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18MAT31

Third Semester B.E. Degree Examination, June/July 2024
Transform Calculus, Fourier Series and Numerical Techniques

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 Laplace transform of
i) $e^{-t}\cos^2 3t$ ii) $t\cos t$ **(06 Marks)**

b. A periodic function of period $\frac{2\pi}{\omega}$ is defined by

$$f(t)=\begin{cases} E\sin\omega t, & 0\le t\le \frac{\pi}{\omega} \\ 0, & \frac{\pi}{\omega}\le t\le \frac{2\pi}{\omega}\end{cases}$$ where E and ω are constants.

Show that $L\{f(t)\}=\frac{E\omega}{(s^2+\omega^2)(1-e^{-\pi s/\omega})}$ **(07 Marks)**

c. Find the Inverse Laplace transform of
i) $\frac{2s-1}{s^2+2s+17}$ ii) $\log\left(\frac{s^2+1}{s(s+1)}\right)$ **(07 Marks)**

OR

2 a. Express the function f(t) in terms of unit step function and find its Laplace transform, where

$$f(t)=\begin{cases} \cos t, & 0<t\le\pi \\ 1, & \pi<t\le 2\pi \\ \sin t, & t>2\pi\end{cases}$$ **(06 Marks)**

b. Using the convolution theorem, obtain inverse Laplace transform of $\frac{s}{(s+1)(s^2+1)}$ **(07 Marks)**

c. Solve the equation $y''+5y'+6y=e^t$ under the condition $y(0)=0,\ y'(0)=0$ **(07 Marks)**

Module-2

3 a. Find the Fourier series of the function $f(x)=x^2$ in $(-\pi,\pi)$. **(08 Marks)**

b. Define half range sine and cosine series in the interval $(0, l)$. **(04 Marks)**

c. Find the constant term and the first two harmonics in the fourier series for f(x) given by the following table.

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

(08 Marks)

OR

4 a. Obtain the fourier series of the saw-tooth function

$f(x) = \frac{Ex}{T}$ for $0 < x < T$ given that $f(x + T) = f(x)$ for all $x > 0$. **(06 Marks)**

b. Obtain the Fourier series expansion of

$$f(x) = \begin{cases} \pi x & \text{in } 0 \le x \le 1 \\ \pi(2 - x) & \text{in } 1 \le x \le 2 \end{cases}$$ over the interval (0, 2)

Deduce that $\frac{\pi^2}{8} = \frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \ldots\ldots$ **(07 Marks)**

c. Expand $f(x) = \sin x$ in half range cosine series over the interval $(0, \pi)$. **(07 Marks)**

Module-3

5 a. Prove that fourier transform of

$$f(x) = \begin{cases} 1 + \frac{x}{a}, & -a < x < 0 \\ 1 - \frac{x}{a}, & 0 < x < a \\ 0, & \text{otherwise} \end{cases}$$ is $\frac{4\sin^2 \frac{au}{2}}{au^2}$, if Fourier transform of $f(x)$ is $F(u)$. **(06 Marks)**

b. Find the Fourier sine transform of $f(x) = e^{-|x|}$ and hence

evaluate $\int_0^\infty \frac{x \sin mx}{1 + x^2} dx$, $m > 0$. **(07 Marks)**

c. Find z-transform of $5n^2 + 4\sin\left(\frac{n\pi}{2} + \frac{\pi}{4}\right)$ **(07 Marks)**

OR

6 a. Find the fourier cosine transform of

$$f(x) = \begin{cases} x & \text{for } 0 < x < 1 \\ 2 - x & \text{for } 1 < x < 2 \\ 0 & \text{for } x > 2 \end{cases}$$ **(07 Marks)**

b. Obtain the inverse z-transform of $\frac{4z^2 - 2z}{(z-1)(z-2)^2}$ **(07 Marks)**

c. Solve the difference equation

$u_{n+2} + 3u_{n+1} + 2u_n = 3^n$, given $u_0 = 0$, $u_1 = 1$, using z-transform. **(06 Marks)**

