

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.
-

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 clearly.

1

a Find $L\left\{\frac{\sin t}{t}\right\}$ [05]

b Find the Fourier coefficient of the function $f(x) = x^2$ in $(-\pi, \pi)$ [05]

c Determine the constants a, b, c, d, e if [05]

$f(z) = (ax^3 + bxy^2 + 3x^2 + cy^2 + x) + i(dx^2y - 2y^3 + exy + y)$ is analytic.

d Given $6y = 5x + 90$, $15x = 8y + 130$, $\sigma_x^2 = 16$. [05]

Find i) the means of x and y ii) r iii) σ_y^2

2 a Using convolution theorem find $L^{-1}\left\{\frac{1}{s^2(s+5)^2}\right\}$ [06]

b Find orthogonal trajectories of $x^3y - xy^3 = c$ [06]

c Solve using Bender-Schmidt method: $\frac{\partial^2 u}{\partial x^2} - 2\frac{\partial u}{\partial t} = 0$; subject to the conditions $u(0, t) = 0$; $u(4, t) = 0$; $u(x, 0) = x(4 - x)$ taking $h = 1$ and find the values of u upto $t = 5$ seconds. [08]

3 a Find the Complex form of Fourier series for $f(x) = e^x$ in $(0, 2\pi)$ [06]

b Obtain Taylor's and Laurent's expansions of [06]

$$f(z) = \frac{z-1}{(z+1)(z-3)} \text{ in } 1 < |z| < 3$$

c Find Laplace transform of $f(t) = t \int_0^t e^{-2u} \sin 4u \, du$ [08]

4 a Production (in metric kiloton) of wheat in a country is given by the following data. [06]

X	2005	2007	2009	2011	2013	2015	2017
Y	8	12	15	19	21	22	25

Fit a straight line to the following data and estimate the production in the year 2010.

b Find $L^{-1}\left\{\frac{3s+7}{s^2-2s-3}\right\}$ [06]

c Evaluate $\int_C \frac{\sin^6 z}{\left(z - \frac{\pi}{6}\right)^3} dz$ where C is the circle $|z| = 1$ [08]

5 a If $v = 3x^2y + 6xy - y^3$, show that v is harmonic and find the corresponding analytic function. [06]

b Obtain the Half Range Fourier Cosine Series of $f(x) = x, 0 \leq x \leq 2$ and deduce that $\frac{\pi^4}{96} = \frac{1}{1^4} + \frac{1}{3^4} + \frac{1}{5^4} + \dots$ [06]

c Solve using Crank-Nicolson formula: $\frac{\partial^2 u}{\partial x^2} - 16 \frac{\partial u}{\partial t} = 0, 0 < x < 1, t > 0$ subject to the conditions: $u(x, 0) = 0; u(0, t) = 0; u(1, t) = 200t$ Compute u for one step in t division taking $h = 0.25$ [08]

6 a

X	12	17	22	27	32
Y	113	119	117	115	121

 [06]

Compute Spearman's rank correlation coefficient (R) from the given data.

b Obtain the Bilinear transformation that transforms the points $z = 2, i, -2$ respectively to the points $w = 1, i, -1$ [06]

c Evaluate $\int_0^{2\pi} \frac{d\theta}{17-8\cos\theta}$ [08]

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 clearly.

1

- a Find $L\left\{\frac{\sin t}{t}\right\}$ [05]
 b Find the Fourier coefficient of the function $f(x) = x^2$ in $(-\pi, \pi)$ [05]
 c Determine the constants a, b, c, d, e if [05]
 $f(z) = (ax^3 + bxy^2 + 3x^2 + cy^2 + x) + i(dx^2y - 2y^3 + exy + y)$ is analytic.
 d Given $6y = 5x + 90, 15x = 8y + 130, \sigma_x^2 = 16$. [05]
 Find i) the means of x and y ii) r iii) σ_y^2

2

- a Using convolution theorem find $L^{-1}\left\{\frac{1}{s^2(s+5)^2}\right\}$ [06]
 b Find orthogonal trajectories of $x^3y - xy^3 = c$ [06]
 c Solve using Bender-Schmidt method: $\frac{\partial^2 u}{\partial x^2} - 2\frac{\partial u}{\partial t} = 0$; subject to the conditions [08]
 $u(0, t) = 0; u(4, t) = 0; u(x, 0) = x(4 - x)$ taking $h = 1$ and find the values of u upto $t = 5$ seconds.

