3 Hours **Total Marks: 80**

Note: (1) Question No. 1 is Compulsory.

(2) Answer any three questions from Q.2 to Q.6

(3) Figures to the right indicate full marks.

Q1.

a) Find the eigen values of $A^2 - 5A + 4I$ if $A = \begin{bmatrix} -1 & 0 & 0 \\ 2 & -3 & 0 \\ 1 & 4 & 2 \end{bmatrix}$ **5**

b) Find the Fourier expansion of $f(x) = x^2, -\pi \le x \le \pi$ **5**

c) Find a , b , c, d if $f(z) = x^2 + 2axy + by^2 + i(cx^2 + 2dxy + y^2)$ is analytic. **5**

d) Find $L[te^{3t}sint]$ **5**

Q2.

a) Evaluate the following Integral using Laplace Transforms. **6**

$$I = \int_0^\infty \frac{sin^2 t\, e^{-t}}{t} dt$$

b) Determine the Fourier Series $f(x) = \left(\frac{\pi - x}{2}\right)^2$ over $[0, 2\pi]$. **6**

c) Prove that $u = x^2 - y^2 - 2xy - 2x + 3y$ is harmonic and find its harmonic conjugate. **8**

Q3.

a) Solve $\frac{\partial^2 u}{\partial x^2} - 32\frac{\partial u}{\partial t} = 0$ by Bender-Schmidt method subjected to the conditions $u(0,t) = 0$, $u(x,0) = 0, u(1,t) = t,$ taking h =0.25, $0 < x < 1$, upto = 5 . **6**

b) Determine the analytic function $f(z) = u + iv$ where $u = 3x^2y - y^3$. **6**

c) Determine the Inverse Laplace Transform of i) $\frac{s+2}{s^2 - 4s + 13}$ **4**

ii) $tan^{-1}(s)$ **4**

Q4.

a) i) If $L\{f(t)\} = \frac{s}{s^2+s+4}$, find $L\{e^{-2t}\ f(2t)\}$ **3**

ii) Find $L(t^2\ sinat)$ **3**

b) Determine the Inverse Laplace Transform of $\log\left[\frac{s^2+a^2}{(s+b)^2}\right]$ **6**

c) $Is\ the\ matrix\ A = \begin{bmatrix} 3 & 1 & 4 \\ 0 & 2 & 6 \\ 0 & 0 & 5 \end{bmatrix}$ diagonalizable? If so find the diagonal form of A and transforming matrix of A. **8**

Q5.

a) Find the Eigen value and the eigen vector of A= $\begin{bmatrix} 1 & 2 & 0 \\ 2 & 1 & -6 \\ 2 & -2 & 3 \end{bmatrix}$ **6**

b) Find Inverse Laplace transform of $\frac{s+29}{(s+4)(s^2+9)}$ using partial fraction method. **6**

c) Solve $\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0$, by Crank-Nicholson simplified formula, where $u(0,t) = 0, u(4,t) = 0, u(x,0) = \frac{x}{3}(16 - x^2)$, find u_{ij} , for $i = 0,1,2,3,4\ and\ j = 0,1,2$ taking $h = 1$. **8**

Q6.

a) Find analytic function f(z) whose imaginary part is $e^x\ cosy + x^3 - 3xy^2$ **6**

b) Find the Laplace Transform of $f(t) = \frac{\cos at - \cos bt}{t}$ **6**

c) Determine the Fourier Series for $f(x) = \begin{cases} x + \frac{\pi}{2}, & -\pi \le x \le 0 \\ \frac{\pi}{2} - x, & 0 \le x \le \pi \end{cases}$ over $[-\pi, \pi]$

Time: 3 Hrs **Max. Marks: 80**

N.B. 1. Question number **one** is **compulsory.**
2. Attempt any **three** from the remaining five questions.
3. Figures to the right indicates **full marks.**
4. Assume suitable data **if needed** and state it clearly.
5. Notations used carries usual meaning.

