SRM VALLIAMMAI ENGEINEERING COLLEGE

(An Autonomous Institution)

(S.R.M.NAGAR, KATTANKULATHUR-603 203)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

QUESTION BANK

I SEMESTER

1918105– APPLIED MATHEMATICS FOR COMMUNICATION ENGINEERS

Regulation – 2019

Academic Year 2019- 2020

Prepared by

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DEPARTMENT OF MATHEMATICS

QUESTION BANK

SUBJECT :1918105 - APPLIED MATHEMATICS FOR COMMUNICATION ENGINEERS

SEM / YEAR: Semester / I year (M.E.COMMUNICATION SYSTEMS)

UNIT I LINEAR ALGEBRA			
Vector spaces – Norms – Inner products – Eigenvalues using QR transformations – QR factorization - Generalized eigenvectors – Canonical forms – Singular value decomposition and applications - Pseudo inverse – Least square approximations - Toeplitz matrices and some applications			
Q.No.	**Question**	**Bloom's Taxonomy Level**	**Domain**
PART – A			
1.	Produce the norms of $x = \begin{pmatrix} 1 \\ 1 \\ -1 \\ 2 \end{pmatrix}$ and $y = \begin{pmatrix} 3 \\ -1 \\ 0 \\ -1 \end{pmatrix}$.Also verify that x and y are orthogonal. Find $< x , y >$	BTL -6	Creating
2.	Summarize the advantage in matrix factorization methods?	BTL -2	Understanding
3.	Define an inner product space	BTL -1	Remembering
4.	Detect the Frobneius norm for the given matrix A=$\begin{pmatrix} 1 & -i \\ 1+i & 2-i \end{pmatrix}$	BTL -4	Analyzing
5.	Construct the canonical basis for A=$\begin{pmatrix} 3 & 5 \\ -2 & -4 \end{pmatrix}$	BTL -6	Creating
6.	Examine $\|X\|_W$ for $X = \begin{pmatrix} 4 \\ 5 \\ 6 \end{pmatrix}$ and $W = \begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 1 \end{pmatrix}$	BTL -4	Analyzing
7.	Explain singular value decomposition in matrix theory	BTL -2	Understanding
8.	Define singular value matrix	BTL -1	Remembering
9.	What is meant by singular value of a matrix?	BTL -1	Remembering
10.	State Singular value decomposition theorem	BTL -1	Remembering
11.	If A is a non singular matrix , then what is A^+	BTL -1	Remembering
12.	Define pseudo inverse of a matrix A	BTL -1	Remembering
13.	Interpret properties of generalized inverse	BTL -3	Applying
14.	Determine the inner product of the vectors (1 2 3) and (3 -2 1)	BTL -2	Understanding
15.	Show a square matrix A is invertible iff$\lambda = 0$ is not an eigen value of A	BTL -2	Understanding
16.	Prepare a note on least square solution	BTL -3	Applying
17.	Solve the system by least square method $x_1 + x_2 = 3 , -2x_1 + 3x_2 = 1 \; and \; 2x_1 - x_2 = 2$	BTL -5	Evaluating
18.	Analyze Toeplitz matrix with an example	BTL -4	Analyzing
19.	Give an example of a Toeplitz matrix of order 3	BTL -2	Understanding
20.	Summarize the general form of the Toeplitz matrix of order n. Also write any two	BTL -5	Evaluating