Module-4

7 a. Use Taylor's series method to find the value of y at x = 0.1, given that $dy/dx = x^2 + y^2$, $y(0) = 1$. Consider upto 4^{th} degree term. **(06 Marks)**

b. By using modified Euler's method, solve the initial value problem $\frac{dy}{dx} = \log(x + y)$, $y(1) = 2$ at the point x = 1.2. Take h = 0.2 and carryout two modifications. **(07 Marks)**

c. Given $\frac{dy}{dx} = xy + y^2$, $y(0) = 1$, $y(0.1) = 1.1169$, $y(0.2) = 1.2773$, $y(0.3) = 1.5049$. Find $y(0.4)$ correct to three decimal places using Milne's predictor – corrector method. Apply corrector formula once. **(07 Marks)**

OR

8 a. Using modified Euler's method compute y(1.1) correct to five decimal places taking h = 0.1, given that $\frac{dy}{dx}+\frac{y}{x}=\frac{1}{x^2}$ and $y=1$ at $x=1$. **(06 Marks)**

b. Use fourth order Runge-Kutta method to find y at x = 0.1, given that $\frac{dy}{dx}=3e^x+2y$, y(0) = 0 and h = 0.1. **(07 Marks)**

c. Apply Adam's – Bashforth method to solve the equation $(y^2+1)dy - x^2\,dx = 0$ at x = 1 given y(0) = 1, y(0.25) = 1.0026, y(0.5) = 1.0206, y(0.75) = 1.0679. Apply corrector formula once. **(07 Marks)**

Module-5

9 a. By Runge-Kutta method solve $y'' = xy'^2 - y^2$ for x = 0.2 correct to four decimal places, using initial conditions y = 1 and y′ = 0 when x = 0. Take step length h = 0.2. **(06 Marks)**

b. Derive the Euler's equation in the form $\frac{\partial f}{\partial y}-\frac{d}{dx}\left(\frac{\partial f}{\partial y'}\right)=0$. **(07 Marks)**

c. Prove that geodesics on a plane are straight line. **(07 Marks)**

OR

10 a. Using Runge-Kutta method solve the differential equation at x = 0.1 under the given conditions:

$\frac{d^2y}{dx^2}=x^3\left(y+\frac{dy}{dx}\right)$, $y(0)=1$, $y'(0)=0.5$. Take step length h = 0.1. **(06 Marks)**

b. Apply Milne's method to compute y(0.8) given that $\frac{d^2y}{dx^2}=1-2y\frac{dy}{dx}$ and the following table of initial values.

x	0	0.2	0.4	0.6
y	0	0.02	0.0795	0.1762
y′	0	0.1996	0.3937	0.5689

Apply corrector formula once. **(07 Marks)**

c. Find the extremal of the functional $\int_a^b (x^2y'^2+2y^2+2xy)dx$ **(07 Marks)**

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18ME32

Third Semester B.E. Degree Examination, June/July 2024
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. Define :
(i) Normal stress
(ii) Shear stress
(iii) Normal strain
(iv) Shear strain
(v) Poisson's ratio **(05 Marks)**

b. A Prismatic bar of circular cross section A, length l, Young's modulus E, is suspended from a support. If γ is the specific weight of the material, find the elongation of bar due to its own weight. **(10 Marks)**

c. A steel rod [E = 200 GPa] with circular cross section is 7.5 m long. Determine the minimum diameter required if the rod must transfer a tensile load of 50 kN without exceeding allowable stress of 180 MPa and stretching not more than 5 mm. **(05 Marks)**

OR

2 a. Explain : (i) Young's modulus (ii) Shear modulus (iii) Bulk modulus (iv) Hooke's law (v) Volumetric strain **(05 Marks)**

b. A circular rod of 25 mm diameter and 500 mm long is subjected to a tensile force of 60 kN. Determine the shear modulus, bulk modulus and change in volume, if Poisson's ratio is 0.3 and Young's modulus is 2×10^5 N/mm^2. **(10 Marks)**

c. Derive the relation between modulus of elasticity and bulk modulus. **(05 Marks)**

