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Reg. No. :						

Question Paper Code: 90814

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Third Semester

Biomedical Engineering

MA 8352 – LINEAR ALGEBRA AND PARTIAL DIFFERENTIAL EQUATIONS

(Common to: Computer and Communication Engineering/Electronics and Communication Engineering/Electronics and Telecommunication Engineering/Medical Electronics)

(Regulations - 2017)

Time: Three hours

Maximum: 100 marks

Answer ALL questions.

PART A - (10 × 2 = 20 marks)



- 1. Show that the vector w = (9, 2, 7) is a linear combination of vectors u = (1, 2, -1) and v = (6, 4, 2).
- 2. Is the set $\{(1,2),(3,4)\}$ in \mathbb{R}^2 linearly independent? Justify.
- 3. Find the kernel of the matrix $A = \begin{bmatrix} 1 & 1 & 5 \\ 2 & -1 & 1 \end{bmatrix}$
- 4. State the dimension theorem for linear transformation.
- 5. Sketch the unit circle in an xy-coordinate system in \mathbb{R}^2 using the weighted Euclidean inner product $< u, v>=\frac{1}{9}u_1v_1+\frac{1}{4}u_2v_2$ where $u=\left(u_1,v_1\right)$ and $v=\left(v_1,v_2\right)$.
- 6. Prove that $||u+v|| \le ||u|| + ||v||$ if u and v are vectors in an inner product space V.
- 7. Form the partial differential equation by eliminating the arbitrary constants a and b from $(x-a)^2 + (y-b)^2 = z^2 \cot^2 \theta$
- 8. Classify the partial differential equation $f_{xx} 2f_y = x^2 + y^2$.

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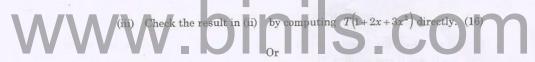
- 9. What are the sufficient conditions for the existence of Fourier series of f(x)?
- 10. Find the Fourier coefficient a_0 if $f(x) = x^2 + x, -2 < x < 2$.

PART B —
$$(5 \times 16 = 80 \text{ marks})$$

11. (a) Determine whether the set of all pairs of real numbers (x,y) with the standard addition and scalar multiplication k(x,y) = (2kx, 2ky) is a vector space or not. If not, list all the axioms that fail to hold. (16)

Or

- (b) Find a basis and dimension of the solution space of the homogeneous system $x_1 + 3x_2 2x_3 + 2x_5 = 0$; $2x_1 + 6x_2 5x_3 2x_4 + 4x_5 3x_6 = 0$; $5x_3 + 10x_4 + 15x_6 = 0$; $2x_1 + 6x_2 + 8x_4 + 4x_5 + 18x_6 = 0$ (16)
- 12. (a) Let $T: P_2 \to P_2$ be a linear operator defined by T(p(x)) = p(3x-5).
 - (i) Find $[T]_B$ with respect to the basis $B = \{1, x, x^2\}$.
 - (ii) Use the indirect procedure to compute $T(1+2x+3x^2)$



- (b) Find the matrix P that diagonalizes $A = \begin{bmatrix} 0 & 0 & -2 \\ 1 & 2 & 1 \\ 1 & 0 & 3 \end{bmatrix}$ (16)
- 13. (a) Find the least square solution of the system Ax = b given by x y = 4; 3x + 2y = 1 and -2x + 4y = 3 and find the orthogonal projection b on the column space of A. (16)

Or

(b) Assume that the vector space R³ has the Euclidean inner product. Apply the Gram-Schmidt process to transform the basis vectors u₁ = (1,1,1), u₂ = (0,1,1), and u₃ = (0,0,1) into an orthogonal basis and then normalize to obtain an orthonormal basis. (16)

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- 14. (a) (i) Solve the partial differential equation $z=px+qy+p^2+pq+q^2$, where $p=\frac{\partial z}{\partial x}, q=\frac{\partial z}{\partial y}$. (8)
 - (ii) Solve the partial differential equation $x^2(y-z)p + y^2(z-x)q = z^2(x-y), \text{ where } p = \frac{\partial z}{\partial x}, q = \frac{\partial z}{\partial y}. \tag{8}$

Or

- (b) Solve the partial differential equation $(D^2 3DD' + 2D'^2 + 2D 2D')z = x + y + \sin(2x + y). \tag{16}$
- 15. (a) A uniform string is stretched and fastened to two points l apart. Motion is started by displacing the string into the form of the curve y = kx(l-x) and then releasing it from this position at time t=0. Find the displacement of the string at a distance x from one end at time t. (16)

Or

(b) A square plate has its faces and its edge y = 0 insulated. Its edges x = 0 and x = 10 are kept at zero temperature and its edge y = 10 at temperature 100°C. Find the steady state temperature distribution in the plate. (16)

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