3

- a Find the Complex form of Fourier series for $f(x) = e^x$ in $(0, 2\pi)$ [06]
 b Obtain Taylor's and Laurent's expansions of [06]
 $f(z) = \frac{z-1}{(z+1)(z-3)}$ in $1 < |z| < 3$

- c Find Laplace transform of $f(t) = t \int_0^t e^{-2u} \sin 4u du$ [08]

4

- a Production (in metric kiloton) of wheat in a country is given by the following data. [06]

X	2005	2007	2009	2011	2013	2015	2017
Y	8	12	15	19	21	22	25

Fit a straight line to the following data and estimate the production in the year 2010.

- b Find $L^{-1}\left\{\frac{3s+7}{s^2-2s-3}\right\}$ [06]

- c Evaluate $\int_C \frac{\sin^6 z}{\left(z - \frac{\pi}{6}\right)^3} dz$ where C is the circle $|z| = 1$ [08]

5 a If $v = 3x^2y + 6xy - y^3$, show that v is harmonic and find the corresponding analytic function. [06]

b Obtain the Half Range Fourier Cosine Series of $f(x) = x, 0 \leq x \leq 2$ and deduce that $\frac{\pi^4}{96} = \frac{1}{1^4} + \frac{1}{3^4} + \frac{1}{5^4} + \dots$ [06]

c Solve using Crank-Nicolson formula: $\frac{\partial^2 u}{\partial x^2} - 16 \frac{\partial u}{\partial t} = 0, 0 < x < 1, t > 0$ subject to the conditions: $u(x, 0) = 0; u(0, t) = 0; u(1, t) = 200t$ Compute u for one step in t division taking $h = 0.25$ [08]

6 a

X	12	17	22	27	32
Y	113	119	117	115	121

 [06]

Compute Spearman's rank correlation coefficient (R) from the given data.

b Obtain the Bilinear transformation that transforms the points $z = 2, i, -2$ respectively to the points $w = 1, i, -1$ [06]

c Evaluate $\int_0^{2\pi} \frac{d\theta}{17-8 \cos\theta}$ [08]

Duration: 3 Hours

Total Marks- 80

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

- 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 its applications. 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) Explain with neat sketches types 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

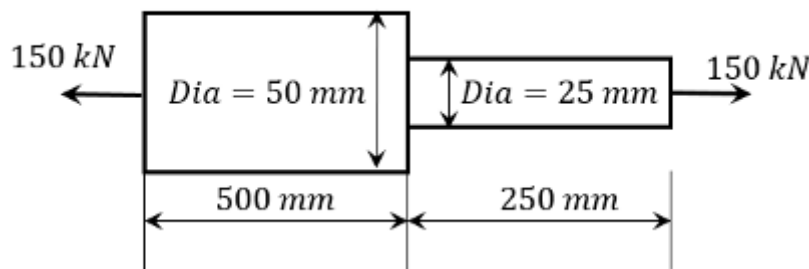
Time: 3 Hrs

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

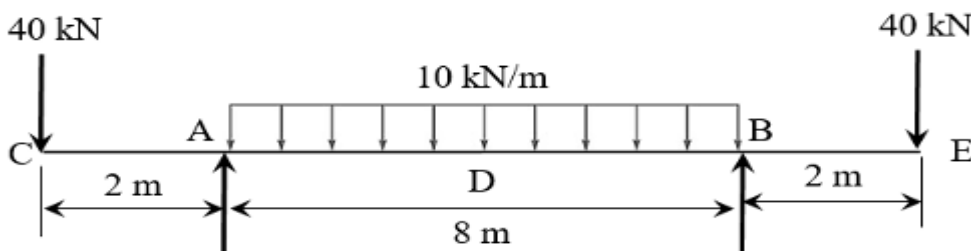
- (a) Derive relation between modulus of elasticity and bulk modulus (5)
- (b) Draw the shear force and bending moment diagrams for a simply supported beam of length L and loaded with uniformly varying load of intensity w kN/m at one end and zero at the other end. (5)
- (c) Derive differential equation for the elastic curve (5)
- (d) Determine the strain energy for the specimens shown in figure loaded with load of 150 kN intensity. Take $E = 2 \times 10^5 \text{ N/mm}^2$. (5)