Module-2

3 a. Derive an expression for normal stress and shear stress on an inclined plane making an angle θ with the vertical axis in a bi-axial stress system subjected to σ_x, σ_y and τ_{xy}. **(10 Marks)**

b. A point in a strained material is subjected to a tensile stress of 120 MPa and a compressive stress of 80 MPa acting at right angles to each other. Find the normal stress, shear stress and resultant stress on an inclined plane making an angle of 30° with the compressive stress. Also find the angle of obliquity. **(10 Marks)**

OR

4 a. Starting from the stress-transformation equations, derive the equation for Mohr's circle and show it on the coordinate axes. **(10 Marks)**

b. Derive an expression for the circumferential and longitudinal stress for a thin cylinder. Also find the maximum shear stress at the outer surfaces. **(10 Marks)**

Module-3

5 a. Obtain the equations for shear force and bending moment for any point on the beam. Also draw the shear force and bending moment diagram. Refer Fig. Q5 (a) **(15 Marks)**

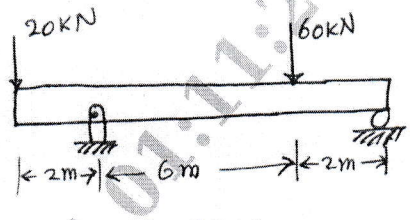

Fig. Q5 (a)

b. Explain with a neat sketch, different types of loads on beam. **(05 Marks)**

OR

6 a. Derive the bending equation for a beam using sample theory of bending. **(10 Marks)**

b. Obtain the expressions for section modulus from the expression of moment of inertia for,
   (i) Rectangular section
   (ii) Hollow rectangular section
   (iii) Circular cross section
   (iv) Hollow circular section
   (v) Triangular section **(10 Marks)**

Module-4

7 a. Find the diameter of a rod subjected to bending moment of 3 kNm and a twisting moment of 1.8 kNm according to maximum normal stress theory. Take the normal stress yield point as 420 MPa and factor of safety as 3. **(10 Marks)**

b. A hollow steel shaft with an outside diameter of 100 mm and a wall thickness of 10 mm is subjected to pure torque of T = 5500 Nm. (i) Determine the maximum shear stress in the shaft. (ii) Determine the minimum diameter of the solid shaft for which the maximum shear stress is same as in part (i), for the same torque T. **(05 Marks)**

c. What are the assumptions made in the theory of pure torsion? **(05 Marks)**

OR

8 a. A compound shaft consists of two pipe segments. Segment (i) has an outer diameter of 200 mm and a wall thickness of 10 mm. Segment (2) has an outside diameter of 150 mm and a wall thickness of 10 mm. The shaft is subjected to torques $T_B = 42\,kNm$ and $T_C = 18\,kNm$ which act in the direction as shown in Fig. Q8 (a). Determine the maximum shear stresss magnitude in each shaft segment. **(10 Marks)**

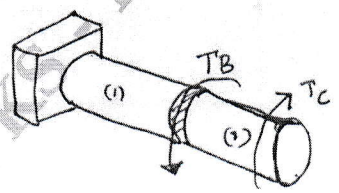

Fig. Q8 (a)

b. A solid circular shaft is subjected to a bending moment of 40 kNm and a torque of 10 kNm. Design the diameter of the shaft according to,
   (i) Maximum principal stress theory.
   (ii) Maximum shear stress theory. **(10 Marks)**

Module-5

9 a. Determine the slenderness ratio and Euler buckling load for a round wooden dowels (cylindrical rod) that are 1 m long and have a diameter of, (i) 16 mm and (ii) 25 mm. Assume E = 10 GPa. **(10 Marks)**

b. A compound solid aluminium rod is subjected to a tensile force P, Make the assumption that E = 69 GPa, d_1 = 16 mm, $L_1 = 600$ mm, d_2 = 25 mm, $L_2 \doteq 900$ mm, $\sigma_{uP} = 276$ MPa. Calculate the largest amount of strain energy that can be stored in the rod without causing any yielding. Refer Fig. Q9 (b).