	applications of it.		
	PART – B		
1	Write the QR decomposition of $\begin{pmatrix} 1 & -1 & 1 \\ 1 & 0 & 1 \\ -1 & 1 & 1 \end{pmatrix}$ (16)	BTL -1	Remembering
2	Describe the QR factorization of $A = \begin{pmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{pmatrix}$ (16)	BTL -1	Remembering
3	Observe the QR factorization of $A = \begin{pmatrix} 1 & -1 & 1 \\ 0 & 1 & 1 \\ -1 & 1 & 1 \end{pmatrix}$ (16)	BTL -3	Applying
4	Create the QR factorization of $A = \begin{pmatrix} 1 & 1 & -1 \\ 1 & 0 & 0 \\ 1 & 0 & -2 \\ 1 & 1 & 1 \end{pmatrix}$ (16)	BTL -6	Creating
5	Construct singular value decomposition for the matrix $\begin{pmatrix} 2 & 2 & -2 \\ 2 & 2 & -2 \\ -2 & -2 & 6 \end{pmatrix}$ (16)		
6	Infer the singular value decomposition of $A = \begin{pmatrix} 1 & 2 \\ 1 & 1 \\ 1 & 3 \end{pmatrix}$ (16)	BTL -3	Applying
7	Let $A = \begin{pmatrix} 1 & 1 \\ 1 & 1 \\ 0 & 0 \end{pmatrix}$ .Analyze the singular values of and singular value decomposition of A.Also find A^{-1}.(16)	BTL -4	Analyzing
8	Infer the singular value decomposition of $A = \begin{pmatrix} 1 & 2 \\ 2 & 2 \\ 2 & 1 \end{pmatrix}$ (16)	BTL -3	Applying
9	Solve the system of equations in the least square sense, $2x + 2y - 2z = 1, 2x + 2y - 2z = 3, -2x - 2y + 6z = 2$ (16)	BTL -2	Understanding
10	Write the least square squares solution of $x + 2y + z = 1 , 3x - y = 2 , 2x + y - z = 2 , x + 2y + 2z = 1$ (16)	BTL -2	Understanding
11	Solve the following system of equations in the least square sense $x + 2y + z = 1,\ 3x - y = 2,\ x + 2y + 2z = 1,\ x + 2y + 2z = 1$ (16)	BTL -5	Evaluating
12	Solve the system by least -square method $x_1 + 4x_2 = 1, 2x_1 + 5x_2 = 1, 3x_1 + 6x_2 = -2$ (16)	BTL- 5	Evaluating
13.	a) Describe the generalized inverse of $\begin{pmatrix} 2 & 2 & -2 \\ 2 & 2 & -2 \\ -2 & -2 & 6 \end{pmatrix}$ by least square method(8)	BTL -1	Remembering
13	b) Define pseudo inverse of any mXn matrix and write an algorithm to find the pseudo inverse. Also find the pseudo inverse. Also find the pseudo inverse of matrix $A = \begin{pmatrix} 1 & -1 & 0 \\ 0 & 1 & 1 \end{pmatrix}$ (8)	BTL -1	Remembering
14.	a) Find the generalized inverse for the matrix $A = \begin{pmatrix} 0 & 0 & 1 & 2 \\ 1 & 2 & 2 & 3 \end{pmatrix}$ (8)	BTL -1	Remembering
14	b) If x and y are any two vectors in an inner product space , then prove that $\lvert < x, y > \rvert \leq \lVert x \rVert \lVert y \rVert$ (8)	BTL -4	Analyzing
	PART -C		
15	Decompose the matrix $\begin{pmatrix} 1 & -1 & 4 \\ 1 & 4 & -2 \\ 1 & 4 & 2 \\ 1 & -1 & 0 \end{pmatrix}$ using QR factorization method (15)	BTL -3	Applying
16	Find the singular value decomposition of the matrix $\begin{pmatrix} 3 & 2 & 2 \\ 2 & 3 & -2 \end{pmatrix}$ (15)	BTL -1	Remembering
17	Find the closest line to the points $(0,6), (1,0),$ and $(2,0)$ (15)	BTL -2	Understanding

18	Find a least square solution to the inconsistent system given by Ax=b where $A = \begin{pmatrix} 2 & 0 \\ 0 & 1 \\ 2 & 2 \end{pmatrix}$ and $\begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$ **(15)**	BTL -4	Analyzing

UNIT –LINEAR PROGRAMMING

Formulation – Graphical solution – Simplex method – Big M method - Two phase method - Transportation problems - Assignment models

PART-A

Q.No.	Question	Bloom's Taxonomy Level	Domain
1	Write down the mathematical formulation of L.P.P.	BTL-1	Remembering
2	Define optimum basic feasible solution	BTL-1	Remembering
3	Compare graphical and simplex methods for solving LPP	BTL-2	Understanding
4	What is the difference between feasible solution and basic feasible solution?	BTL-4	Analyzing
5	Explain optimal solution in L.P.P	BTL-2	Understanding
6	Express the general form of an LP model in algebraic form	BTL -3	Applying
7	Define (i) Basic solution (ii) Feasible solution	BTL-1	Remembering
8	A firm manufactures 3 products A,B,C . The profits are Rs.3,Rs.2 and Rs.4 respectively. The firm has two machines X and Y and below is the required processing time in minutes for each machine to each product Product $\begin{array}{c\|c\|c\|c\|c} & & A & B & C \\ \hline \text{Machines} & X & 4 & 3 & 5 \\ & Y & 3 & 2 & 4 \end{array}$ Machine X and Y have 2000 and 2500 machine minutes respectively. The firm must manufacture1000A's and 200B's and 50C's, but no more than150A's. Formulate the above problems as an LPP so as to maximize the profit.	BTL-6	Creating
9	A factory manufactures nails and screws. The profit earned is Rs. 2/kg nails and Rs. 3/kg screws. Three units of labours are required to manufacture 1 kg nails and 6 units to make 1 kg screws. Twenty four units of labour are available. Two units of raw materials are needed to make 1kg nails and 1 unit for 1 kg screws. Formulate the problem as an LP model which yields maximum profit from 10 units of raw materials.	BTL-6	Creating
10	Use graphical method , to maximize $z = 2x_1 + 3x_2,\ s.t\ x_1 + x_2 \leq 1, 3x_1 + x_2 \leq 4, x_1, x_2 \geq 0$	BTL-3	Applying
11	Solve the following by Graphical method Maximize $z = 2x_1 + 3x_2, s.t\ x_1 - x_2 \leq 2, x_1 + x_2 \geq 4, x_1 \geq 0, x_2 \geq 0$	BTL-5	Evaluating
12	Solve the following L.P.P by using graphical method $Maximize\ Z = 5x_1 + 3x_2$, Subject to $3x_1 + 5x_2 \leq 15, 5x_1 + 2x_2 \leq 10, x_1, x_2 \geq 0$	BTL-5	Evaluating
13	How many basic variables will be there for a balanced transportation with 3 rows and 3 columns?	BTL-2	Understanding
14	Define degeneracy in a transportation model.	BTL-2	Understanding
15	List any two basic differences between a transportation and assignment problem	BTL-1	Remembering
16	When will you say a transportation problem is said to be unbalanced?	BTL-1	Remembering
17	Point out the methods to find the initial basic feasible solution for transportation problem	BTL-4	Analyzing