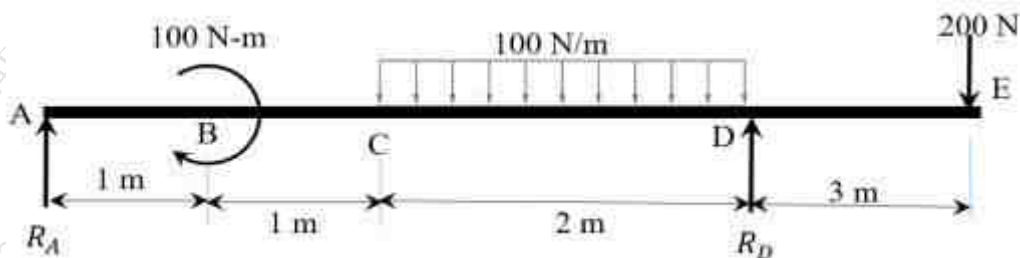
- (e) Describe the types of end conditions for column. (5)

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 $EI = \text{Constant}$. (10)

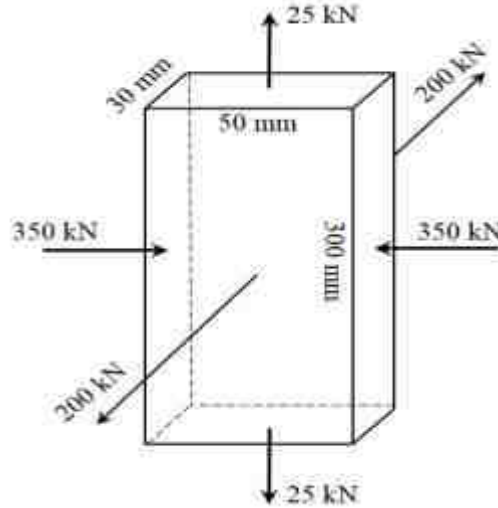


Q3 (a) Beam, A-E is loaded as shown in figure. Determine the shear force and bending moment diagram. (10)



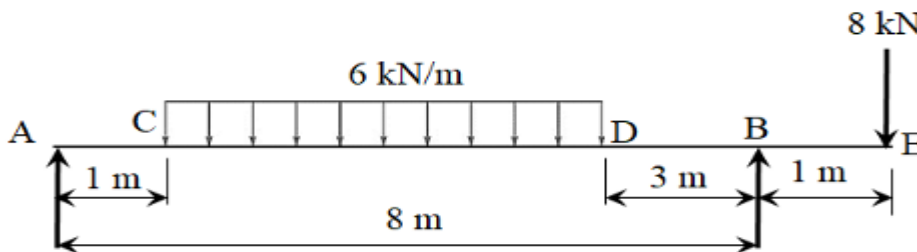
- (b) A cylindrical shell 3m long which is closed at the ends has an internal diameter of 1m and a wall thickness of 15mm. Calculate the circumferential and longitudinal stresses induced and also change in the dimensions of the shell if subjected to an internal pressure of 1.5 MPa. Take $E = 200 \text{ GPa}$ and $\nu = 0.3$ (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 figure. Determine the change in volume of bar. Take $E = 140 \text{ GPa}$ and $\nu = 0.4$. (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 $E = 210 \text{ GPa}$ and $I = 20 \times 10^6 \text{ mm}^4$ (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 $E = 200 \text{ GPa}$. (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 $E = 200 \text{ GPa}$ and $\nu = 0.3$. (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)

(3 Hours)

[Total Marks :80]

N.B.

