel bar surrounded by a closely fitting cast iron tube of 4mm wall thickness. Length of the compound bar is 1.8m. Determine the load required to compress the compound bar so that the deformation induced in it is 1mm. Take the values of Young's modulli as $E_s = 200GPa$ and $E_{CI} = 100GPa$. **(08 Marks)**

OR

2 a. Derive a relationship between modulus of Dasticity (E) and Bulk modulus (K). **(08 Marks)**

b. A Steel bar is sandwiched between two copper bars each having the same area and length as the steel bar, at an initial temperature of 10°C. These are rigidly connected together at both the ends. When the temperature is raised to 260°C, the length of the bars increases by 1.0mm. Determine the original length and the final stresses in the bars. Take the following values :

$E_s = 2 \times 10^5$ N/mm^2 ; $E_c = 1 \times 10^5$N/mm^2

$\alpha_s = 12 \times 10^{-6}$ per °C ; $\alpha_c = 18 \times 10^{-6}$ per °C **(08 Marks)**

Module-2

3 a. What are principle stresses and principle planes? **(04 Marks)**

b. Show that sum of any two orthogonal components of stresses at a point in constant. **(04 Marks)**

c. The state of stress in a two dimensionally stressed body is as shown Fig Q3(c). Determine the principal planes, principle stresses, maximum shear stress and their planes.

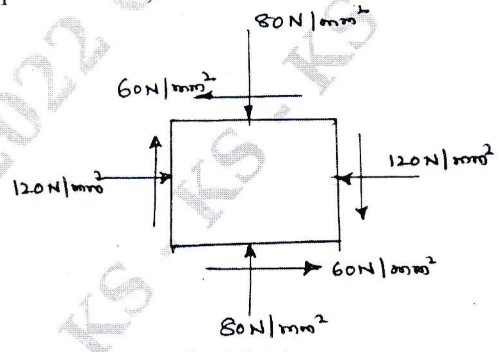

Fig Q3(c) **(08 Marks)**

OR

4 a. Show that

i) Circumferential stress $\sigma_c = \frac{pd}{2t}$ **(03 Marks)**

ii) Longitudinal stress $\sigma_L = \frac{pd}{4t}$ **(03 Marks)**

b. A thick cylinder of external and internal diameter of 300mm and 180mm is subjected to an internal pressure of $42N/mm^2$ and external pressure $6N/mm^2$. Determine the stresses in the material. Now if the external pressure is doubled, what internal pressure can be maintained without exceeding the previously determined maximum stress? **(10 Marks)**

Module-3

5 Draw the SF and BM diagrams for a simply supported beam subjected to the loads as shown below Fig Q5.

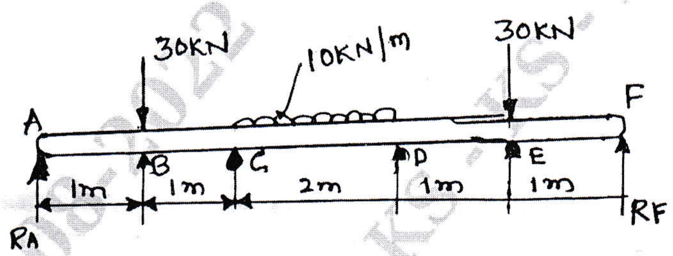

Fig Q5 **(16 Marks)**

OR

6 a. Show that $\frac{\sigma_b}{y} = \frac{E}{R}$ **(06 Marks)**

b. Show that maximum deflection $y_C = \frac{-5}{384}\frac{WL^4}{EI}$ and slope $\theta = \frac{WL^3}{24EI}$ when simply supported beam subjected to uniformly distributed load. **(10 Marks)**

Module-4

7 a. State the assumptions made in the theory of pure torsion. **(04 Marks)**

b. Prove that crippling load $P_{Cr} = \frac{\sigma_c A}{1 + a\left(\frac{L}{K}\right)^2}$. **(04 Marks)**

c. What percentage of strength of a solid circular steel shaft 100mm diameter is lost by boring 50mm axial how in it? Compare the strength and weight ratio of the two cases. **(08 Marks)**

OR

8 a. Derive an expression for crippling load when one and fixed and other end free. **(08 Marks)**

b. A hollow cast from iron whose outside diameter is 200mm and has a thickness of 20mm is 4.5m long and is fixed at formulate 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 loads. Take $E = 1 \times 10^5 N/mm^2$ and to Rankine constant = 1/1600 for both end pinned case and $\sigma_c = 550N/mm^2$. **(08 Marks)**

Module-5

9 a. Determine the internal strain energy stored within an elastic bar subjected to a torque T. **(08 Marks)**

b. A simply supported beam is loaded as shown in Fig Q9(b). Determine the deflection using Castigliane theorem.

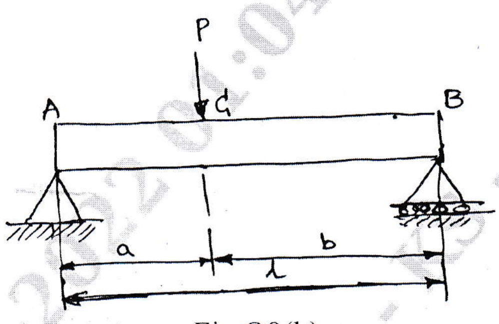

Fig Q9(b) **(08 Marks)**

OR

10 a. Explain :

i) Maximum principal stress theory

ii) Maximum shear stress theory **(08 Marks)**

b. A bolt is subjected to an axial pull of 12kN together with a transverse shear force of 6kN. Determine the diameter of bolt by using :

i) Maximum principal stress theory

ii) Maximum shear stress theory. **(08 Marks)**

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