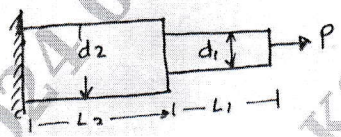

Fig. Q9 (b) **(10 Marks)**

OR

10 a. A solid 2.5 m long stainless steel rod has a yield strength of 276 MPa and an elastic modulus of 193 GPa. A strain energy of W = 13 Nm must be stored in the rod when a tensile load P is applied to rod. What is

(i) the maximum strain energy density that can be stored in the solid rod if a factor of safety of 4.0 with respect to yielding is specified?

(ii) the minimum diameter d required for the solid rod? **(10 Marks)**

b. Explain : (i) Buckling (ii) Stable equilibrium (iii) Unstable equilibrium (iv) Neutral equilibrium (v) Slenderness ratio **(10 Marks)**

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18ME33

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024
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 DHB and Steam tables permitted.

Module-1

1 a. With an example, define the terms :
(i) Microscopic approach
(ii) Open system
(iii) Intensive properties
(iv) Mechanical equilibrium
(v) Path function. **(10 Marks)**

b. State Zeroth law of thermodynamics and explain the concepts of temperature. **(04 Marks)**

c. A thermocouple with test junction at t °C on gas thermometer scale and reference junction at ice point gives the e.m.f as,
$e = 0.20t - 5\times10^{-4}t^2$ mV
The millivoltmeter is calibrated at ice and steam points. What will be reading on this thermometer where the gas thermometer reads 70 °C? **(06 Marks)**

OR

2 a. Explain Quasi-static process with a neat sketch. **(06 Marks)**

b. With a neat sketch, explain constant volume gas thermometer. **(06 Marks)**

c. A temperature scale of certain thermometer is given by the relation t = a ln p + b where a and b are constants and p is the thermometric property of the fluid in the thermometer. If at the ice point and steam point the thermometric properties are found to be 1.5 and 7.5 respectively. What will be the temperature corresponding to the thermometric property of 3.5 on Celsius scale. **(08 Marks)**

Module-2

3 a. Write the differences and similarities between work and heat transfer. **(06 Marks)**

b. With the help of P-V diagrams derive expressions for various displacement work. **(08 Marks)**

c. To a closed system 150 kJ of work is supplied. If the initial volume is 0.6 m^3 and pressure of the system changes as p = 8 – 4 V, where p is in the bar and V is in m^3, determine the final volume and pressure of the system. **(06 Marks)**

OR

4 a. Explain Joules experiments and hence define first law of thermodynamics. **(06 Marks)**

b. With proper assumptions derive SFEE and apply the same for nozzles and compressors. **(08 Marks)**

c. In a gas turbine unit, the gases flow through the turbine is 15 kg/s and the power developed by the turbine is 12000 kW. The enthalpies of gases at the inlet and outlet are 1260 kJ/kg and 400 kJ/kg respectively and the velocities are 50 m/s and 110 m/s respectively. Calculate (i) The rate at which heat is rejected to the turbine and (ii) Area of the inlet pipe when specific volume of the gas at the inlet is 0.45 m^3/kg. **(06 Marks)**

Module-3

5 a. Briefly explain the terms :
   (i) Thermal reservoir.
   (ii) Reversed heat engine.
   (iii) Kelvin Planck's statement of second law of thermodynamics.
   (iv) PMMII **(08 Marks)**

b. Explain the equivalence of Clausius statement to the Kelvin-Planck statement. **(06 Marks)**

c. A reversible heat engine operates between two reservoirs at temperatures 700°C and 50°C. The engine drives a refrigerator which operates between reservoirs at temperatures of 50°C and −25°C. The heat transfer to the engine is 2500 kJ and the net work output of the combined engine refrigerator plant is 400 kJ. Determine the heat transfer to the refrigerant and the net heat transfer to the reservoir at 50°C. **(06 Marks)**

