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 $L\{f(t)\} = \dfrac{s}{s^2+s+4}$, 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 $f(t) = \dfrac{\cos at - \cos bt}{t}$ **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 $[-\pi, \pi]$

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

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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.

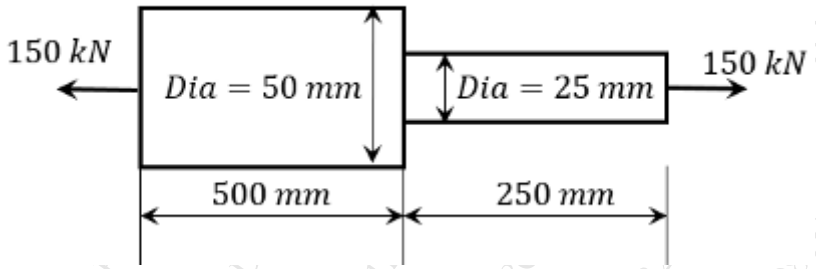
Q1 Attempt any **four** of the following

(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)**

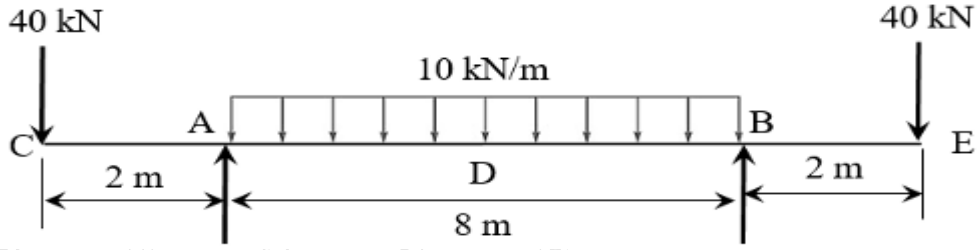
(d) Determine the strain energy for the specimens shown in figure loaded with load of 150 kN intensity. Take E = 2 x 10^5 N/mm^2. **(5)**



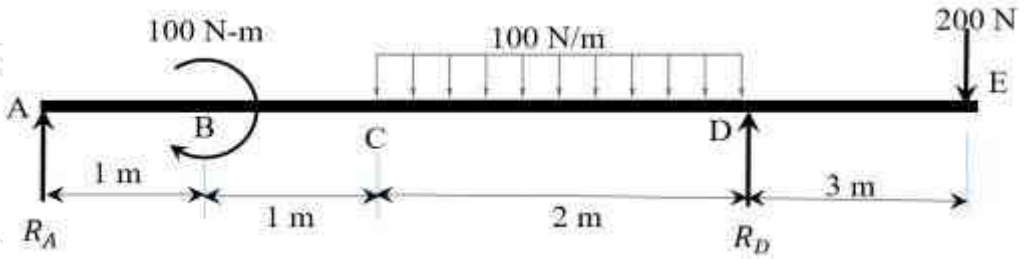
(e) Describe the types of end conditions for column. **(5)**

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)**

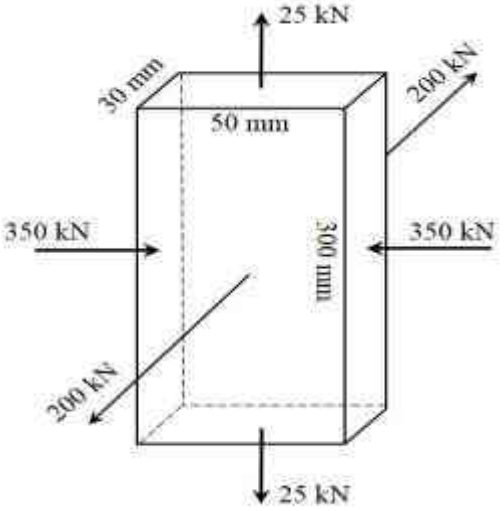


Q3 (a) Beam, A-E is loaded as shown in figure. Determine the shear force and bending moment diagram. **(10)**



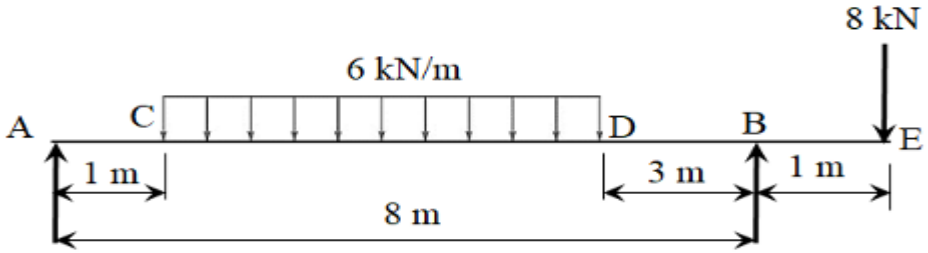
(b) A cylindrical shell 3m long which is closed at the ends has an internal diameter of 1m and a wall thickness of 15mm. Calculate the circumferential and longitudinal stresses induced and also change in the dimensions of the shell if subjected to and internal pressure of 1.5 MPa. Take E = 200 GPa and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

NB: 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) Explain types of gates .
b) Differentiate between soldering and brazing.
c) Explain selection of grinding wheel.
d) Explain Internet of Things.
e) Discuss Electro-chemical machining.
f) Various steps involved in powder metallurgy.

