

(3 Hours)

Total Marks :80

- N.B.** (1) Question No. 1 is compulsory.  
 (2) Attempt any three questions form remaining five questions.  
 (3) Draw neat sketches wherever necessary.  
 (4) Figures to the right indicate full marks.  
 (5) Answer each and every question combined manner in order.
- Q. 1. (a) Identify the following minerals with the help of physical properties **5**  
 (i) Conchoidal fracture, cleavage absent, colour smoky, hardness 7  
 (ii) Lamellar form, luster pearly, colour black, cleavage basal pinacoid  
 (iii) Rhombohedral form, cleavage three sets, hardness 3, colour white  
 (iv) Barrel shape, colour reddish grayish, hardness 9, used as abrasive and its varieties used as precious stones  
 (v) Crystalline form, flesh colour, hardness 6, cleavage two sets
- (b) Name the following- **5**  
 (i) Two Igneous rocks  
 (ii) The heap of angular fragments at the base of hill in permafrost area  
 (iii) Metamorphism of limestone  
 (iv) Rock contains silica percent more than 66 %  
 (v) Discontinuity between crust and mantle
- (c) Write the difference between- **10**  
 (i) Streak and strike  
 (ii) Crust and Crest  
 (iii) Aquifer and Aquifuge  
 (iv) Rock forming mineral and ore mineral  
 (v) Conglomerate and breccia
- Q. 2. (a) Describe in detail the geological action of river with different types of landforms. **10**  
 (b) State different types of weathering with examples. **10**
- Q. 3. (a) Explain terminology of fold with diagram. Explain various types of fold. **10**  
 (b) Explain Divergent Plate boundary ? **4**  
 (c) At a brick site a sill is exposed in a level ground which dips 40° northwards and its true thickness is 180 m. Determine its vertical thickness and width of the outcrop. **6**
- Q. 4. (a) Describe various structures of igneous rock. **10**  
 (b) Explain formation of sedimentary rock with structures. **10**

- Q. 5 Write short notes on **(any four)** **20**
- (i) Thermal metamorphism
  - (ii) Angular unconformity
  - (iii) Describe various suitable and unsuitable geological structures while construction of dam.
  - (iv) Types of Geological Investigation
  - (v) Cone of depression
  - (vi) Volcanic products
  - (vii) What are the precautionary measures for landslide.
  - (viii) Elastic Rebound Theory

- Q. 6. (a) Classify the rocks according to Geomechanics classification for a Rock having UCS of 200 Mpa and RQD of 75 % with average spacing of discontinuity of 1000 mm which is slightly rough in nature and highly weathered. The strike is perpendicular to the tunnel axis and drive with dip is  $40^\circ$ . Also 7 lit/min groundwater inflows the tunnel length per 10 m. State the condition of rocks for tunnel construction (Geomechanical classification parameter table should be provided to students). **10**

- (b) What is Run, core recovery and RQD? Calculate the value of Core Recovery and RQD from the following data. Mention your opinion. Total Run = 3 m. **10**

Sr.No.	Length of core sample (in cm)	Nature of joints at lower end of core sample
1	12	N
2	4	M
3	3	N
4	17	M
5	3	M
6	7	M
7	29	N
8	5	N
9	8	N
10	6	N
11	42	N
12	35	N
13	5	N
14	3	M
15	4	N

(3) Hours

Total Marks : 80

- N.B.**
1. Question No. 1 is compulsory
  2. Attempt any Three questions out of remaining Five questions.
  3. Draw neat labeled diagrams wherever necessary.
  4. All the parts of a question should be grouped together.
  5. Figures to the right indicate marks

- Q.1a** Write the identifying properties and economic use of the following minerals **5**
- (i) Hematite
  - (ii) Gypsum
  - (iii) Quartz
  - (iv) Talc
  - (v) Diamond
- Q.1b** Explain with labeled diagram- **10**
- (i) Zones of Groundwater
  - (ii) Dip and strike
  - (iii) Disconformity
  - (iv) Focus
  - (v) Sill
- Q.1c** Answer the following- **5**
- (i) Lithification
  - (ii) Hinge of the fold
  - (iii) Solifluction
  - (iv) Fissure Eruption
  - (v) Asthenosphere
- Q.2** **10**
- (a) Explain types of weathering? Differentiate between physical and chemical weathering. **10**
  - (b) Define Plate Tectonics. How the movement of lithospheric plates modifies earth surface? **10**
- Q.3(a)** Explain texture and classification of igneous rocks with suitable diagram. **10**
- (b) At a brick site a sill is exposed in a level ground which dips 60° northwards and its true thickness is 200 m. Determine its vertical thickness and width of the outcrop. **6**
  - (c) Explain shallow water structure of sedimentary rock. **4**
- Q.4 (a)** **10**
- What are Faults? Explain classification of faults and its engineering consideration. **10**
- (b) What is the aquifer? Explain fluctuations in unconfined aquifer and its use in civil engineering. **10**
- Q.5** **10**
- (a) What are the various forces acting on the dam? What are the geological consideration for site selection of a dam? **10**

- (b) Define RQD and Core Recovery, Calculate RQD and Core Recovery from the given data and comment on the suitability of rocks for foundation purpose. **10**  
Total run 2m.

