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17MAT31

Third Semester B.E. Degree Examination, July/August 2021
Engineering Mathematics - III

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions.***

1 a. Obtain the Fourier series for the function
$$f(x) = \begin{cases} -\pi, & -\pi < x < 0 \\ x, & 0 < x < \pi \end{cases}$$
Hence deduce $\frac{\pi^2}{8} = \frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \ldots\ldots\ldots$ **(08 Marks)**

b. Find the Fourier series for the function $f(x) = 2x - x^2$ in $0 < x < 3$. **(06 Marks)**

c. Obtain the constant term and the first sine and cosine terms of the Fourier for y using the following table :

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

(06 Marks)

2 a. Obtain the Fourier series for the function $f(x) = |\cos x|$, $-\pi < x < \pi$. **(08 Marks)**

b. Find the Half range cosine series for $f(x) = x(\ell - x)$, $0 \le x \le \ell$. **(06 Marks)**

c. Express y as a Fourier series upto first harmonic given :

x :	0	$\pi/3$	$2\pi/3$	π	$4\pi/3$	$5\pi/3$	2π
y :	1.98	1.30	1.05	1.30	-0.88	-0.25	1.98

(06 Marks)

3 a. If $f(x) = \begin{cases} 1 - x^2, & |x| < 0 \\ 0, & |x| \ge 1 \end{cases}$

Find the Fourier transform of f(x) and hence find the value of $\int_0^\infty \left(\frac{x\cos x - \sin x}{x^3}\right) dx$ **(08 Marks)**

b. Find the Fourier sine transform of $f(x) = e^{-|x|}$ and hence evaluate $\int_0^\infty \frac{x \sin mx}{1 + x^2}\, dx$ $(m > 0)$ **(06 Marks)**

c. Find $Z_T^{-1}\left[\frac{3z^2 + 2z}{(5z-1)(5z+2)}\right]$. **(06 Marks)**

4 a. Find the Fourier transform of
$$f(x) = \begin{cases} 1 - |x|, & |x| \le 1 \\ 0, & |x| > 1 \end{cases}$$
and hence evaluate $\int_0^\infty \frac{\sin^2 t}{t^2}\, dt$. **(08 Marks)**

b. Find the Z – transform of $2n + \sin\left(\frac{n\pi}{4}\right) + 1$. **(06 Marks)**

c. Solve by using Z – transforms $Y_{n+2} - 4\ Y_n = 0$ given that $Y_0 = 0$, $Y_1 = 2$. **(06 Marks)**

5 a. Obtain the lines of regression and hence find the coefficient of correlation for the data :

x :	1	3	4	2	5	8	9	10	13	15
y :	8	6	10	8	12	16	16	10	32	32

(08 Marks)

b. Fit a Second degree parabola in the least Square sense for the following data:

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

(06 Marks)

c. Use the Regula-Falsi method to obtain the real root of the equation $\cos x = 3x - 1$ correct to 3 decimal places in (0, 1). (06 Marks)

6 a. Given the equation of the regression lines $x = 19.13 - 0.87y$, $y = 11.64 - 0.5x$. Compute the mean of x's , mean of y's and the coefficient of correlation. (08 Marks)

b. Fit a curve of the form, $y = a\,e^{bx}$ for the data:

x :	0	2	4
y :	8.12	10	31.82

(06 Marks)

c. Using Newton-Raphson method to find a real root of $x \log_{10}^{x} = 1.2$ upto 5 decimal places near $x = 2.5$. (06 Marks)

7 a. Given Sin 45° = 0.7071, Sin 50° = 0.7660, Sin 55° = 0.8192, Sin 60° = 0.8660, find Sin 57° using an Backward Interpolation formula. (08 Marks)

b. Applying Lagrange's Interpolation formula inversely find x when y = 6 given the data

x :	20	30	40
y :	2	4.4	7.9

(06 Marks)

c. Using Simpson's $\frac{1}{3}^{rd}$ rule with Seven ordinates to evaluate $\int_{2}^{8} \frac{dx}{\log_{10} x}$. (06 Marks)

8 a. Fit an Interpolating polynomial for the data $u_{10} = 355$, $u_0 = -5$, $u_8 = -21$, $u_1 = -14$, $u_4 = -125$ by using Newton's Divided difference formula and hence find u_2. (08 Marks)

b. Use Lagrange's Interpolation formula to fit a polynomial for the data :

x :	0	1	3	4
y :	-12	0	6	12

Hence estimate y at x = 2. (06 Marks)

c. Evaluate $\int_{4}^{5.2} \log_e x \, dx$ taking six equal strips by applying Weddle's rule. (06 Marks)