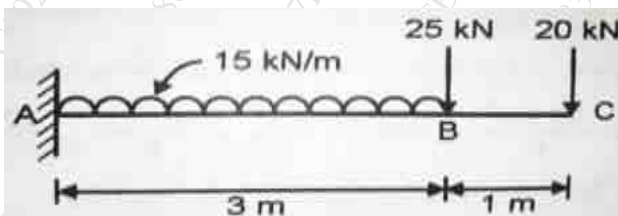
1. Question No.1 is compulsory.
2. Answer any three questions from remaining questions.
3. Assume suitable data if required.
4. Figure to the right indicates full marks.

Q1 Answer any four. Each question carries same mark **5x4=20**

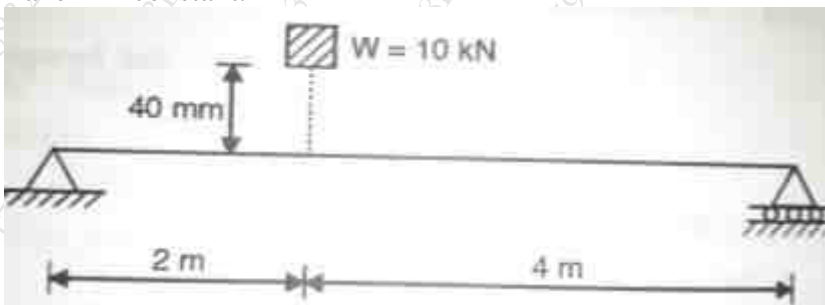
- a For a two-dimensional state of stress What do you mean by principal stresses and maximum shear stress? Explain with example.
- b Derive expression for deformation of uniformly tapering circular section bar.
- c Write the assumptions made in theory of pure torsion and derive torsional formula.
- d What are the different end conditions used in columns?
- e Explain the stress strain diagram for ductile material.

Q2 a A bar of 25 mm diameter is tested in tension. It is observed that when a load of 60kN is applied, the extension measured over a gauge length of 200 mm is 0.12 mm and contraction in diameter is 0.0045 mm. Find Poisson's ratio and elastic constants E, G, K. **10**

- b Calculate deflection at point B and C for the beam as shown in figure using any method. Take $EI=32000\text{KN.m}^2$. **10**

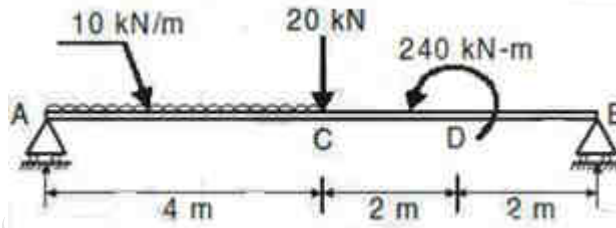


Q3 a A weight of 10 KN is dropped on to a simply supported beam for a height of 40 mm. Assuming the impact to be perfect without any loss of energy, Determine the instantaneous deflection at the impact point. Take $EI=$ constant. **10**

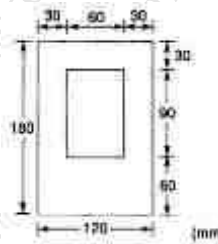


- b An I section beam 350mm x 150 mm has a web thickness 10mm and flange thickness 20mm. If the shear force acting on the section is 40 KN find: **10**

- 1 Max shear stress developed in the section
 2 Sketch the shear stress distribution diagram.
 3 The total shear force carried by web.
- Q4** a A beam of span 8 m has roller support at A and hinge support at B as shown in Fig. Calculate SF and BM at important points and Draw SF and BM diagrams **10**



- b Derive bending equation. Also state the assumption made in the analysis **10**
- Q5** a The cross section of the beam is shown in figure. Determine the moment of resistance for both positive and negative of bending moment about horizontal neutral axis. Take tensile and compressive stresses as 24 and 85 N/mm^2 respectively. **10**