Sample No.	Length of the core in cms	Nature of the lower end of the core sample	Sample No.	Length of the core in cms	Nature of the lower end of the core sample
a	16	N	i	20	N
b	12	N	j	10	N
c	11	N	k	17	N
d	19	M	l	7	N
e	9	M	m	5	M
f	8	N	n	3	N
g	12	N	o	10	M
h	16	N	p	5	N

- Q.6** Write short notes on any four of the following- **20**
- (i) Types of folds
  - (ii) Types of joints
  - (iii) Layered structure of Earth
  - (iv) Agents of Metamorphism
  - (v) Types of tunnels
  - (vi) Subsurface geological investigations

(03 Hours)

Marks: 80

**Instructions:**

1. Question No. 1 is Compulsory.
2. Answer any Three Questions from the remaining.
3. Each full question carries 20 marks.
4. Assume suitable data, if needed and state it clearly.

**Q. 1)** Answer any four sub-questions.

- (a) Write the assumptions of simple bending theory. (05 M)
- (b) Discuss principle of virtual work and Castigliano's theorems. (05 M)
- (c) A thin cylindrical shell has 3.5 m length. Its internal diameter is 1.5 m. & thickness is 12 mm. Determine hoop stress, longitudinal stress and maximum shear stress. Internal fluid pressure is 2 MPa, Young's modulus is 210 GPa and Poisson's ratio is 0.26. (05 M)
- (d) Derive the relationships between loading, shear force and bending moment at a section of the beam. (05 M)
- (e) Derive an expression for the strain energy stored due to gradually applied axial load. (05 M)
- (f) Explain, in brief, torsional flexibility, torsional rigidity & torsional stiffness. (05 M)

**Q. 2)** (a) A T-beam has flange dimensions of (140 mm X 25 mm) and web dimensions of (30 mm X 120 mm). It is subjected to a shear force of 90 kN. Draw shear stress distribution diagram. (10 M)

(b) A hollow circular steel shaft of 5.5 m length has to transmit 1700 kW power at 170 rpm. If internal diameter is 0.7 times the external diameter, total angle of twist is not to exceed 4.2 degrees and shear stress is limited to  $55 \text{ N/mm}^2$ , determine the diameters of the shaft. Take  $G = 85 \text{ kN/mm}^2$ . (10 M)

**Q. 3)** (a) The principal stresses at a point across two perpendicular planes are 110 MPa horizontal (Tensile) and 85 MPa vertical (Tensile). Find the normal stress, tangential stress and resultant stress and its obliquity on a plane at 32 degrees with the major principal plane. (10 M)

(b) A cantilever beam ABCD of span 12 m is fixed at left end A and is free at right end D. Spans AB = BC = CD = 4 m each. Span AB carries a UDL of 35 kN/m. A point load of 30 kN acts at C and a point load of 40 kN acts at D. Using Macaulay's double integration method, determine slope at free end D and deflection at C. (10 M)

**Q. 4)** (a) A hollow cylindrical column has both its ends fixed. The height of the column is 4.7 m. It carries an axial load of 325 kN. Adopting a factor of safety of 4, design the column by Rankine's theory. Internal diameter is 75% of external diameter. Crushing stress for material is 530 MPa and Rankine's constant is (1/1600). (10 M)

(b) Derive an expression for the change in length of a circular tapering bar which is subjected to an axial load. (10 M)

**Q. 5** (a) A T-beam of span 5.8 m is simply supported. Flange is (20 mm X 130 mm) and web is (25 mm X 170 mm). Maximum permissible bending stress is 150 MPa. Determine the maximum UDL which the beam can carry safely. (10 M)

(b) For a rectangular cross-section having width of 400 mm and depth of 650 mm, locate core or kernel of the section. (05 M)

(c) Write a note on flitched beam with neat sketches. (05 M)

**Q. 6** (a) A portal frame ABCD has left end A hinged and right end D roller-supported. Left vertical column AB and right vertical column CD are 4 m high. Top horizontal beam BC is 3 m long. Column CD carries a UDL of 25 kN/m throughout its height. Beam BC carries a central point load of 60 kN. Draw AFD, SFD and BMD for the frame. (15 M)

(b) A cantilever beam AB of span 7 m is fixed at left end A and is free at right end B. It carries a UVL varying from 25 kN/m at free end to Zero at fixed end. Draw SFD and BMD. (05 M)