18	Differentiate between balanced and unbalanced cases in Assignment model	BTL-4	Analyzing
19	Define an assignment problem? Give two applications.	BTL-1	Remembering
20	Define transshipment problem	BTL-3	Applying
	PART-B		
1	a) Solve the L.P.P by Simplex method $Maximize\ Z = 3x + 2y$ Subject to $2x + y \leq 6, x + 2y \leq 6, x, y \geq 0$ (8)	BTL-2	Understanding
1	b) Solve by Big M method Minimize $Z = 4x_1 + x_2$, Subject to $3x_1 + x_2 = 3$; $4x_1 + 3x_2 \geq 6$; $x_1 + 2x_2 \leq 3$ and $x_1, x_2, \geq 0$ (8)	BTL-2	Understanding
2.	a) Write the solution by Simplex method. Maximize $Z = 5x_1 + 4x_2$, Subject to $4x_1 + 10x_2 \leq 10, 3x_1 + 2x_2 \leq 9, 8x_1 + 3x_2 \leq 12, x_1, x_2 \geq 0$ (8)	BTL-1	Remembering
2	b) Analyze the solution by two phase Simplex method to solve Maximize $Z = 5x_1 + 8x_2$, Subject to $3x_1 + 2x_2 \geq 3, x_1 + 4x_2 \geq 4, x_1 + x_2 \leq 5, x_1, x_2 \geq 0$ (8)	BTL-4	Analyzing
3	a) Write the solution of the LPP by using Simplex method, Maximize $Z = 4x_1 + x_2 + 3x_3 + 5x_4$ Subject to ; $4x_1 - 6x_2 - 5x_3 + 4x_4 \geq -20, 3x_1 - 2x_2 + 4x_3 + x_4 \leq 10, 8x_1 - 3x_2 + 3x_3 + 2x_4 \leq 20, x_1, x_2, x_3, x_4 \geq 0$ (8)	BTL-1	Remembering
3	a) Write the solution of the LPP by graphical method, Maximize $Z = 100x_1 + 40x_2$ Subject to ; $5x_1 + 2x_2 \leq 1000$, $3x_1 + 2x_2 \leq 900, x_1 + 2x_2 \leq 500, x_1, x_2 \geq 0$ (8)	BTL-1	Remembering
4.	a) Point out the solution by using two phase Simplex method to solve Maximize $Z = 2x_1 - 2x_2 + 4x_3$, Subject to $-x_1 + x_2 + x_3 \leq 20$, $2x_4 - x_2 + x_3 \leq 10, x_1 + x_2 + 3x_3 \leq 60$ and $x_1, x_2, x_3 \geq 0$ (8)	BTL-4	Analyzing
4	b) Identify the solution of the L.P.P by using Simplex method, Maximize $Z = 5x_1 - 6x_2 - 7x_3$, Subject to $x_1 + 5x_2 - 3x_3 \geq 15, 5x_1 - 6x_2 + 10x_3 \leq 20$, $x_1 + x_2 + x_3 = 5, x_1, x_2, x_3 \geq 0$ (8)	BTL-1	Remembering
5	a) Write the solution of the LPP by graphical method Maximize $Z = x_1 + x_2$, Subject to $x_1 + x_2 \leq 1, -3x_1 + x_2 \geq 3, x_1, x_2 \geq 0$ (8)	BTL-1	Remembering
5	b) Identify the solution of the following L.P.P. by using Simplex method : Maximize $Z = 20x_1 + 6x_2 + 8x_3$ Subject to the constraints $8x_1 + 2x_2 + 3x_3 \leq 250, 4x_1 + 3x_2 \leq 150, 2x_1 + x_2 \leq 50$, $x_1, x_2, x_3 \geq 0$ (8)	BTL-1	Remembering
6.	a) Solve by Simplex method Maximize $Z = 15x_1 + 6x_2 + 9x_3 + 2x_4$, Subject to $2x_1 + x_2 + 5x_3 + 6x_4 \leq 20$, $3x_1 + x_2 + 3x_3 + 25x_4 \leq 24, x_1 + x_4 \leq 70, x_1, x_2, x_3, x_4 \geq 0$ (8)	BTL-6	Creating
6	b) Point out the solution by using two- phase simplex method to solve the L.P.P Maximize $Z = 2x_1 + x_2 + x_3$ Subject to $4x_1 + 6x_2 + 3x_3 \leq 8$, $3x_1 - 6x_2 - 4x_3 \leq 1, 2x_1 + 3x_2 - 5x_3 \geq 4, x_1, x_2, x_3 \geq 0$ (8)	BTL-4	Analyzing
7	a) Point out the solution by using simple method solve the L.P.P Maximize $Z = 2x_1 + 3x_2$, Subject to $x_1 - x_2 \leq 2, x_1 + x_2 \leq 4, x_1, x_2 \geq 0$ (8)	BTL-4	Analyzing
7	b) A gear manufacturing company received an order for three specific type of gears of regular supply. The management is considering to devote the available excess capacity to one or more of the three types say A,B and C. The available capacity on the machines which might limit output and the number of machine hours required for each unit of respective gear is also given below:	BTL-6	Creating