9 a. 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 $y = \frac{2}{\pi}x$. (08 Marks)

b. Using Divergence theorem evaluate $\int_S \vec{F} \cdot ds$, where $\vec{F} = 4x\,i - 2y^2 j + z^2 K$ and S is the surface bounding the region $x^2 + y^2 = 4$, $z = 0$ and $z = 3$. (06 Marks)

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

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

b. Derive Euler's equation in the standard form $\frac{\partial f}{\partial y} - \frac{d}{dx}\left[\frac{\partial f}{\partial y^1}\right] = 0$. **(06 Marks)**

c. Find the Extremals of the functional

$$\int_{x_0}^{x_1} \frac{y^{1^2}}{x^3}\, dx.$$ **(06 Marks)**

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CBCS SCHEME

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17CV/CT32

Third Semester B.E. Degree Examination, July/August 2021
Strength of Materials

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions.***

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.

1 a. Draw stress strain diagram for mild steel and explain in brief. **(06 Marks)**
b. Define Poisson's Ratio and Modulus of Rigidity. **(04 Marks)**
c. A bar of uniform cross-section 20mm diameter is subjected to a load as shown in Fig.Q.1(c). Find the total elongation of the bar and maximum stress in the bar. Given E = 200GPa. **(10 Marks)**

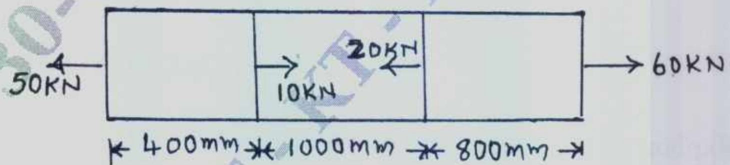

Fig.Q.1(c)

2 a. Derive an expression for the total extension of the tapered bar of circular cross section when it is subjected to an axial tensile load 'P'. **(06 Marks)**
b. Derive the relation between Young's modulus (E) and modulus of rigidity (G) in the form $E = \frac{9KG}{3K + G}$. **(06 Marks)**
c. A compound bar is made of central steel plate 50mm wide and 10mm thick to which copper plate of 50mm wide and 5mm thick are connected rigidly on each sides as shown in Fig.Q.2(c). The length of compound bar is 1000mm at room temperature. If the temperature is raised by 100°C determine stresses in each material and change in length of compound bar. Assume E = 200GPa, E_C = 100GPa, $\alpha_S = 12 \times 10^{-6}$/°C and $\alpha_C = 18 \times 10^{-6}$/°C. **(08 Marks)**

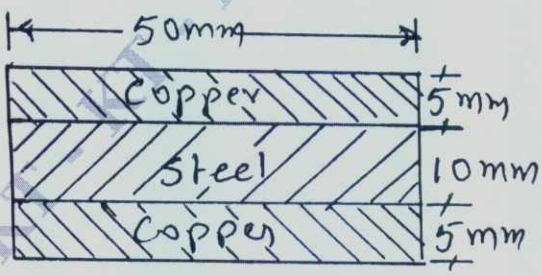

Fig.Q.2(c)

3 a. For thin cylinder subjected to internal pressure 'P' prove that the circumferential stress equal to Pd/2t and longitudinal stress equal to Pd/4t where d = Internal diameter, t = wall thickness. **(06 Marks)**

b. What are principal stresses and principal planes? **(04 Marks)**

c. An element in plane stress is subjected to stresses $P_1 = 120 N/mm^2$ and $P_2 = 45 N/mm^2$ and shear stress $30 N/mm^2$ as shown in Fig.Q.3(c). Determine the normal stress, shear stress, major principal stress, minor principal stress and maximum shear stress acting on an element rotated through an angle $\theta = 45°$. **(10 Marks)**

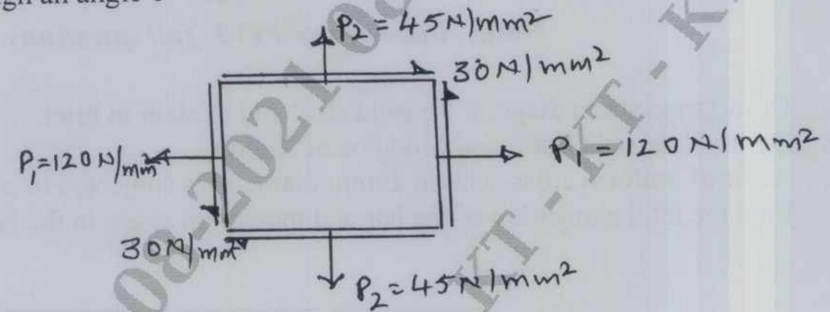

Fig.Q.3(c)