OR

6 a. Show that entropy is a property of the system. **(05 Marks)**

b. Explain inequality of Clausius. **(07 Marks)**

c. 3 kg of water at 80°C is mixed with 4 kg of water at 15°C in an isolated system. Calculate the change of entropy due to mixing process. **(08 Marks)**

Module-4

7 a. Briefly explain the terms availability and unavailable energy. **(04 Marks)**

b. Derive an expression for maximum useful work in a reversible process. **(06 Marks)**

c. 8 kg of air at 650 K and 5.5 bar pressure is enclosed in a system. If the atmospheric temperature and pressure are 300 K and 1 bar respectively. Determine (i) Availability if the system goes through the ideal work producing process. (ii) Availability and effectiveness if the air is cooled at constant pressure to atmospheric temperature. Take $C_V = 0.718$ kJ/kg K and $C_P = 1.005$ kJ/kgK. **(10 Marks)**

OR

8 a. With a neat sketch and h-s diagram, explain throttling calorimeter. **(08 Marks)**

b. Explain T-S diagram for a pure substance. **(05 Marks)**

c. A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find the pressure, mass, specific volume, enthalpy, entropy and internal energy. **(07 Marks)**

Module-5

9 a. Briefly explain Dalton's law of partial pressures and Amagat's law of additive volumes. **(04 Marks)**

b. Differentiate between ideal gas and real gas. **(04 Marks)**

c. A mixture of ideal gases contains and 4 kg of nitrogen and 6 kg of carbon dioxide at a pressure of 4 bar and temperature of 20°C. Find :
   (i) Mole fraction of each constituents.
   (ii) Equivalent molecular weight of the mixture.
   (iii) Equivalent gas constant of the mixture.
   (iv) Partial pressures and partial volumes.
   (v) Volume and density of the mixture. **(12 Marks)**

OR

10 a. Briefly explain law of corresponding states and compressibility factor. **(04 Marks)**

b. Write Vanderwaal's constants in terms of critical properties. **(08 Marks)**

c. 1 kg of carbon di oxide has a volume of 1 m^3 at 100°C. Compute the pressure by
   (i) Vanderwaal's equation
   (ii) Perfect gas equation. **(08 Marks)**

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18ME34

Third Semester B.E. Degree Examination, June/July 2024
Material Science

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Define APF. Derive an expression for APF for HCP and FCC. **(10 Marks)**

b. What is diffusion? Explain the laws of diffusion with equations. **(10 Marks)**

OR

2 a. Draw Stress-Strain curve for ductile materials. Explain salient point. **(08 Marks)**

b. Explain mechanical properties in both plastic and elastic region. **(12 Marks)**

Module-2

3 a. Define endurance strength and explain the method to find the endurance strength of the material. **(10 Marks)**

b. What is Creep? Explain different stages of creep curve with a neat diagram. **(10 Marks)**

OR

4 a. Give brief description of different phases formed in Iron-carbon phase diagram with a neat sketch of phase diagram. **(12 Marks)**

b. Define homogeneous and heterogeneous nucleation. Obtain an expression for critical radius of nucleation. **(08 Marks)**

Module-3

5 a. Draw TTT diagram for a plain Carbon Steel and label all the regions. Show the cooling curve which forms 100% martensite and explain it. **(10 Marks)**

b. Define Annealing. Explain various Annealing processes. **(10 Marks)**

OR

6 a. What is age hardening? Explain age hardening of 4% Cu alloy with its microstructure, with sketch. **(10 Marks)**

b. Explain the composition, structure and properties and applications of 3 types of cast Iron. **(10 Marks)**