Machine Type	Available Machine Hours/Week	Productivity in Machine hours/unit		
		Gear A	Gear B	Gear C
Gear Hobbing m/c	250	8	2	3
Gear Shaping m/c	150	4	3	0
Gear Grinding m/c	50	2	0	1

The unit profit would be Rs.20,Rs.6 and Rs.8 respectively for the gears A,B and C . Find how much of each gear company should produce in order to maximize profit. (8)

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8 | BTL-2 | Understanding

a) Find the initial solution to the following TP using Vogel's approximation method

	Destination				
	D_1	D_2	D_3	D_4	Supply
F_1	3	3	4	1	100
F_2	4	2	4	2	125
F_3	1	5	3	2	75
Demand	120	80	75	25	300

(8)

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8 | BTL-3 | Applying

b)Solve the assignment problem represented by the matrix

	1	2	3	4	5	6
A	9	22	58	11	19	27
B	43	78	72	50	63	48
C	41	28	91	37	45	33
D	74	42	27	49	39	32
E	36	11	57	22	25	18
F	3	56	53	31	17	28

(8)

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9 | BTL5 | Evaluating

a) Determine the basic feasible solution to the transportation problem

	Distribution centers				
	D_1	D_2	D_3	D_4	Supply
F_1	2	3	1	7	6
F_2	1	0	6	1	1
F_3	5	8	1	9	10
Requirement	7	5	3	2	17

(8)

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9 | BTL-4 | Analyzing

b) A company has a team of four sales man and four districts where the companywants to start its business. After taking into account the capabilities of sales men and the nature of districts, the company estimates that the profit per day in hundreds of rupees for each salesman in each district is as below. Examine the assignment of sales man to various district which will yield maximum profit . (8)

c)

	1	2	3	4
A	1	10	1	11
B	1	11	1	15
C	1	15	1	12
D	1	12	1	15

10. a) Identify the optimal solution of the transportation (8) — BTL-1 — Remembering

Destination

Origin	D_1	D_2	D_3	D_4	Capacity
O_1	19	30	50	10	7
O_2	70	30	40	60	9
O_3	40	8	70	20	18
Demand	5	8	7	14	

10 b) A travelling sales man has to visit 5 cities .He wishes to start from a particular city, visit each city once and then returns to his starting point. Cost of going from one city to another is shown below. Find the least cost route (8) — BTL-2 — Understanding

To City

	A	B	C	D	E
A	∞	4	10	14	2
B	12	∞	6	10	4
C	16	14	∞	8	14
D	24	8	12	∞	10
E	2	6	4	16	∞

11. a) Find an optimal solution to the following transportation problem (8) — BTL-2 — Understanding

Distribution centers

	D_1	D_2	D_3	D_4	Supply
F_1	2	3	11	7	6
F_2	1	0	6	1	1
F_3	5	8	15	9	10
Requirement	7	5	3	2	17