4 a. Explain the construction of Mohr's circle for compound stresses in two dimensional systems. **(10 Marks)**

b. The external and internal radius of a thick cylinder is 300mm and 200mm respectively. The maximum stress permitted is $15.5 N/mm^2$. The external pressure is $4 N/mm^2$. Find the internal pressure. Plot the curves showing the hoop and radial stresses across the thickness. **(10 Marks)**

5 a. Explain:
   i) Sagging Bending moment
   ii) Hogging Bending moment
   iii) Point of contra flexure. **(06 Marks)**

b. For the beam shown in Fig.Q.5(b) draw SFD and BMD, show the salient values on the figure. Locate the point of contra flexure if any. **(14 Marks)**

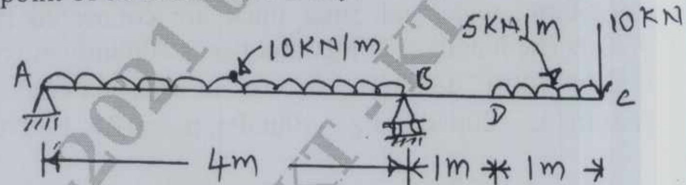

Fig.Q.5(b)

6 a. Derive the relation between load intensity shear force and bending moment. **(06 Marks)**

b. Draw the shear force and bending moment diagram indicating principal values for an overhanging beam shown in Fig.Q.6(b). **(14 Marks)**

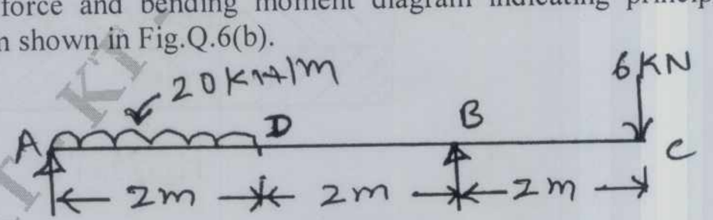

Fig.Q.6(b)

7 a. Explain maximum principal stress theory and maximum shear stress theory. **(10 Marks)**

b. Design a shaft to transmit 1M Watt of power at 300rpm. The stress in the shaft should not exceed 60MPa and angle of twist should not be more than 1° in the length of 10 times diameter. Assume C = 80MPa for the material. **(10 Marks)**

8 a. Derive the torque equation $\frac{T}{J} = \frac{C\theta}{L} = \frac{q}{R}$. **(10 Marks)**

b. State the assumptions made in the theory of pure torsion. **(05 Marks)**

c. Explain maximum principal strain theory. **(05 Marks)**

9 a. Derive expression for buckling load on column with both ends hinged. **(06 Marks)**

b. Define the terms:

i) Neutral axis

ii) Section modulus

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

c. A T-section shown below in Fig.Q.9(c) is used as simply supported beam over a span of 4m. It carries a udl of 8kN/m over its entire span. Calculate maximum tensile and compressive stresses in the beam. **(08 Marks)**

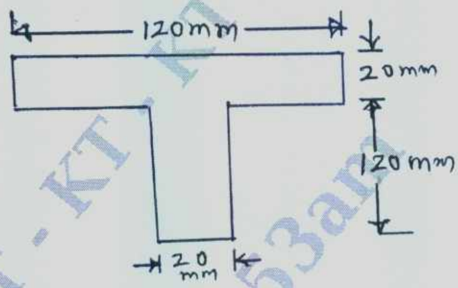

Fig.Q.9(c)

10 a. A 1.5m long column has a circular cross-section of 5cm diameter. One end of the column is fixed in direction and position and the other end is free. Take factor of safety as 3. Calculate safe load using.

i) Rankines formula, taking yield stress 560N/mm^2 and $a = \frac{1}{1600}$.

ii) Eulers formula taking $E = 1.2 \times 10^5$N/mm^2. **(08 Marks)**

b. A beam with an I-section consists of 180mm × 15mm flange and web of 280mm depth and 15mm thick. It is subjected to a moment of 80kN-m and shear force of 60kN. Sketch the bending and shear stresses distribution along the depth of the section. **(12 Marks)**

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17CV33

Third Semester B.E. Degree Examination, July/August 2021
Fluid Mechanics

Time: 3 hrs. Max. Marks: 100

Note: ***1. Answer any FIVE full questions.***
2. Assume any missing data suitably and mention about it.

