M.E. / M.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

First Semester

ME - Embedded Systems Technologies

(Common to Power Electronics and Drives)

24PESMA102 - APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS

Regulations - 2024

(Use of *Tables* is permitted)

Duration: 3 Hours   Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)
Answer ALL Questions

		Marks	K−Level	CO

1. The singular values of A are: — *1 K1 CO1*
   (a) The diagonal entries of Σ (b) The eigenvalues of A
   (c) The entries of U (d) The determinant of A

2. The generalized eigenvalue problem $Ax = \lambda Bx$ can be rewritten as: — *1 K1 CO1*
   (a) $A^{-1}Bx = \lambda x$ (b) $B^{-1}Ax = \lambda x$ (c) $AB^{-1}x = \lambda x$ (d) $B^T Ax = \lambda x$

3. For $J[u] = \iint F(x, y, u, u_x, u_y)\, dx\, dy$, the Euler–Lagrange equation is: — *1 K1 CO2*
   (a) $\frac{\partial F}{\partial u} - \frac{d}{dx}\frac{\partial F}{\partial u_x} = 0$
   (b) $\frac{\partial F}{\partial u} - \frac{\partial}{\partial x}\frac{\partial F}{\partial u_x} - \frac{\partial}{\partial y}\frac{\partial F}{\partial u_y} = 0$
   (c) $\frac{\partial F}{\partial u_x} + \frac{\partial F}{\partial u_y} = 0$
   (d) $u_x = u_y = 0$

4. If the boundary points are not fixed, the variation of the endpoints contributes through: — *1 K1 CO2*
   (a) The transversality condition   (b) Euler's condition
   (c) Isoperimetric constraint   (d) Hamilton–Jacobi condition

5. Tickets numbered 1 to 20 are mixed up and then a ticket is drawn at random. The probability that the ticket drawn bears a number which is a multiple of 3 is — *1 K2 CO3*
   (a) 3/10   (b) 3/20   (c) 2/5   (d) ½

6. The probability distribution that can be described by just one parameter is the — *1 K1 CO3*
   (a) Uniform   (b) Binomial   (c) Normal   (d) Exponential

7. A basic solution is called non-degenerate, if — *1 K1 CO4*
   (a) All the basic variables are zero   (b) None of the basic variables is zero
   (c) At least one of the basic variables is zero   (d) None of these

8. If the net evaluation corresponding to any non -basic variable is zero, it is an indication of the existence of an _____. — *1 K1 CO4*
   (a) initial basic feasible solution   (b) optimum basic feasible solution
   (c) optimum solution.   (d) alternate optimum solution.

9. If the point $x = a$ is the discontinuous point, then the Fourier series converges to — *1 K1 CO5*
   (a) $\frac{1}{2}[f(x + a) - f(x - a)]$
   (b) $\frac{1}{2}[f(x + a) + f(x - a)]$
   (c) $\frac{1}{2}[f(x - a) - f(x + a)]$
   (d) $\frac{1}{4}[f(x + a) - f(x - a)]$

10. If the function $f(x)$ is to be expanded as half range cosine series, then the extension of $f(x)$ is — *1 K1 CO5*
    (a) Even function   (b) Odd function
    (c) Any function even or odd   (d) Can't be determined

PART - B (12 × 2 = 24 Marks)
Answer ALL Questions

11. Find the Cholesky decomposition of the matrix $A = \begin{pmatrix} 4 & 2 \\ 2 & 3 \end{pmatrix}$. — *2 K2 CO1*

12. Find A^+ for the matrix $A = \begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \end{pmatrix}$. — *2 K2 CO1*

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate; K6 – Create   **14250**

13. Find the extremal of the functional $\int_{x_0}^{x_1} \left(y'^2 - y^2 \right) dx.$ 2   K2   CO2

14. Define isoperimetric problem.   2   K1   CO2

15. A continuous random variable X has probability density function $f(x) = kx^2, 0 \leq x \leq 1$. Find the value of k.   2   K2   CO3

16. The probability that a candidate can pass in an examination is 0.6. What is the probability that he will pass in third trial?   2   K2   CO3

17. Derive the moment generating function of a random variable which follows uniform distribution.   2   K2   CO4

18. Use the graphical method to solve the following LPP: $Max\ Z = 3x + 4y\ s.t\ x - y \leq -1,\ -x + y \leq 0,\quad x, y \geq 0$.   2   K2   CO4