Q. 2 a) Draw and explain Geometry of a Single Point Cutting Tool. **10**
b) Draw and explain screw type injection moulding process with its advantages, Limitations and applications. **10**

Q. 3 a) Explain working, advantages and limitations of ultrasonic machining. **10**
b) Draw and explain significance of various elements of gating system in sand casting. **10**

Q. 4 a) Draw and explain in brief the various welding defects their causes and remedies. **10**
b) Describe the types of drilling machine and their application. **10**

Q. 5 a) Explain working of Submerged Arc Welding with its applications, advantages. and limitations. **10**
b) Draw and explain in brief the various rolling defects their causes and remedies. **10**

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

a) Compare wood and metal as pattern materials.
b) Classify Production Processes..
c) Quick return mechanism on shaper.
d) Open die and Closed die forging.
e) CO2 Shell Moulding Process.
f) Cloud manufacturing.

(3 Hours) **Total Marks :80**

Note: 1) Question No.1 is compulsory

2) Attempt any Three from the remaining

Q1

a) Find L[$sinh^5 t$] **5**

b) Find a , b , c, d ,e if
f(z)= (ax^3 +by^2x + $3x^2$ +cy^2 +x)+i(d x^2y - $2y^3$ +exy +y) is analytic **5**

c) Find half range sine series of f(x) = x(π – x) in (0 , π) **5**

d) If $A = \begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}$ Find eigenvalue of Adj(A) **5**

Q2

a) If L[f(t)] = $\frac{9s}{9s^2-3s+6}$ then find L[e^t f(3t)] **6**

b) Find Fourier series for f(x)= x^2 ; $-\pi < x < \pi$ and f(x+ 2π) = f(x) **6**

c) Find analytic function f(z)=u+iv in terms of z where **8**
u + v = e^x (cosy + siny)

Q3

a) A string is stretched and fastened to two points distance l apart. Motion is started by displacing the string in the form y=a sin(πx/ l) from which it is released at time t=0.Show that the displacement of a point at a distance x from one end at time t is given by **6**

$$y = a \sin\left(\frac{\pi x}{l}\right) \cos\left(\frac{\pi ct}{l}\right)$$

b) Prove that u=x^2 -y^2 -2xy +2x -3y is harmonic function hence find it's harmonic conjugate function. **6**

c) Find the Fourier series to represent f(x) = $\begin{cases} x\ , & 0 < x < \pi \\ 2\pi - x\ , & \pi < x < 2\pi \end{cases}$ in (0 , 2π) **8**

Q4

a) Evaluate $\int_0^\infty e^{-t}\left[\frac{\cos 6t-\cos 4t}{t}\right]dt$ **6**

b) Find inverse Laplace transform of $\frac{1}{(s-2)^2(s+1)}$ **6**

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

Q5

Using Cayley Hamilton Theorem find $A^9-6A^8+10A^7-3A^6+A+I$

a) where $A=\begin{bmatrix}1 & 2 & 3\\ -1 & 3 & 1\\ 1 & 0 & 2\end{bmatrix}$ **6**

b) Solve by Crank-Nicholson simplified formula $\frac{\partial^2 u}{\partial x^2}-\frac{\partial u}{\partial t}=0$, $0\le x\le 1$ subject to the condition $u(0,t)=0, u(1,t)=100$, $u(x,0)=100\,(x-x^2)$ & h=0.25 for one time step **6**

c) Find the inverse Laplace transform of **8**

(i) $\log[(s^2-4)(s^2-9)]$

(ii) $\frac{s}{(s-5)^2}$

Q6

a) Find the Laplace Transform of $\int_0^t ucoshusinhudu$ **6**

b) Find the solution of $\frac{\partial^2 u}{\partial x^2}-32\frac{\partial u}{\partial t}=0$, $0<x<1$, u(x,0)=0, u(0,t)=0, u(1,t)=10+t, taking h=0.25, k=0.025 for $0\le t\le 1$ where 'h' is the step length for x axis and 'k' is the step size in time direction using Bender-Schmidt method. **6**

c) Find inverse Laplace transform of $\frac{s}{(s^2+16)^2}$ using convolution theorem **8**