1 a. Explain the concept of fluid continuum. **(04 Marks)**

b. Define the terms and give their units in S.I. system.
i) Mass density ii) Weight density iii) Specific gravity iv) Specific volume
v) Surface tension vi) Viscosity. **(09 Marks)**

c. The capillary rise in a glass tube used for measuring water level is not to exceed 0.5mm. Determine its minimum size. Given that the surface tension for water in contact with air = 0.07112 N/m. **(07 Marks)**

2 a. State and prove hydrostatic law. **(06 Marks)**

b. Differentiate between absolute pressure, gauge pressure and vacuum pressure with the help of an indicative diagram. **(06 Marks)**

c. The right limb of a simple U-tube manometer containing mercury is open to atmosphere while the left limb is connected to a pipe in which a fluid of specific gravity 0.9 is flowing. The center of the pipe is 12cm below the level of mercury in the right limb. Find the pressure of fluid in the pipe if the difference of mercury level in the two limbs is 20cm. **(08 Marks)**

3 a. Derive an expression for total pressure and center of pressure on an inclined plane surface immersed in liquid. **(10 Marks)**

b. A lock gate 15m high and 7.5m wide is hinged horizontally at the bottom and maintained in vertical position by a horizontal chain at top. Sea water stands upto a depth of 10m on one side and 7.5m on the other. Find the total tension in the chain. Specific gravity of sea water is 1.03. **(10 Marks)**

4 a. With the help of sketches, explain Lagrangian and Eulerian methods of describing fluid flow. **(04 Marks)**

b. Calculate velocity component V, given $u = \frac{2}{3}xy^3 - x^2y$ so that the equation of continuity is satisfied. **(08 Marks)**

c. Derive the general equation of continuity in three dimensional forms. **(08 Marks)**

5 a. State and prove Bernoulli's theorem for motion of fluid along a stream line, starting from Euler's equation. **(06 Marks)**

b. 250 liters per second of water is flowing in a pipe having diameter 300mm. If the pipe is bent by 135°, find the magnitude and direction of the force on the bend. The pressure of water flowing is $400 kN/m^2$. Take specific weight of water as $9.81 kN/m^3$. **(10 Marks)**

c. List all the forces acting on a fluid in motion, which of these are considered in Euler's equation. **(04 Marks)**

6 a. Draw a neat labeled sketch of an orificemeter. **(04 Marks)**

b. Derive an expression for rate of flow through venturimeter. **(08 Marks)**

c. A venturimeter has its axis vertical. The inlet and throat diameters are 150mm and 75mm respectively. The throat is 225mm above the inlet. Petrol of specific gravity 0.78 flows up through the venturimeter at a rate of 29 liters per second. Find the pressure difference between the inlet and the throat. Take $C_d = 0.96$. **(08 Marks)**

7 a. What is a mouth piece and how are they classified? **(06 Marks)**

b. Define hydraulic coefficients C_c, C_v and C_d and derive their inter-relationship. **(06 Marks)**

c. A jet of water issuing from an orifice 25mm diameter under a constant head of 1.5m falls 0.915m vertically before it strikes the ground at a distance of 2.288m measured horizontally from the vena contracta. The discharge was found to be 102*l*pm. Calculate the hydraulic coefficients of the orifice. **(08 Marks)**

8 a. What are notches? How are they classified? **(06 Marks)**

b. Derive an expression for discharge over a V-notch. **(08 Marks)**

c. A cipolletti weir has a crest length of 0.25m. If the head on the crest is 0.15m, calculate the discharge flowing over it. Take $C_d = 0.64$. **(06 Marks)**

9 a. Derive Darcy-Weisbach equation for headloss in pipes due to friction. **(08 Marks)**

b. Which are the major and minor losses in pipe flows? **(04 Marks)**

c. A water distribution network is an equilateral triangle 'ABC' in shape. If the inflow at junction 'A' is 60 units and the outflow at junctions 'B' and 'C' are 40 and 20 units respectively, find the discharge in each pipe. Take initial value of discharge from 'A' to 'B' as 15 units. Take value of 'r' in expression $h_f = r.Q^n$ as for AB:4, for BC:1 and CA:2. Take n = 2. **(08 Marks)**

10 a. Explain the phenomenon of water hammer in pipe flow. **(04 Marks)**

b. Derive an expression for pressure rise inside a pipe due to gradual closure of valve. **(08 Marks)**

c. A pipeline consists of 3 pipes in series:

i) 300m long 15cm diameter
ii) 150m long 10cm diameter
iii) 240m long 20cm diameter.