11 b)Solve the assignment problem (8) — BTL-3 — Applying

	P	Q	R	S
A	18	26	17	11
B	13	28	14	26
C	38	19	18	15
D	19	26	24	10

12. a) Solve the following transportation problem (8) — BTL-5 — Evaluating

Store

	A	B	C	a_i
F_1	10	8	8	8
F_2	10	7	10	7
F_3	11	9	7	9
F_4	12	14	10	4
b_j	10	10	8	

<table>
<tr>
<td>12</td>
<td>b)A computer center has three expert programmers. The center wants three application programs to be developed. The head of the computer center , after studying carefully the programs to be developed, write the computer time in minutes required by the experts for the application programs
Programmers
<table>
<tr><th></th><th></th><th>A</th><th>B</th><th>C</th></tr>
<tr><td>programs</td><td>1</td><td>120</td><td>100</td><td>80</td></tr>
<tr><td></td><td>2</td><td>80</td><td>90</td><td>110</td></tr>
<tr><td></td><td>3</td><td>110</td><td>140</td><td>120</td></tr>
</table>
Assign the programmers to the programs in such a way that the total computer time is minimum. (8)</td>
<td>BTL-1</td>
<td>Remembering</td>
</tr>
<tr>
<td>13.</td>
<td>a) Solve the following transportation problem to maximize the profit (8)
<table>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>Supply</th></tr>
<tr><td>1</td><td>15</td><td>51</td><td>42</td><td>33</td><td>23</td></tr>
<tr><td>2</td><td>80</td><td>42</td><td>26</td><td>81</td><td>44</td></tr>
<tr><td>3</td><td>90</td><td>40</td><td>66</td><td>60</td><td>33</td></tr>
<tr><td>Demand</td><td>23</td><td>31</td><td>16</td><td>30</td><td></td></tr>
</table></td>
<td>BTL-3</td>
<td>Applying</td>
</tr>
<tr>
<td>13</td>
<td>b)A department has five employees with five jobs to be performed. The time (in hours) each men will take to perform each job is given in the effectiveness matrix
Employees
<table>
<tr><th>Jobs</th><th>I</th><th>II</th><th>III</th><th>IV</th><th>V</th></tr>
<tr><td>A</td><td>10</td><td>5</td><td>13</td><td>15</td><td>16</td></tr>
<tr><td>B</td><td>3</td><td>9</td><td>18</td><td>13</td><td>6</td></tr>
<tr><td>C</td><td>10</td><td>7</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>D</td><td>7</td><td>11</td><td>9</td><td>7</td><td>12</td></tr>
<tr><td>E</td><td>7</td><td>9</td><td>10</td><td>4</td><td>12</td></tr>
</table>
How should the jobs be allocated, one per employee, so as to minimize the total man- hours? (8)</td>
<td>BTL-3</td>
<td>Applying</td>
</tr>
<tr>
<td>14.</td>
<td>a) A Company has four machines to do three jobs. Each job can be assigned to one and only one machine. The cost of each job on each machine is given in the following table. (8)
<table>
<tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>A</td><td>18</td><td>24</td><td>28</td><td>32</td></tr>
<tr><td>B</td><td>8</td><td>13</td><td>17</td><td>19</td></tr>
<tr><td>C</td><td>10</td><td>15</td><td>19</td><td>22</td></tr>
</table></td>
<td>BTL-2</td>
<td>Understanding</td>
</tr>
</table>

14

b)A military equipment is to be transportated from origins x,y,z to the destinations A ,B ,C and D The supply at the origins, the demand at te destinations and time of shipment is sown in the table Point out the transportation plan so that the time required for shipment is the minimum

Destinations					
	A	B	C	D	Supply
X	10	22	0	22	8
Y	15	20	12	8	13
Z	21	12	10	15	11
Demand	5	11	8	8	32

(8)

BTL-4 | Evaluating

PART-C

15

Three grades of coal A,B and C contain phosphorous and ash as impurities .In particular Industrial process, fuel up to 100 ton (maximum) is requires which shouldcontain ash not more than 3% and phosphorous not more than 0.03%. It is desired to maximize the profit while satisfying these conditions. There is an unlimited supply of each grades .The percentage of impurities and the profits of grades are given below

Coal	Phosphorous (%)	Ash (%)	Profit (Rs per ton)
A	0.02	2	12
B	0.04	3	15
C	0.03	5	14

Find the proportion in which the three grades be used (15)

BTL -2 | Understanding

16

A firm uses lathes, milling machines and grinding machines to produce two machine parts. The table below represents the machining times required for each part , the machining times available on different machines and the profit on each machine part .

Type of Machine	Machine time for the machine part (minute)		Maximum time Available / week (minutes)	
	I	II		
Lathes	12	6	3000	
Milling	4	10	2000	
Grading	2	3	900	
Profit per unit	Rs 40	Rs 100		

Find the number of parts I and II to be manufactured per week to maximize the profit by graphical method (15)

BTL-3 | Applying

17

A company has three plants A,B,C and 3warehouses X,Y,Z. The number of units available at the plants are 60,70,80 and the demand at X,Y,Z is 50,80,80 respectively. The unit cost of the transportation is given in the following table

	X	Y	Z

BTL-1 | Remembering

A	8	7	3
B	3	8	9
C	11	3	5

Find the allocation so that the total transportation cost is minimum (15)

18	A marketing manager has 5sales man and three are 5 sales districts. Considering the capabilities of the salesman and the nature of districts the estimates made by the marketing manager for the sales per month (in 1000 Rs)for each salesman in each in each district would be as follows	BTL-3	Applying

	A	B	C	D	E
1	32	38	40	28	40
2	40	24	28	21	6
3	41	27	33	30	37
4	22	38	41	36	36
5	29	33	40	35	39

Find the assignment of salesman to the districts that will result in the maximum sales. (15)

UNIT –III NUMERICAL SOLUTION TO ORDINARY DIFFERENTIAL EQUATIONS

RungeKutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method solution of stiff ODEs, , BVP: Finite difference method, collocation .