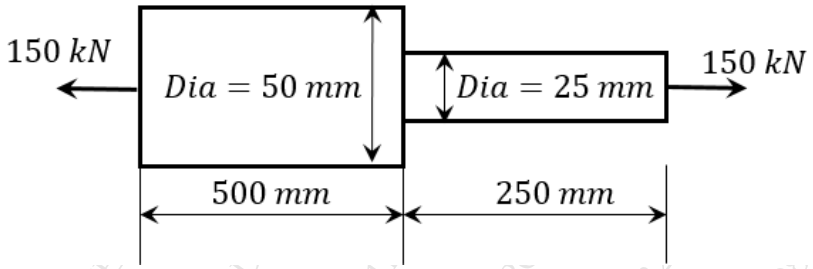
Q1 Attempt any **four** of the following

(a) Derive relation between modulus of elasticity and bulk modulus **(5)**

(b) Draw the shear force and bending moment diagrams for a simply supported beam of length L and loaded with uniformly varying load of intensity w kN/m at one end and zero at the other end. **(5)**

(c) Derive differential equation for the elastic curve **(5)**

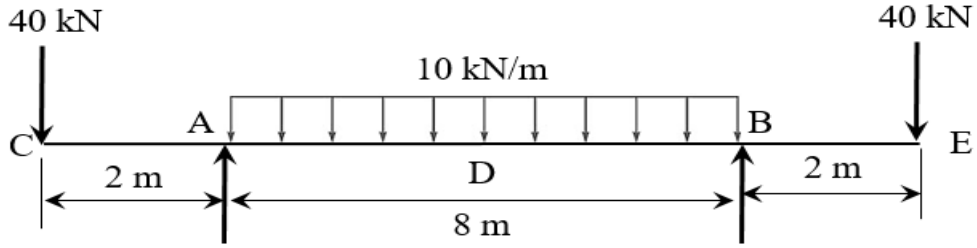
(d) Determine the strain energy for the specimens shown in figure loaded with load of 150 kN intensity. Take E = 2 x 10^5 N/mm^2. **(5)**



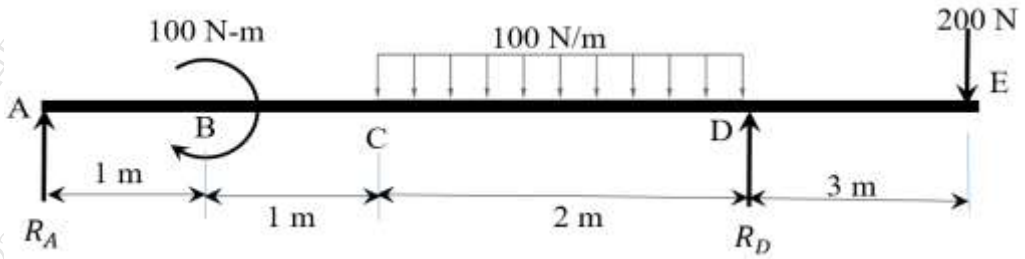
(e) Describe the types of end conditions for column. **(5)**

Q2 (a) At a point in a bracket the stresses on two mutually perpendicular planes are 35 MPa and 15 MPa both tensile. The shear stress across these planes is 9 MPa. Find analytically, the magnitude and direction of the resultant stress on a plane making an angle of 40 degrees with the plane of first stress. Find also the normal and tangential stresses on the planes. Verify the answer graphically. **(10)**

(b) An overhanging beam with supports at point A and B is loaded as shown in figure. Compute the slope at A and deflection at the midpoint. Take EI = Constant. **(10)**

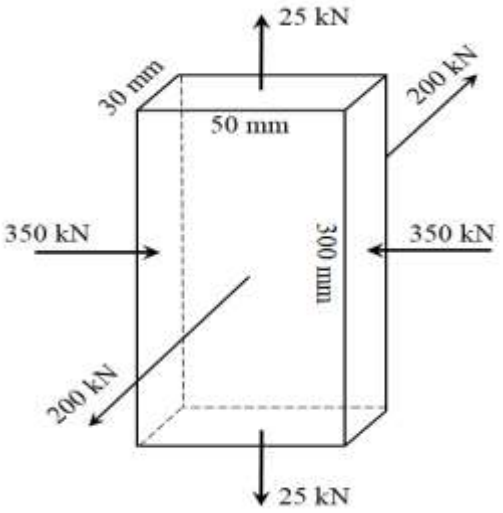


Q3 (a) Beam, A-E is loaded as shown in figure. Determine the shear force and bending moment diagram. **(10)**



