| Reg. No. | | | | | | | | | | | | | | | | |
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| Question Paper Code | 14210 |
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**M.E. / M.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025**

First Semester

**M.E. - Communication Systems**

**24PCOMA103 - APPLIED MATHEMATICS FOR COMMUNICATION ENGINEERS**

Regulations - 2024

Duration: 3 Hours | Max. Marks: 100

**PART - A (MCQ) (10 × 1 = 10 Marks)**

Answer ALL Questions

| | | Marks | K – Level | CO |
|---|---|---|---|---|
| 1. | In a real inner product space $V$, for any vectors $u$ and $v$, the Cauchy-Schwarz inequality states that<br>(a) $\lvert\langle u,v\rangle\rvert \geq \lVert u\rVert + \lVert v\rVert$ (b) $\lvert\langle u,v\rangle\rvert \leq \lVert u\rVert + \lVert v\rVert$ (c) $\lvert\langle u,v\rangle\rvert \geq \lVert u\rVert\lVert v\rVert$ (d) $\lvert\langle u,v\rangle\rvert \leq \lVert u\rVert\lVert v\rVert$ | 1 | K1 | CO1 |
| 2. | Every matrix $A = U\sum V^T$ has pseudoinverse<br>(a) $A^+ = V\sum U^T$ (b) $A^+ = V\sum^+ U^T$ (c) $A^+ = V^+\sum U^T$ (d) $A^+ = V^T\sum^+ U$ | 1 | K1 | CO1 |
| 3. | The constraints of Maximisation problem are of<br>(a) Greater than or equal type (b) Less than or equal type<br>(c) Less than type (d) Greater than type | 1 | K1 | CO2 |
| 4. | Assignment problem is basically a<br>(a) Maximisation Problem (b) Minimisation Problem<br>(c) Transportation Problem (d) Primal Problem | 1 | K1 | CO2 |
| 5. | The final weighted average for the increment in y ($\Delta y$) in the Runge-Kutta method of fourth order is given by<br>(a) $\Delta y = \frac{h}{6}(k_1 + k_2 + k_3 + k_4)$ (b) $\Delta y = \frac{h}{6}(2k_1 + 2k_2 + 2k_3 + 2k_4)$<br>(c) $\Delta y = \frac{h}{6}(k_1 + 2k_2 + 2k_3 + k_4)$ (d) $\Delta y = \frac{h}{6}(2k_1 + k_2 + k_3 + 2k_4)$ | 1 | K1 | CO3 |
| 6. | When applying the finite difference method to a boundary value problem, the differential equation is converted into a system of<br>(a) Integral equations<br>(b) Linear algebraic equations (if the original ODE is linear)<br>(c) Initial value problems<br>(d) Eigenvalue problems | 1 | K1 | CO3 |
| 7. | Two events are said to be mutually exclusive if<br>(a) $P(A \cap B) = P(A)P(B)$ (b) $P(A \cup B) = P(A) - P(B)$<br>(c) $P(A \cup B) = P(A) + P(B)$ (d) $P(A \cup B) = P(A)P(B)$ | 1 | K1 | CO4 |
| 8. | If Var(X) = 1, Var(Y) = 9 and Cov(X, Y) = 1 then r(X, Y) is<br>(a) $\frac{1}{3}$ (b) 0 (c) – 1 (d) $-\frac{1}{3}$ | 1 | K2 | CO4 |
| 9. | The system of loading and unloading of goods usually follows:<br>(a) LIFO (b) FIFO (c) SIRO (d) SBP | 1 | K1 | CO5 |
| 10. | A person who leaves the queue by losing his patience to wait is said to be:<br>(a) Reneging (b) Balking (c) Jockeying (d) Collusion | 1 | K1 | CO5 |

**PART - B (12 × 2 = 24 Marks)**

Answer ALL Questions

| | | | | |
|---|---|---|---|---|
| 11. | Consider $f(t) = 3t - 5$ and $g(t) = t^2$ in the polynomial space $P(t)$ with inner product $\langle f, g\rangle = \int_0^1 f(t)\,g(t)\,dt$. Find $\lVert f\rVert$ and $\lVert g\rVert$. | 2 | K3 | CO1 |