The pipeline takes off from a reservoir with water at an elevation of +500m. The elevation at the exit is +400m. Find the discharge in the pipe. Neglect minor losses. Take f = 0.04. **(08 Marks)**

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CBCS SCHEME

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17MATDIP31

Third Semester B.E. Degree Examination, July/August 2021
Additional Mathematics – I

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions.***

1 a. Find the modulus and amplitude of $\dfrac{4+2i}{2-3i}$. **(06 Marks)**

b. Find a unit vector normal to both the vectors $4i-j+3k$ and $-2i+j-2k$. Find also sine of the angle between them. **(07 Marks)**

c. Show that $\left[\vec{a}+\vec{b},\ \vec{b}+\vec{c},\ \vec{c}+\vec{a}\right] = 2\left[\vec{a},\vec{b},\vec{c}\right]$. **(07 Marks)**

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

b. Find the modulus and amplitude of $1+\cos\theta+i\sin\theta$. **(07 Marks)**

c. Find λ so that $\vec{a}=2\hat{i}-3\hat{j}+\hat{k}$, $\vec{b}=\hat{i}+2\hat{j}-3\hat{k}$ and $\vec{c}=\hat{j}+\lambda\hat{k}$ are coplanar. **(07 Marks)**

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

b. Find the angle of intersection of the curves $r=\sin\theta+\cos\theta$ and $r=2\sin\theta$. **(07 Marks)**

c. If, $z=f(x,y)$ where $x=e^{u}+e^{-v}$, $y=e^{-u}-e^{v}$. Prove that $x\dfrac{\partial z}{\partial x}-y\dfrac{\partial z}{\partial y}=\dfrac{\partial z}{\partial u}-\dfrac{\partial z}{\partial v}$. **(07 Marks)**

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

b. Find the pedal equation for the curve $\dfrac{2a}{r}=1+\cos\theta$. **(07 Marks)**

c. If, $u=x^2+y^2+z^2$, $v=xy+yz+zx$, $w=x+y+z$, then find $\dfrac{\partial(u,v,w)}{\partial(x,y,z)}$. **(07 Marks)**

5 a. Obtain the reduction formula for $\int \cos^n x\,dx$. **(06 Marks)**

b. Using reduction formula, find the value of $\int_0^1 x^2(1-x^2)^{\frac{3}{2}}dx$. **(07 Marks)**

c. Evaluate $\int_{-1}^{1}\int_{0}^{2}\int_{x-z}^{x+z}(x+y+z)\,dx\,dy\,dz$. **(07 Marks)**

6 a. Evaluate $\int_0^{\pi} x\sin^8 x\,dx$. (06 Marks)

b. Evaluate $\int_0^1 \int_0^{\sqrt{1-y^2}} x^3 y\,dx\,dy$. (07 Marks)

c. Evaluate $\int_0^{\pi} x\sin^2 x\cos^4 x\,dx$. (07 Marks)

7 a. A particle moves along the curve $\vec{r} = 3t^2\hat{i} + (t^3 - 4t)\hat{j} + (3t+4)\hat{k}$. Find the component of velocity and acceleration at $t = 2$ in the direction of $\hat{i} - 2\hat{j} + 2\hat{k}$. (06 Marks)

b. Find the angle between the tangents to the surface $x^2y^2 = z^4$ at (1, 1, 1) and (3, 3, −3). (07 Marks)

c. Find div $\vec{F}$ and curl $\vec{F}$ where $\vec{F} = \nabla(x^3 + y^3 + z^3 - 3xyz)$. (07 Marks)

8 a. Find the angle between the tangents and to the curve $\vec{r} = \left(t - \frac{t^3}{3}\right)\hat{i} + t^2\hat{j} + \left(t + \frac{t^3}{3}\right)\hat{k}$ at $t = \pm 3$. (06 Marks)

b. Find the directional derivative of $f = x^2yz + 4xz^2$ at (1,−2,−1) along $2\hat{i} - \hat{j} - 2\hat{k}$. (07 Marks)

c. Prove that $\text{div}(\text{curl}\,\vec{F}) = 0$. (07 Marks)

9 a. Solve $\frac{dy}{dx} = e^{3x-2y} + x^2e^{-2y}$. (06 Marks)

b. Solve $x^2y\,dx - (x^3 + y^3)dy = 0$. (07 Marks)

c. Solve $\frac{dy}{dx} - \frac{2y}{x} = x + x^2$. (07 Marks)

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

b. Solve $(5x^4 + 3x^2y^2 - 2xy^3)dx + (2x^3y - 3x^2y^2 - 5y^4)dy = 0$. (07 Marks)

c. Solve $\frac{dy}{dx} - \frac{y}{x+1} = e^{3x}(x+1)$. (07 Marks)

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