

Duration: 3 Hrs

Maximum marks: 70

Note: All Questions are compulsory.

Use of simple calculator is allowed.

Figure at right indicate maximum marks.

Q.1 (a) Attempt any 7 [2 marks each]**[14]**(i) If $\begin{vmatrix} 6 & 2 \\ x+1 & 3 \end{vmatrix} = \begin{vmatrix} 2x & 4 \\ 1 & 7 \end{vmatrix}$ then the value of x is:

- (a) 3 (b) -5/4 (c) 4/5 (d) 5/4

(ii) With respect to Rolle's theorem the value of 'c' corresponding to $f(x)=x^2-4x+3$ is:

- (a) 1 (b) 2 (c) 3 (d) 4

(iii) The value of $\int_0^1 (2x + 3x^2 + 4x^3 + 1)dx$ is:

- (a) 0 (b) 1 (c) 3 (d) 4

(iv) If $y=2x^2$, then Δy by taking $h=1$ is:

- (a)
- $2x+1$
- (b)
- $4x+2$
- (c)
- $2x^2-2x$
- (d)
- $2x^2-1$

(v) If $A = \begin{bmatrix} k & k & 4 \\ 3 & 1 & 2 \\ 1 & 2 & 3 \end{bmatrix}$ is a singular matrix, then the value of k is:

- (a)
- $5/4$
- (b)
- $5/2$
- (c)
- $15/4$
- (d)
- $40/8$

(vi) The N^{th} derivative of $f(x)=\log(2x+1)$ is:

- (a)
- $y_n = \frac{1}{2(2x+1)}$
- (b)
- $y_n = \frac{(1)^{n-1}(n-1)!2^n}{(2x+1)^n}$
- (c)
- $y_n = \frac{(1)^n(n)!2^n}{(2x+1)^n}$
- (d)
- $y_n = \frac{(1)^n(n-1)!2^n}{(2x+1)^n}$

(vii) General solution for the differential equation $(D^3-6D^2+9D)y=0$ is:

- (a)
- $(c_1x+c_2)e^{3x}+c_3$
- (b)
- $c_1e^{3x}+c_2e^{3x}+c_3e^{0x}$
- (c)
- $(c_1x+c_2x)e^{3x}+c_3$
- (d)
- $(c_1x+c_2)e^{3x}+c_3e^{3x}$

(viii) The partial derivative of $Z=3x^2+2xy+xy^2$ with respect to x is:

- (a)
- $6x+2y+2xy$
- (b)
- $6x+2y+2y^2$
- (c)
- $3x+2y+y^2$
- (d)
- $2x+xy+xy^2$

(ix) The inverse of the matrix $A = \begin{bmatrix} 2 & -2 \\ 4 & 3 \end{bmatrix}$ is:

- (a)
- $\frac{1}{14} \begin{bmatrix} 3 & -4 \\ 2 & 2 \end{bmatrix}$
- (b)
- $\frac{1}{12} \begin{bmatrix} -3 & 4 \\ -2 & 2 \end{bmatrix}$
- (c)
- $\frac{1}{14} \begin{bmatrix} 2 & -4 \\ -2 & 3 \end{bmatrix}$
- (d)
- $\frac{1}{14} \begin{bmatrix} 2 & 2 \\ -4 & 3 \end{bmatrix}$

(b) Attempt any 1:**[1]**

(x) Which of the following is not a homogeneous differential equation?

- (a)
- $f(x,y)=2x-9y$
- (b)
- $f(x,y)=3x^2-7y^2$
- (c)
- $f(x,y)=x^2+3y^2-1$
- (d) a and b

(xi) The value of $\int_{-1}^1 3x^3 dx$ is:

- (a)
- $15/2$
- (b)
- $16/3$
- (c) 0 (d)
- $3/2$

Q2. (a) Attempt any two (4 marks each)**[8]**(i) Find the N^{th} derivative of $y = \frac{x}{x^2-4}$ (ii) State the Lagrange's Mean Value theorem. Use it to verify for $f(x)=x^2-5x+6$ in $[2,4]$ (iii) Prove that: $U_{xx} + U_{yy} = 0$, where $U = e^x \cos y$ **TURN OVER**

(b) Attempt any one (3 marks)

- (i) State Roll's Mean Value Theorem. Use it to verify for $f(x) = x^2 - 5x + 6$ in [2, 3]
 (ii) Find the N^{th} derivative of $y = \frac{x+1}{x^2-4}$

Q3. (a) Attempt any two (4 marks each)**[8]**

- (i) Obtain the reduction formula for $\int_0^{\frac{\pi}{2}} \sin^n x \, dx$, hence evaluate $\int_0^{\frac{\pi}{2}} \sin^7 x \, dx$.
 (ii) Find the volume generated by revolving the arc of the curve $y = \sin x$, between the lines $x=0$ and $x=\pi$
 (iii) Evaluate: $\int e^x \cos x \, dx$

