Total No. of Questions : 6]

SEAT No. :

PF12249

[Total No. of Pages : 5

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BSC-101-BES : ENGINEERING MATHEMATICS - I

(2024 Credit Pattern) (Semester - I/II)

Time : 2½ Hours] *[Max. Marks : 60*

Instructions to the candidates:

1) ***All questions are compulsory.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Assume suitable data if necessary.***
5) ***Use of electronic pocket calculator is allowed.***

Q1) Write the correct option for the following :

a) Fourier coefficient a_0 in the fourier series expansion of $f(x) = e^{-x}$, $0 \le x \le 2\pi$ & $f(x + 2\pi) = f(x)$ is **[2]**

i) $\frac{1}{\pi}\left(1 - e^{-2\pi}\right)$ ii) $\frac{1}{2\pi}\left(1 - e^{2\pi}\right)$

iii) $\frac{2}{\pi}\left(e^{-2\pi} - 1\right)$ iv) $\frac{1}{\pi}\left(1 + e^{2\pi}\right)$

b) If $u = \sin^{-1}\left(\frac{\sqrt{x^2 + y^2}}{x + y}\right)$ then $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$ is equal to **[2]**

i) $= u$ ii) $2u$

iii) 0 iv) none

c) If $u = x^2 - y^2$ and $v = 2xy$ then the value of $\frac{\partial(u, v)}{\partial(x, y)}$ is **[2]**

i) $\frac{1}{r}$ ii) r

iii) r^2 iv) none

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d) The rank of matrix $A=\begin{bmatrix}1 & 3 & 6\\ 1 & 4 & 5\\ 1 & 5 & 4\end{bmatrix}$ is equal to **[2]**

i) 3 ii) 1

iii) 4 iv) 2

e) The sum and product of the eigenvalues of the matrix $A=\begin{bmatrix}2 & 2 & 1\\ 1 & 3 & 1\\ 1 & 2 & 2\end{bmatrix}$ are respectively. **[2]**

i) 7 and 7 ii) 7 & 5

iii) 5 and 6 iv) 5 and 8

Q2) Solve any two

a) Using Lagrange's mean value theorem prove that if $0 < a < b$, then **[5]**

$$\frac{b-a}{1+b^2} < \tan^{-1}(b) - \tan^{-1}(a) < \frac{b-a}{1+a^2}$$

Hence show that

$$\frac{5\pi+4}{20} < \tan^{-1}(2) < \frac{\pi+2}{4}$$

b) Use Taylor's theorem to expand $x^3 - 2x^2 + 3x + 5$ in powers of $(x-2)$. **[5]**

c) Prove that **[5]**

$$(1+x)^x = 1 + x^2 - \frac{1}{2}x^3 + \frac{5}{6}x^4 - \frac{3}{4}x^5 + \ldots$$

d) Find the fourier series to represent the function $f(x) = x^2 - 2$ in the interval $-2 < x < 2$ & $f(x+4) = f(x)$. **[5]**

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Q3) Solve any two

a) If $z = \tan(y + ax) + (y - ax)^{3/2}$ then find the value of $\frac{\partial^2 z}{\partial x^2} - a^2 \frac{\partial^2 z}{\partial y^2}$. **[5]**

b) If $u = ax + by$, $v = bx - ay$ then find the value of **[5]**

$$\left(\frac{\partial u}{\partial x}\right)_y \cdot \left(\frac{\partial x}{\partial u}\right)_v \cdot \left(\frac{\partial y}{\partial v}\right)_x \cdot \left(\frac{\partial v}{\partial y}\right)_u$$

c) If $u = \sin^{-1}\sqrt{x^2 + y^2}$ then prove that **[5]**

$$x^2 \frac{\partial^2 u}{\partial x^2} + 2xy \frac{\partial^2 u}{\partial x \partial y} + y^2 \frac{\partial^2 u}{\partial y^2} = \tan^3(u)$$

d) If $u = f(x - y, y - z, z - x)$ then prove that $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z} = 0$. **[5]**

Q4) Solve any two

a) If $x + y + z = 4, y + z = uv, z = uvw$ then find $\frac{\partial(x, y, z)}{\partial(u, v, w)}$. **[5]**

b) Examine $u = y + z, v = x + 2z^2, w = x - 4yz - 2y^2$ are functionally dependent. If so, find the relation between them. **[5]**

c) The resonant frequency in a series electric circuit is given by $f = \frac{1}{2\pi\sqrt{LC}}$.
If the measurements in L and C are in error by 2% and –1% respectively. Find the percentage error in *f*. **[5]**

d) Divide 24 into three parts such that the continued product of the first, square of the second and cube of third may be maximum. [Use Lagrange's method]. **[5]**

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Q5) Solve any two

a) Solve the system of equations **[5]**

$$x_1 + x_2 + x_3 = 0, \quad -2x_1 + 5x_2 + 2x_3 = 1$$

$$8x_1 + x_2 + 4x_3 = -1$$

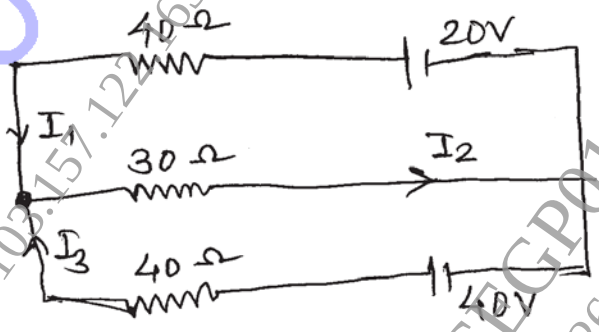
b) Examine the following system of vectors for linear dependance. If dependent, find relation between them **[5]**

$X_1 = (3, 1, -4)$, $X_2 = (2, 2, -3)$, $X_3 = (0, -4, 1)$

c) Determine value of a, b & c when **[5]**

$$A = \begin{bmatrix} \frac{1}{3} & \frac{2}{3} & a \\ \frac{2}{3} & \frac{1}{3} & b \\ \frac{2}{3} & -\frac{2}{3} & c \end{bmatrix} \text{ is orthogonal}$$

d) Find the current I_1, I_2, & I_3 in the circuit shown in the figure. **[5]**



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Q6) Solve any two

a) Find the Eigenvalues and Eigenvector corresponding to largest Eigenvalue for the following matrix $A = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$ **[5]**

b) Find A^{-1} by using Cayley-Hamilton theorem for the following matrix A **[5]**

$$A = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

c) Find the modal matrix which diagonalizes the matrix $A = \begin{bmatrix} 4 & 1 \\ 2 & 3 \end{bmatrix}$. **[5]**

d) Reduce the following quadratic form to the "Sum of the squares form" and Also find the corresponding linear transformation. **[5]**

$$Q(x) = 2x^2 + 9y^2 + 6z^2 + 8xy + 8yz + 6zx$$

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