PART-A

Q.No.	Question	Bloom's Taxonomy Level	Domain
1.	Write down Runge- Kutta method of order four for solving initial value problems in solving ordinary differential equations	BTL-2	Understanding
2.	State the stability region for R-K method of fourth order	BTL-1	Remembering
3.	Use R-K method of second order to find $y\ (0.4)$ given $y' = xy\ , y(0) = 1$	BTL-3	Applying
4.	State an algorithm of the RungeKutta method of order four to solve $y' = f(x,y), y(x_0) = y_0\ at\ x = x_0 + h$	BTL-1	Remembering
5.	What is the difference between initial and boundary value problems?	BTL-4	Analyzing
6.	When a single step method is applied to the test equation $u^{/} = \lambda u$, what are the conditions for absolutely stable and relatively stable?	BTL-3	Applying
7.	Discuss the stability of Euler's method	BTL-1	Remembering
8.	What is meant by Numerical stability	BTL-1	Remembering
9.	What is a predictor- corrector method?	BTL-1	Remembering
10.	Differentiate single step and multi step method	BTL-4	Analyzing
11.	Write down Adam Bashforth 's predictor and corrector method	BTL-1	Remembering

12.	Explain stiff ordinary differential equations	BTL-2	Understanding
13.	Using fourth order Runge – Kutta method to find y (0.1) given $\frac{dy}{dx} = x + y$ y (0) = 1, h = 0.1	BTL-4	Analyzing
14.	Summarize the methods available to solve boundary value problems	BTL-5	Evaluating
15.	Estimate $y\ (1.25)$ if $\frac{dy}{dx} = x^2 + y^2$, $y\ (1) = 1$ taking $h = 0.25$, using Euler's method	BTL-3	Applying
16.	What is weighting function of collocation method?	BTL-2	Understanding
17.	Summarize first four derivatives of finite difference method	BTL-5	Evaluating
18.	Find y(0.4) given $\boldsymbol{y' = xy}, \boldsymbol{y(0) = 1}$, using R-K method of fourth order	BTL-6	Creating
19.	Discuss the collocation method	BTL-2	Understanding
20.	Analyse y (0.4) given $y' = xy, y(0) = 1$, using R-K method of second order	BTL-6	Creating
	PART-B		
1.	a) Write the solution by using Runge- Kutta method of fourth order to find $y(0.1)$ given $\frac{dy}{dx} = x + y$ with $y(0) = 1$. (16)	BTL-1	Remembering
2.	a) Write the solution by Runge- Kutta method of fourth order, find $y(0.8)$ correct to 4 decimal places if $y' = y - x^2, y(0.6) = 1.7379$. (8)	BTL-1	Remembering
2	b)Solve by orthogonal collocation method y" + (1 +x^2)y + 1 = 0 With y(-1) = y(1) = 0. (8)	BTL-2	Understanding
3.	a)Write the solution by Runge-Kutta method of fourth order solve $\frac{dy}{dx} = \frac{y^2-x^2}{y^2+x^2}$ with $y(0) = 1$ at $x = 0.2, 0.4, 0.6$ and hence find $x = 0.8$ by Adam's method (16)	BTL-1	Remembering
4.	a)Solve the following equation $y'' - (0.1)(1 - y^2)y' + y = 0$ using R-K method for $x = 0.2$ with the initial values $y(0) = 1, y'(0) = 0$ (8)	BTL-2	Understanding
4	b)Using finite difference method solve $\frac{d^2y}{dx^2} = y$ in (0,2)given $y(0) = 0, y(2) = 3.63$ (8)	BTL-3	Applying
5.	a)Solve the initial value problem $y' = t + y, y(0) = 1$, by classical Runge- Kutta method of fourth order with $h = 0.1$, to get $y(0.1)$ (16)	BTL-2	Understanding
6.	a) Given $\frac{dy}{dx} = 1 + y^2$, where $x = 0, y(0.2) = 0.2027, y(0.4) = 0.4228, y(0.6) = 0.6841$. Compute $y(0.8)$by Adams- Bashforth multistep method (8)	BTL-1	Remembering
6	b)Point out the solution of the BVP $\frac{d^2y}{dx^2} = y$ $with$ $y(0) = 0$ and $y(2) = 3.627$ by finite difference method [Take $h = 0.5$] (8)	BTL-4	Analyzing
7.	a) Given $\frac{dy}{dx} = 1 + y^2$, where $x = 0, y(0.2) = 0.2027, y(0.4) = 0.4228, y(0.6) = 0.6841$. Compute $y(0.8)$by Adams- Bashforth multistep method (8)	BTL-1	Remembering
7	b)Solve the boundary value problem by using Galerkin method $y'' + y = -x, 0 < x < 1$ with $y(0) = y(1) = 0$ (8)	BTL-5	Evaluating