| | | | | |
|---|---|---|---|---|
| 12. | Define Toeplitz matrix. | 2 | K1 | CO1 |
| 13. | Define feasible solution and basic feasible solution to a general L.P.P. | 2 | K1 | CO2 |
| 14. | Define: Assignment problem. | 2 | K1 | CO2 |
| 15. | State the special advantage of RK method. | 2 | K1 | CO3 |
| 16. | Write down the finite difference scheme for the differential equation $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} = 2$. | 2 | K3 | CO3 |
| 17. | If $f(x) = \begin{cases} kx^2, & 0 < x < 3 \\ 0, & otherwise \end{cases}$ is a pdf of $X$, then find the value of $k$. | 2 | K2 | CO4 |
| 18. | Give any two properties of correlation coefficient. | 2 | K1 | CO4 |
| 19. | Write down the Little's formulas that hold good for the infinite capacity single server Poisson queue models. | 2 | K1 | CO5 |
| 20. | Suppose there are 2 parallel servers. Each can serve an average of 6 customers/hr. If $\lambda = 10$ /hr and $P_0 = \frac{1}{11}$ then find the number of customers in the queue. | 2 | K3 | CO5 |
| 21. | If the joint pdf of $(X, Y)$ is given by $f(x, y) = 2$, in $0 \le x < y \le 1$, find $E(X)$. | 2 | K3 | CO4 |
| 22. | Write down the Little's formulae for the average waiting time in the system and in the queue for an (M/M/1) : (K/FIFO) queueing model. | 2 | K2 | CO5 |

**PART - C (6 × 11 = 66 Marks)**

Answer ALL Questions

23. a) Find the QR factorization of $A = \begin{bmatrix} 1 & 2 & 3 \\ 3 & 2 & 1 \\ 2 & 1 & 3 \end{bmatrix}$. — 11 K3 CO1

**OR**

b) Find the singular value decomposition of $A = \begin{bmatrix} 2 & 0 & -1 \\ 0 & 2 & 0 \\ -1 & 0 & 2 \end{bmatrix}$. — 11 K3 CO1

24. a) Use simplex method to Maximize $z = x_1 - x_2 + 3x_3$ subject to constraints: $x_1 + x_2 + x_3 \le 10$, $2x_1 - x_3 \le 2$, $2x_1 - 2x_2 + 3x_3 \le 0$, $x_1, x_2, x_3 \ge 0$. — 11 K3 CO2

**OR**

b) Solve the following transportation problem by VAM. — 11 K3 CO2

| | | Distribution Centre | | | | |
|---|---|---|---|---|---|---|
| | | A | B | C | D | Supply |
| Plant | I | 2 | 3 | 11 | 7 | 6 |
| | II | 1 | 0 | 6 | 1 | 1 |
| | III | 5 | 8 | 15 | 9 | 10 |
| Demand | | 7 | 5 | 3 | 2 | |

25. a) Apply the fourth order Runge-Kutta method to find $y(0.2)$ given that $f(x, y) = \frac{y - x}{y + x}$, $y(0) = 1$ by taking $h = 0.1$. — 11 K3 CO3

**OR**

b) Solve $5x\frac{dy}{dx} + y^2 = 2$, $y(4) = 1$ at $x = 4.4$ using Adam Bashforth's predictor-corrector method, given that $y(4.1) = 1.0049$, $y(4.2) = 1.0097$, $y(4.3) = 1.0143$. — 11 K3 CO3

26. a) The joint probability mass function of $(X, Y)$ is given by $p(x, y) = k(2x + 3y)$, $x = 0, 1, 2$ ; $y = 1, 2, 3$. Find all the marginal and conditional distributions. *11 K3 CO4*

**OR**

b) Two random variables have joint p.d.f. $f(x,y) = \frac{1}{3}(x+y)$, $0 \le x \le 1$, $0 \le y \le 2$. Find the correlation coefficient. *11 K3 CO4*

27. a) The arrivals at a telephone booth are considered to be Poisson with an average time of 12 minutes between one arrival and the next. The length of a phone call is assumed to be distributed exponentially with mean 4 minutes.
(1) Find the average number of persons waiting in the system.
(2) What is the probability that a person arriving at the booth will have to wait in the queue?
(3) Estimate the fraction of the day when the phone will be in use.
(4) What is the probability that it will take him more than 10 minutes altogether to wait for the phone and complete his call? *11 K3 CO5*

**OR**

b) There are 3 typists in an office. Each typist can type an average of 6 letters per hour. If letters arrive for being typed at the rate of 15 letters per hour.
(1) What fraction of the time all the typists will be busy?
(2) What is the average number of letters waiting to be typed?
(3) What is the average time a letter has to spend for waiting and for being typed?
(4) What is the probability that a letter will take longer than 20 min waiting to be typed and being typed? *11 K3 CO5*

28. a) From the following data, find (i) the two regression equations (ii) the correlation coefficient between $X$ and $Y$ (iii) the value of $Y$, when $X = 30$. *11 K3 CO4*

| $X$ | 25 | 28 | 35 | 32 | 31 | 36 | 29 | 38 | 34 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|
| $Y$ | 43 | 46 | 49 | 41 | 36 | 32 | 31 | 30 | 33 | 39 |

**OR**

b) If the joint pdf of $(X, Y)$ is given by $f(x,y) = x + y$, $0 \le x, y \le 1$, find the pdf of $U = XY$. *11 K3 CO4*