(b) Attempt any one (3 marks)**[3]**

- (i) The loop of the curve $y^2 = x(x-1)^2$ rotates about x-axis. Find the volume of the solid formed.
 (ii) By using the properties of Definite Integral Evaluate $I = \int_0^{\frac{\pi}{2}} \frac{1}{1+\cot x} \, dx$

Q4. (a) Attempt any two (4 marks each)**[8]**

- (i) By using the Adjoint method, find the inverse of the matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \\ 3 & 5 & 6 \end{bmatrix}$

- (ii) Find the Eigen values and one of the Eigen vectors of the matrix:

$$A = \begin{bmatrix} 2 & -2 & 3 \\ 1 & 1 & 1 \\ 1 & 3 & -1 \end{bmatrix}$$

- (iii) Verify Cayley Hamilton theorem for the matrix $A = \begin{bmatrix} 1 & 2 \\ -1 & 3 \end{bmatrix}$

(b) Attempt any one (3 marks)**[3]**

- (i) Find the rank of the matrix $A = \begin{bmatrix} 2 & 3 & 4 \\ 4 & 3 & 1 \\ 1 & 2 & 4 \end{bmatrix}$

- (iii) Verify Cayley Hamilton theorem for the matrix: $-A = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

TURN OVER

Q5. (a) Attempt any two (4 marks each)

[8]

(i) solve $(x^3 + y^3)dy = x^2y dx$

(ii) Form the differential equation for $y = A \cos(\log x) + B \sin(\log x)$

(iii) Find the particular solution of $\frac{d^2y}{dx^2} - 5 \frac{dy}{dx} + 6y = 0$, when $x = 0, y = 1$ and $\frac{dy}{dx} = 0$

(b) Attempt any one(3 marks)

[3]

(i) Form the Differential Equation of $x^2 + y^2 = a^2$, where a is an arbitrary constant.

(ii) Solve the differential equation: $x \frac{dy}{dx} = y - x$

Q6. (a) Attempt any two (4 marks each)

[8]

(i) If $f(1) = 1, f(4) = -1, f(6) = 1$, evaluate $f(2)$ using Lagrange's interpolation formula.

(ii) Find the approximate value of $\int_0^8 (1 + x^2) dx$, using Trapezoidal rule (take $n = 8$)

(iii) Estimate the missing term by using E and Δ from the following:

x:	1	2	3	4	5
y:	4	8	--	22	32

(b) Attempt any one(3 marks)

[3]

(i)

Given:

x	1	2	4
f(x)	2	6	24

Estimate $f(3)$ by constructing difference table and making a suitable assumption.

(ii) Evaluate: $\left(\frac{\Delta^2}{E}\right)x^4, (h=1)$

(3 HOURS)

[TOTAL MARKS : 80]

N.B. 1) All questions are compulsory.**2) Draw neat and labelled diagrams wherever necessary.**

- a). With neat and labelled diagrams discuss simple manometer. 3M
 b). Explain the concept of mass transfer. 3M
 c). Elaborate factors affecting rate of crystallization. 2M
 d). Define Economy and capacity of evaporation. 2M
 e). Enlist the different methods for distillation of miscible binary liquid system. 2M
 f). Write notes on aluminium as material for plant construction. 3M
 g). Discuss Meir's Theory of Supersaturation. 3M
 h). Discuss expansion traps as evaporator accessories. 2M

Q2.

- a). Discuss principal, construction and working of Rotary pump. 4M
 b). Elaborate design and working of Krystal crystallizer. 4M

OR.

- b). Elaborate design and working of Circulating Magma crystallizer. 4M
 c). Explain principal of molecular distillation unit and give its application. 4M

Q3.

- a). Explain construction and working of Orifice meter. 4M

OR

- a). Explain construction and working of Pitot tube 4M
 b). Elaborate on the construction and working of horizontal tube evaporator. 4M
 c). Discuss Refrigeration. Load in detail. 4M

Q.4

- a). Discuss the experiment for understanding of Bernoulli's theorem. 4M
 b). Define different modes of heat transfer and write notes on Fourier's Law. 4M

OR

- b). Enlist various types of temperature measurement device and explain any one in detail. 4M
 c). Discuss in brief crystal Habit and Crystal Form. 4M

Q.5

- a). Explain design and working of centrifugal pump. 4M
 b). Discuss a fractional distillation. 4M

OR

- b). Elaborate on the construction and working of plate column. 4M
 c). Write note on Chemical hazards. 4M

Q.6

- a). Discuss construction and working of Screw conveyor. 4M
 b). Elaborate on the construction and working of falling film evaporator. 4M
 c). Explain factor affecting rate of corrosion. 4M

OR

- c). Define corrosion and discuss methods to combat corrosion.