8.	a) Evaluate y(0.9), using Adam Bashforth 's method - given that $y' = xy^{\frac{1}{3}}, y(1) = 1, y(1.1) = 1.10681,$ $y(1.2) = 1.22787 \ and \ y(1.3) = 1.36412$ (16)	BTL-5	Evaluating
9	b) Find y(0.1) , y(0.2) ,y(0.3) from $y' = xy + y^2, y(0) = 1$by using the RK method and y(0.4) by Adam Bashforth method (16)	BTL-1	Remembering
10	b)Solve y" = x + y with the conditions y(0) = y(1) = 0 by finite difference method, taking h = 0.25 (8)	BTL-2	Understanding
11	a)Point out the solution of 2y' –x – y = 0 given y(0) = 2 , y(0.5) = 2.636, y(1) = 3.595, y(1.5) = 4.968 to get y(2) by Adam's method (8)	BTL-4	Analyzing
11	b)Point out the solution of boundary value problem x^2 y '' – 2y +x = 0 subject to y(2) =0 = y(3) , find y (2.25) by finite difference method. (8))	BTL-4	Analyzing
12.	a)Find $y(4.4)$ by Adam –Bashforth multi step method given $5xy' + y^2 = 2, y(4) = 1.2, y(4.1) = 1.2003, y(4.2) = 1.012,$ $y(4.3) = 1.023$ (8)	BTL-1	Remembering
12	b)By finite difference method solve $xy'' + y = 0, y(1) = 1, y(2) = 2$ With $h = 0.25$ (8)	BTL-3	Applying
13.	a)Solve :$\frac{dy}{dx} = y - \frac{2x}{y}, y(0) = 1.0954, y(0.2) = 1.1832,$ $y(0.3) = 1.2649$, compute $y(0.4)$ by Adam's predictor and corrector method. (8)	BTL-3	Applying
13	b)Devise the solution by finite difference method find y(0.25), y(0.5) at y(0.75) satisfying the Differential equation $\frac{d^2y}{dx^2}$ +y =x subject to the boundary condition y(0)= 0, y(1) =2. (8)	BTL-6	Creating
14.	a)Find $y(0.1), y(0.2)\ y(0.3)$ from $y' = xy + y^2, y(0) = 1$. Examine the solution by R.K method and hence obtain $y(0.4)$ using Adams-Bash forth method. (8)	BTL-4	Analyzing
	PART-C		
15	Discuss the stability of the RungeKutta method of fourth order (15)	BTL-4	Analyzing
16	Consider the differential equation for a problem as $\frac{d^2y}{dx^2} + 300x^2 = 0$ $0 \le x \le 1$ with the boundary conditions y(0)=0, y(1)=0. Find the solution of the problem using a one coefficient trial function as $y = a_1 x(1 - x^3)$. Use (i)Point collocation method (ii)Sub – domain collocation method (iii)Galerkin'smethod. (15)	BTL-1	Remembering
17	Solve the simultaneous differential equations $\frac{dy}{dx} = 2y + z, \frac{dz}{dx} = y -$ 3;y(0)=0 ;z(0)=0.5 for y(0.1) and z(0.1) using RK method of the fourth order . (15)	BTL-3	Applying
18	An Isothermal tubular reactor with axial mixing with an irreversible ,second order reaction taking place is describes in chemical engineering by$\frac{1}{Pe}\frac{d^2y}{dx^2} - \frac{dy}{dx} - Day^2 = 0, 0 \le x \le 1$ with boundary conditions $\frac{dy}{dx} = Pe(y - 1) at\ x = 0, \frac{dy}{dx} = 0 at\ x = 1$.Solve this equation by finite difference method with n=3 . (15)	BTL-3	Applying