Module-4

7 a. Under Iso-strain condition derive an expression for Young's modulus of fiber reinforced composites. List the advantages and applications of composite materials. **(08 Marks)**

b. Explain Resin transfer moulding process. **(08 Marks)**

c. Calculate the tensile modulus of elasticity of an unidirectional carbon fiber material which contains 62% by volume of carbon fibers in ISO – stress and ISO – strain condition. $E_C = 3.86 \times 10^4$ Kgf/mm^2 ; $E_{eposy} = 428 \times 10^2$ Kgf/mm^2. **(04 Marks)**

OR

8 a. Calculate the modulus of elasticity, tensile strength, and the fraction of the load carried by the fiber for the following composite material stressed under iso-strain condition. The composite consists of a continuous glass fiber reinforced epoxy resin produced by using 60% by volume of E-glass ($E = 72400 \times 10^6 N/m^2$), tensile strength of $2400 \times 10^6 N/m^2$ and a hardened epoxy resin with a modulus of elasticity of $3100 \times 10^6 N/m^2$ and a tensile strength of $60 \times 10^6 N/m^2$. Also find the modulus of elasticity of the composite when stressed under iso stress condition. **(08 Marks)**

b. With a neat sketch, explain pultrusion process. **(08 Marks)**

c. Discuss the role of composite materials in technological development. **(04 Marks)**

Module-5

9 a. What are ceramic materials? Write chemical, optical, thermal and mechanical properties of ceramics. **(10 Marks)**

b. Discuss about mechanical behavior of plastics. **(04 Marks)**

c. Explain Injection moulding technique. **(06 Marks)**

OR

10 a. What is NiTinol? How is it different from its alloying materials? **(05 Marks)**

b. Explain the following :

i) Materials used in Human implants

ii) Fiber optic materials

iii) Pseudoelasticity. **(15 Marks)**

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18ME35A

Third Semester B.E. Degree Examination, June/July 2024
Metal Cutting and Forming

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. With a neat sketch, explain the types of Chips formed during metal cutting. **(10 Marks)**

b. What do you mean by tool signature? Explain with respect to single point cutting tool. **(10 Marks)**

OR

2 a. Classify Lathes. Briefly explain various parts of lathe, with neat sketch. **(10 Marks)**

b. List the operations performed on lathe and explain any four operations with a neat sketch. **(10 Marks)**

Module-2

3 a. With sketch, write comparison between Up milling and Down milling. **(10 Marks)**

b. Sketch and explain Radial drilling machine highlighting its advantages and disadvantages. **(10 Marks)**

OR

4 a. With a neat sketch, explain Quick return mechanism of a shaper. **(10 Marks)**

b. With sketch, explain the External centreless grinding highlighting the feed mechanism. **(10 Marks)**

Module-3

5 a. Explain the types of tool wear with necessary sketches. **(10 Marks)**

b. A mild steel bar of diameter 50mm is to be turned at over length of 160mm with a depth of cut of 1.5mm , feed of 0.2mm/rev at 230 rpm by HSS tools. If the tool life equation is given $VT^{0.2} f^{0.3} d^{0.12} = 50$. Determine how many components may be turned before regrinding the tool. **(10 Marks)**

OR

6 a. Explain the properties and functions of cutting fluids. **(06 Marks)**

b. Explain the effect of machining parameters on surface finish. **(08 Marks)**

c. Explain Machinability and mention its importance. **(06 Marks)**

Module-4

7 a. What is Forging? Explain the working of board hammer with sketch. **(10 Marks)**

b. Give the brief classification of Metal forming. **(10 Marks)**

OR

8 a. With a neat sketch, explain the Wire drawing process. **(10 Marks)**

b. Explain the various types of Extrusion processes. **(10 Marks)**

Module-5

9 a. Briefly explain the operations that can performed in the sheet metal. (10 Marks)

b. Explain the variables in drawing process. (06 Marks)

c. Differentiate between Trimming and Shearing. (04 Marks)

OR

10 a. Explain the following with respect to bending operations :

i) Embossing ii) Coining iii) Progressive die. (12 Marks)

b. With a line diagram, explain Compound and Combination dies. (08 Marks)

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