19. Explain how maximization problems are solved in the assignment model.   2   K1   CO4

20. Find the Fourier series of $f(x) = x, -\pi < x < \pi$.   2   K2   CO5

21. State Parseval's theorem.   2   K1   CO5

22. Define generalized Fourier series.   2   K1   CO5

PART - C (6 × 11 = 66 Marks)
Answer ALL Questions

23. a) Construct the QR-decomposition of the matrix $A = \begin{pmatrix} -4 & 2 & 2 \\ 3 & -3 & 3 \\ 6 & 6 & 0 \end{pmatrix}$.   11   K3   CO1

OR

b) Write the least square solutions to $x + 2y + z = 1, 3x - y = 2, 2x + y - z = 2$ and $x + 2y + 2z = 1$.   11   K3   CO1

24. a) State and prove Brachistochrone problem.   11   K3   CO2

OR

b) Using Ritz method, solve the boundary value problem $y'' - y + x = 0, 0 \leq x \leq 1$, $y(0) = y(1) = 0$.   11   K3   CO2

25. a) (i) A factory has two machines. Past records show that the first machine produces 40 percent of output and the second machine produces 60 percent of output. Further, 4 percent and 2 percent of products produced by the first machine and the second machine were defectives. If a defective item is drawn at random, what is the probability that the defective item was produced by the first machine or second machine?   6   K3   CO3

(ii) The pmf of a random variable X is defined as $P(X = 0) = 3c^2, P(X = 1) = 4c - 10c^2, P(X = 2) = 5c - 1$ where $c > 0$ and $P(X = r) = 0, r \neq 0,1,2$. Find 1. c 2. Cdf   3. The largest value of x for which $F(x) < 1/2$.   4. $P(0 < X < 2/X > 0)$.   5   K3   CO3

OR

b) (i) Given $F(x) = 1 - \frac{4}{x^2}, x > 2$. Find 1. $P(X < 3)$ 2. $P(4 < X < 5)$ 3. $P(X \geq 3)$ using both cdf and pdf   6   K3   CO3

(ii) Given a random variable X with pdf $f(x) = kx(2 - x), 0 \leq x \leq 2$. Find the rth moment about origin and hence find mean and variance.   5   K3   CO3

26. a) Solve the LPP using Big M method:
Maximise $Z = 2x_1 + x_2 + x_3$
subject to $4x_1 + 6x_2 + 3x_3 \leq 8$, $3x_1 - 6x_2 - 4x_3 \leq 1$, $2x_1 + 3x_2 - 5x_3 \geq 4$, $x_1, x_2, x_3 \geq 0$.   11   K3   CO4

OR

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate; K6 – Create

b) Solve the following transportation problem: A company operates three coal mines A, B and C which provide 400,500, and 700 ton respectively per week. Orders for 500,400,300,300 and 600 ton per week have been received from customers C_1, C_2, C_3, C_4 and C_5 respectively. Transportation cost in Rs. per tome from each mine to each customer are given below: *11   K3   CO4*

	C_1	C_2	C_3	C_4	C_5	Supply
A	4	16	1	16	14	400
B	18	10	8	12	12	500
C	6	1	4	13	2	700
Demand	500	400	300	300	600	

Find the weekly shipping schedule which minimizes the total expenses.

27. a) Find the eigen values and eigen functions of $y'' + \lambda y = 0; 0 < x < p, y(0) = y(p) = 0$.   *11   K3   CO5*

OR

b) Find the Fourier series for $f(x) = x^2, -\pi < x < \pi$. Hence deduce that $\frac{1}{1^4} + \frac{1}{2^4} + \cdots = \frac{\pi^4}{90}$.   *11   K3   CO5*

28. a) (i) The number of accidents in a year to taxi drivers in city follows a Poisson distribution with mean equal to 3. Out of 1000 taxi drivers, find approximately the number of drivers with no accidents in a year. Also find the number of drivers with more than 3 accidents in a year.   *6   K3   CO3*

   (ii) The daily consumption of milk in excess of 20,000 gallons is approximately exponentially distributed with parameter $\lambda = \frac{1}{3000}$. The city has a daily stock of 35,000 gallons. What is the probability that of two days selected at random, the stock is insufficient for both the days?   *5   K3   CO3*

OR

b) State and prove memoryless property of exponential distribution. Use it to solve the problem: *11   K3   CO3*
The time in hours required to repair a machine is exponentially distributed with parameter ½ .
What is the probability that the repair time exceeds 2 hours?
What is the probability that the repair time takes at least 10 hours given that its duration exceeds 9 hours.