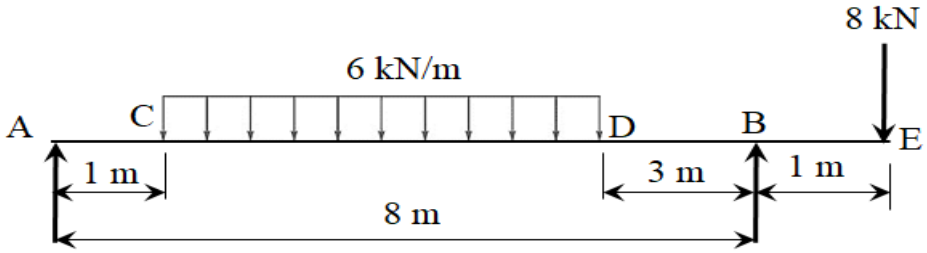
(b) A cylindrical shell 3m long which is closed at the ends has an internal diameter of 1m and a wall thickness of 15mm. Calculate the circumferential and longitudinal stresses induced and also change in the dimensions of the shell if subjected to and internal pressure of 1.5 MPa. Take E = 200 GPa and 1/m = 0.3 **(10)**

Q4 (a) A cast iron bar 300 mm long and of 30 mm by 50 mm uniform section is acted upon by the forces as shown in forces. Determine the change in volume of bar. Take E = 140 GPa and m = 4. **(10)**



(b) Classify beams and also explain concept of statically determinate and indeterminate beams. **(10)**

Q5 (a) Beam AE is loaded as shown in figure. Determine the deflection at free end E and slope at A. Take E = 210 GPa and I = 20 x 10^6 mm^4 **(10)**



(b) A vertically hung bar is 2m long and has a diameter of 25mm. A weight of 600N is dropped from a height h on a collar attached to the end of the bar. Find the height of drop if the stress in the bar is not to exceed 100 MPa. Also find the maximum weight that can be dropped from this height without causing any permanent deformation. The stress at elastic limit is 220 MPa and E = 200 GPa. **(10)**

Q6 (a) A thin spherical shell 1m in diameter with wall thickness of 12 mm is filled with a fluid at atmospheric pressure. What will be the intensity of pressure if 175 cm^3 more fluid is pumped into it? Also calculate circumferential stress at that pressure and increase in diameter. Take E = 200 GPa and 1/m = 0.3. **(10)**

(b) A 4m long fixed end hollow cast iron column supports an axial load of 1 MN. The external diameter of the column is 200mm. Determine the thickness of the column using Rankine formula taking a constant of 1/6400 and working stress of 78 MPa. **(10)**

Duration: 3 Hours **Total Marks- 80**

N.B. 1) FirstQuestion(Q.1)isCompulsory.
2) Attemptany three questionsfromtheremainingquestions.
3) Figurestotherightindicatefullmarks
4) Proportionateand labelledfree-handsketcheswoulddo

Q1. Write a short note on (Any four) 20

a) Shell moulding.
b) Radiant welding.
c) Grinding operation.
d) Thermosetting plastic.
e) Defects in forged components.

Q2. a) Differentiate between open die forging and closed die forging. 10
b) Explain friction welding process with advantages and disadvantages 10

Q3. a) Explain the classification of production processes with itsapplications. 10
b) Explain the standard gear cutters with its advantages and limitations. 10

Q4. a) Describe eight casting defects with their causes and remedies.
b) Explainwith neat sketchestypes of welding joints and welding positions. 10

Q5. a) What is meant by riser? Explain its types and applications. 10
b) Explain Trueing and Dressing in grinding process 10

Q6. a) Derive Taylor's tool life equation. 10
b) Explain cloud manufacturing and Internet of things(IoT) in manufacturing. 10

****

Duration: 3 Hours **Total Marks- 80**

1) First Question (Q.1) is Compulsory.
2) Attempt any 3 questions from the remaining 5 (Q.2 - Q.6) questions.
3) Figures to the right indicate full marks
4) Proportionate and labelled free-hand sketches would do

Q. 1 Solve any Four out of Six. **20**

a) Differentiate between Edge and Screw dislocation.
b) Draw and discuss the S-N diagram.
c) Explain Jomny-End-Quench Test.
d) Explain Ultrasonic testing.
e) Discuss classification of materials.
f) Discuss ductile-brittle transition in steel.