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Duration: 3 Hours

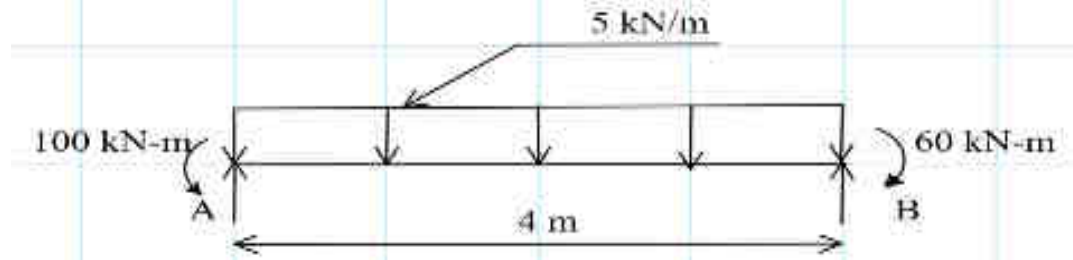
Maximum Marks: 80

Note:

1. Question No .1 is compulsory
2. Answer any Three Questions from the remaining.
3. Each full question carries 20 marks.
4. Assume suitable data, if needed and state it clearly.

Q. 1 Attempt any four

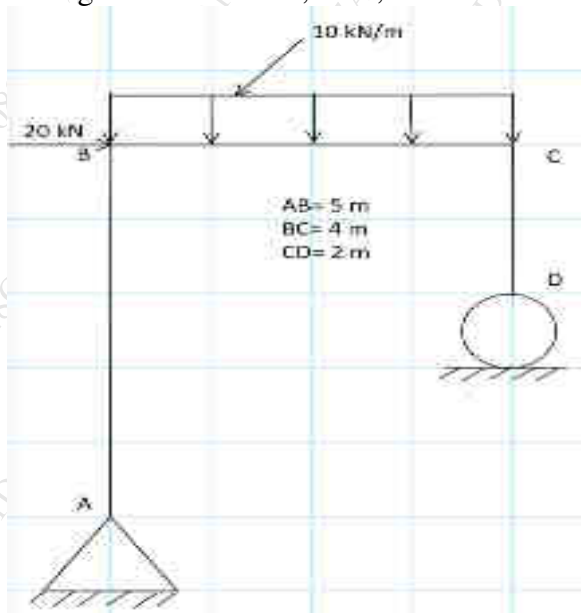
- a Water main 90 cm in diameter, contains water at a pressure head of 100m. If the unit weight of water is  $10 \text{ kN/m}^3$ , find the thickness of the metal required for the water main. Take the allowable stress as 20 MPa. 5
- b FBD of a member is as shown. Draw BMD and locate point of contra-flexure from A. 5



- c Determine the strain energy stored in the hollow circular shaft of 2 m length having internal diameter 250 mm with metal wall thickness 50 mm, if the maximum allowable shear stress 50 MPa. Take  $G = 8 \times 10^4 \text{ N/mm}^2$ . 5
- d Find the power transmitted by a circular shaft 5 cm in diameter at 2.5 Hz. If the maximum permissible shear stress is  $80 \text{ N/mm}^2$ . 5
- e Explain "Principal planes" and "Principal Stresses." 5

Q. 2

- a A portal frame shown in figure. Draw AFD, SFD, & BMD. 12



- b A built up thin cylindrical shell of 1m diameter, 4 m long and 8 mm thick is subjected to an internal fluid pressure of  $3.75 \text{ MN/m}^2$ . Calculate the hoop and longitudinal strains of the cylindrical shell, if the efficiencies of the longitudinal and circumferential joints are 80% and 40% respectively. Take  $E = 210 \text{ GN/m}^2$  &  $\mu = 0.3$ . 08