- b A short hollow cylindrical column of 200 mm external diameter, 100mm internal diameter and 8m long has both ends fixed. It is subjected to axial compression load. Taking FOS as 5, $\sigma_c=450$ MPa & $\alpha = 1/1600$. Determine safe Rankine's load. **10**
- Q6** a A cylindrical shell is 150 cm long, 22cm internal diameter of 8mm thick plates is subjected to internal pressure 15 N/mm^2 , $E=2.1 \times 10^5$ N/mm^2 , Bulk modulus of water is 200 N/mm^2 and $1/m=0.28$. Find the change in volume of the shell. **10**
- b A bar of brass 20 mm is enclosed in a steel tube of 40 mm external diameter and 20 mm internal diameter. The bar and the tubes are initially 1.2 m long and are rigidly fastened at both ends using 20 mm diameter pins. If the temperature is raised by 60°C, find the stresses induced in the bar, tube and pins. **10**
- $E_s = 2 \times 10^5$ N/mm^2
 $E_b = 1 \times 10^5$ N/mm^2
 $\alpha_s = 11.6 \times 10^{-6}/^\circ C$
 $\alpha_b = 18.7 \times 10^{-6}/^\circ C$

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 $f(x) = x^2, -\pi \leq x \leq \pi$ 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 $L[te^{3t} \sin t]$ 5

Q2.

- Evaluate the following Integral using Laplace Transforms. 6
- a) $I = \int_0^{\infty} \frac{\sin^2 t e^{-t}}{t} dt$ 6
- b) Determine the Fourier Series $f(x) = \left(\frac{\pi-x}{2}\right)^2$ over $[0, 2\pi]$. 8
- c) Prove that $u = x^2 - y^2 - 2xy - 2x + 3y$ is harmonic and find its harmonic conjugate. 8

Q3.

- 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
- a) Determine the analytic function $f(z) = u + iv$ where $u = 3x^2y - y^3$. 6
- b) Determine the Inverse Laplace Transform of i) $\frac{s+2}{s^2-4s+13}$ 4
- c) ii) $\tan^{-1}(s)$ 4

Q4. i) If $L\{f(t)\} = \frac{s}{s^2 + s + 4}$, find $L\{e^{-2t} f(2t)\}$ **3**

a)

ii) Find $L(t^2 \sin at)$ **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**

a)

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

b)

Solve $\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0$, by Crank-Nicholson simplified formula, where **8**

c) $u(0, t) = 0, u(4, t) = 0, u(x, 0) = \frac{x}{3} (16 - x^2)$, find u_{ij} , for

$i = 0, 1, 2, 3, 4$ and $j = 0, 1, 2$ taking $h = 1$.

Q6. a) Find analytic function $f(z)$ whose imaginary part is $e^x \cos y + x^3 - 3xy^2$ **6**

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

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

over $[-\pi, \pi]$

(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 $f(z) = (ax^3 + by^2x + 3x^2 + cy^2 + x) + i(dx^2y - 2y^3 + exy + y)$ is analytic 5
- c) Find half range sine series of $f(x) = x(\pi - x)$ in $(0, \pi)$ 5
- d) If $A = \begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}$ Find eigenvalue of $\text{Adj}(A)$ 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 $f(x + 2\pi) = f(x)$ 6
- c) Find analytic function $f(z) = u + iv$ in terms of z where $u + v = e^x (\cos y + \sin y)$ 8

Q3

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

- 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 its 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 $(0, 2\pi)$ 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 $\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0$, $0 \leq x \leq 1$ 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

Find the inverse Laplace transform of

c) (i) $\log[(s^2 - 4)(s^2 - 9)]$ 8
 (ii) $\frac{s}{(s-5)^2}$

Q6

a) Find the Laplace Transform of $\int_0^t u \cosh u \sinh u du$ 6

Find the solution of $\frac{\partial^2 u}{\partial x^2} - 32 \frac{\partial u}{\partial t} = 0$, $0 < x < 1$,

b) $u(x, 0) = 0, u(0, t) = 0, u(1, t) = 10 + t$, taking $h = 0.25, k = 0.025$ for $0 \leq t \leq 1$ 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