Q. 2 a) Draw and explain slow cooling of steel containing 0.9% carbon when cooled from 1600^0C temperature to room temperature **10**

b) Draw and explain ceramic injection moulding process with its advantages, Limitations. **10**

Q. 3 a) Define creep and explain classical creep curve in detail. **10**

b) How surface hardening different from case hardening? Explain flame hardening in detail. **10**

Q. 4 a) Classify crystal imperfections. Explain surface defect in detail. **10**

b) Explain isomorphous and eutectic reaction with neat sketch. **10**

Q. 5 a) Derive an expression for Griffith's theory of brittle fracture **10**

b) Explain critical resolved shear stress, Derive an expression for the same. **10**

Q. 6 Write short notes on **(Any four)** **20**

a) Composite and its classification.
b) Effect of retained austenite on steels.
c) Nano materials and their synthesis route.
d) Hume- Rothery's rules of solid solubility.
e) Maraging Process.
f) Smart Material.

Duration: 3hrs **[Max Marks:80]**

N.B. : (1) Question No 1 is Compulsory.
(2) Attempt any three questions out of the remaining five.
(3) All questions carry equal marks.
(4) Assume suitable data, if required and state it clear

1 Attempt any FIVE **[20]**

a) Define property and explain the difference between Intensive and extensive properties with example.

b) In a non-flow reversible process, the pressure and volume are related by $p = V^2 + \frac{10}{V}$
Where p is N/m^{2}and V is Volume in m^3, During the process the volume changes from 1.5 m^3 to 4.5 m^3 and heat added is 3000 J. Determine the change in Internal Energy.

c) Define second law of thermodynamics and explain PMM of second kind

d) Define a) wet steam b) Superheated steam c) Dryness fraction d) Saturation temperature.

e) Define a) Mach Number b) Stagnation temperature c) Stagnation Pressure d) Sonic velocity

f) What is Brayton Cycle? Represent this on (P-v) and (T-S) diagram

g) Prove that Entropy is property of the system

2 **a)** A system executes a cyclic process which comprise of three processes. The energy transfer in each process are tabulated below. If the net workdone per cycle is 30 kJ and the system completes 10 cycles/min. Complete the table and find the rate of work in kw **[10]**

Process	Q	W	dU
1-2	50	---	20
2-3	----	30	-10
3-1	----	----	----

b) Define Thermal Reservoir. Difference between Heat Engine, Heat pump, Refrigerator Drive the COP of heat pump is greater than one **[10]**

3 **a)** 2 kg of an ideal gas occupies a volume of 0.3m^3 at 10 bar pressure and 500K temperature when this gas expands polytropically $PV^{1.2}$ =C the internal energy decreases by 300KJ . and γ = 1.4 Determine a) Specific gas constant b) Final temperature, pressure and volume c) Heat and work interaction across the system boundary. **[12]**

b) Define and explain the terms Available energy, Un-available energy, irreversibility and Dead state. **[08]**

4	**a)**	Draw Schematics and derive efficiency equation for Rankine cycle.	**[10]**
	b)	Explain various components of a simple steam power plant with sketch.	**[06]**
	c)	Draw PV diagram of Lenoir cycle and explain the processes	**[04]**
5	**a)**	Draw Otto and Diesel cycle using P-V and T-S diagram, show that the efficiency of the Otto cycle depends only on the compression ratio.	**[10]**
	b)	Define a) wet steam b) Superheated steam c) Dryness fraction d) Saturation temperature. Steam initially at 0.95 dry and 12 bar expands isentropic ally in a non-flow process in a final dryness fraction of 0.8. What is the final pressure of steam and enthalpy change during the process?	**[10]**
6	**a)**	Explain the effect of variation in back pressure on C-D nozzle performance	**[10]**
	b)	Prove that Entropy is property of the system	**[06]**
	c)	Write the Maxwell equation, Clapeyron Equation, Mayer relation	**[04]**

****