- Q. 3**
- a** The stresses at a point in a bar are  $80 \text{ N/mm}^2$  and  $60 \text{ N/mm}^2$  both tensile. Calculate normal, tangential and resultant stresses & its obliquity on an inclined plane making an angle of  $70^\circ$  with the axis of first principal stress. Use Mohr's circle method. **10**
- b** An object 150 N weight falls by gravity at a vertical distance 5 m, when it is suddenly stopped by a collar at the end of vertical rod of length 12 m and diameter 20 mm. The top of the bar is rigidly fixed. Calculate the maximum stress and strain energy induced in the bar due to impact. Take  $E = 200 \text{ GN/m}^2$ . **10**
- Q. 4**
- a** A seamless thin spherical shell 900mm internal diameter, 10mm thick. It is subjected to a fluid pressure of 2.5 MPa. Determine the change in diameter and volume of the shell. Take  $E=200 \text{ kN/mm}^2$  and  $1/m = 0.3$ . **10**
- b** Determine the strain energy of a cantilever beam of span 4 m having c/s 50 mm wide x 80 mm deep and subjected to a UDL of 6 kN/m through-out its span. Take  $E = 200 \text{ GN/m}^2$ . **10**
- Q. 5**
- a** At a point two mutually perpendicular direction the stresses are  $90 \text{ N/mm}^2$  tensile and  $60 \text{ N/mm}^2$  compressive. Each of above stress accompanied by a shear stress of  $40 \text{ N/mm}^2$ . Determine analytically resultant stress and its obliquity on an oblique plane inclined at an angle of  $30^\circ$  with the axis of minor tensile stress. **10**
- b**
- State and Explain Principle of virtual work. **10**
  - State and Explain Principle of Superposition. **10**
- Q. 6**
- a** A seamless cylindrical shell 3m long which is closed at the ends has an internal diameter of 1.1 m and a wall thickness of 12 mm. Calculate the hoop and longitudinal stresses induced and also determine change in diameter and length of shell, if it is subjected to an internal pressure of 2.5 MPa. Take  $E = 200 \text{ GPa}$  and Poisson's ratio = 0.3. **10**
- b** A solid steel shaft has to transmit 100 kW at 200 rpm. Calculate suitable diameter of the shaft, if the maximum torque transmitted on each revolution exceeds the mean by 30 % and permissible shear stress as 75MPa. **10**

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**(3 Hours)**

**Maximum Marks: 80**

1. Question No.1 is compulsory.
2. Attempt any three from remaining.
3. Assume any suitable data if required, state the same clearly.
4. Figures to the right indicate full marks.
5. Attempt sub questions in order.

1. Attempt any four (20)
  - a. Define Surveying and explain its principles
  - b. Explain orientation and its methods in PTS.
  - c. Write short note on reciprocal leveling.
  - d. Describe importance of GTT.
  - e. Explain Dip and Declination.
  - f. State principle of tacheometry and its advantages.
  
2.
  - a. Define contour and Contour gradient. Explain interpolation methods of contours. (05)
  - b. Write detailed note calculation of volume from spot level. (05)
  - c. Write detailed note on permanent adjustments of theodolite. (05)
  - d. Explain distance and elevation calculation procedure using Subtense bar. (05)
  
3.
  - a. Explain procedure of horizontal angle measurement by repetition method using theodolite. (05)
  - b. Following observations pertain to compass traverse survey. State the stations free from local attraction. Determine correct bearings and the true bearings, if the declination was  $1^{\circ}15'$  E from following bearings data: (10)

Line	AB	BC	CD	DE
FB	$83^{\circ} 30'$	$359^{\circ} 30'$	$262^{\circ} 15'$	$161^{\circ} 30'$
B B	$264^{\circ} 0'$	$179^{\circ} 15'$	$83^{\circ} 0'$	$341^{\circ} 30'$

- c. Discuss necessity and procedure of reciprocal ranging. (05)
  
4.
  - a. In fly leveling from a BM of RL 151.50, the following readings were observed: (10)  
 B S : 1.545, 2.195, 1.815, 2.985, 2.135  
 F S : 0.685, 1.245, 0.790, 0.925  
 From the last position of the instrument, six pegs at 30m interval are to be set out on uniformly rising gradient of 1 in 60, the first peg is to have a RL of 155.50. Find the staff readings & RLs of the pegs.
  - b. Compare plane and geodetic surveying. (05)
  - c. Explain method of area is calculation using Amslar Planimeter. (05)

5.a. Calculate the length and bearing of line EA for a closed traverse ABCDEA from data shown: **(10)**

Line	AB	BC	CD	DE	EA
Length in m	225	360	425	276	?
Bearing	130° 15'	65° 30'	320° 0'	215° 15'	?

b. Write detailed note on difficulties in leveling. **(05)**

c. Explain necessity and procedure of profile leveling. **(05)**

6. a. Determine the gradient between staff station P and Q from following observations taken with tacheometer fitted having multiplying constant 100 and additive constant 0.3, when the staff was held vertical. **(10)**

Instrument Station	Staff Station	Vertical Angle	Staff Readings
R	P	+7° 15'	1.25, 1.810, 2.370
	Q	-4° 30'	1.30, 2.12, 2.94

b. What is EDM? Write principle of EDM and its applications in surveying. **(05)**

c. Compare Surveyor's compass and Prismatic compass. **(05)**

(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  $f(x) = \begin{cases} x, & 0 < x < \pi \\ 2\pi - x, & \pi < x < 2\pi \end{cases}$  8
- in  $(0, 2\pi)$

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

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  $h=0.25, 0 < x < 1, \text{ upto } = 5$ . 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
- 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.** **6**

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**

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  $[-\pi, \pi]$