UNIT -IV-PROBABILITY AND RANDOM VARIABLES

Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function - Two dimensional random variables - Joint distributions – Marginal and conditional

distributions – Functions of two dimensional random variables – Regression curve – Correlation			
PART-A			
Q.No.		**Bloom's Taxonomy Level**	**Domain**
1.	If A and B are events such that P(A+B) = ¾ , P(AB) = ¼ and P(A) = 2/3. Find P($\bar{A}/B$), P(B)	BTL -1	Remembering
2.	Let X and Y be continuous RVs with joint density function $f(x,y) = \frac{x(x-y)}{8}$,$0 < x < 2$, $-x < y < x and f(x,y) = 0 elsewhere$.Find $f(y/x)$	BTL -1	Remembering
3.	A box contains 4 bad and 6 good tubes. Two are drawn out from the box at a time. One of them is tested and found to be good .What is the probability that the other one is also good?	BTL -1	Remembering
4.	Find P (X +Y < 1) for the RVs whose joint pdf is $f(x,y) = \begin{cases} 2xy + \left(\frac{3}{2}\right) y^3, 0 < x < 1, 0 < y < 1 \\ 0, \quad otherwise \end{cases}$	BTL -1	Remembering
5.	The joint probability mass function of a two dimensional discrete random variable (X,Y) is given by $P(X = x, Y = y) = C(2x + y)$ x= 0,1,2 and y = 0,1,2,3.Infer the marginal distributions of X	BTL -4	Analyzing
6.	If $f(x,y) = e^{-(x+y)}$, $x > 0$, $y > 0$ is the joint pdf of the RVs X and Y,check whether X and Y are independent	BTL -4	Analyzing
7.	The regression equations are $3x + 2y = 26$ *and* $6x + y = 31$.Devise the correlation coefficient between them	BTL -6	Creating
8.	Find the acute angle between the two lines of regression	BTL -1	Remembering
9.	Find the value of k , if $f(x,y) = k(1-x)(1-y)$ in $0 < x,y < 1$ and $f(x,y) = 0$ otherwise ,is to be the joint density function	BTL -2	Understanding
10.	If $\bar{X} = 970$, $\bar{Y} = 18$, $\sigma_x = 38$, σ_y= 2 and r =0.6 , Develop the line of regression of X on Y	BTL -6	Creating
11.	If $f(x,y) = 8xy$, $0 < x < 1$, $0 < y < x$ is the joint pdf of X and Y , find $f(y/x)$	BTL -2	Understanding
12.	If the joint pdf of (X , Y) is given by $f(x,y) = 2 - x - y$, in $0 < x < y < 1$, find $E(X)$	BTL -3	Applying
13.	If $Y = 2x + 3$, find the COV (X,Y)	BTL -2	Understanding
14.	Find the correlation coefficient from the regression equations $y = 3.5 - 1.2x, x = 1.8 - 0.3y$	BTL -3	Applying
15.	The joint probability density function of the random variable (X,Y) is given by $f(x,y) = Kxye^{-(x^2+y^2)}$, $x > 0, y > 0$ Find the value of K	BTL -3	Applying
16.	Let X and Y be two independent RVs with joint pmf $P(X = x, Y = y) = \begin{cases} \frac{x+2y}{18}, x = 1,2, y = 1,2 \\ 0, \quad otherwise \end{cases}$ Point out the marginal probability mass function of X and E (X)	BTL -4	Analyzing
17.	Define joint pdf of two RVs X and Y and state its properties	BTL -1	Remembering
18.	If two RV Xand Y have the pdf $p(x,y) = k(2x + 3y)$ for $x = 0,1,2, y = 1,2,3$,evaluate k	BTL -5	Evaluating
19.	If two random variables X and Y have probability density function $f(x,y) = k(2x + y)$ for 0≤ x ≤ 2 and 0 ≤ y ≤ 2, evaluate k	BTL -5	Evaluating

20.	The two regression equations of two random variables X and Y are $8x - 10y + 66 = 0 \; and \; 40x - 18y = 214$.Find the mean values of X and Y.	BTL -2	Understanding
	PART-B		
1.	a) The joint probability density function of a two dimensional random variable (X,Y) is given by $f(x,y) = xy^2 + \frac{x^2}{8}, 0 \le x \le 2 , \;\; 0 \le y \le 1$ Compute $P(X > 1), P\left(Y < \frac{1}{2}\right), P(X > 1, Y < \frac{1}{2})$ (8)	BTL -3	Applying
1	b)Identify the coefficient of correlation between x and y from the given data x: 1, 3, 5, 8, 9, 10 y: 3, 4, 8, 10, 12, 11 (8)	BTL -1	Remembering
2	a)In a bolt factory machines A, B, C manufacture respectively 25%, 35% and 40% of the total of their output 5, 4, 2 percent are defective bolts. If A bolt is drawn at random from the product and is found to be defective, what are the probabilities that is was manufactured by machines A, B and C? (8)	BTL -1	Remembering
2	b)Infer the two regression coefficients $b_{yx} \; and \; b_{xy}$ and hence find the correlation coefficient for the given data $\Sigma x = 24$, $\Sigma y = 214, \Sigma xy = 306, \Sigma x^2 = 164, \Sigma y^2 = 576, N = 4$ (8)	BTL -4	Analyzing
3	a)The joint pdf of Rv X and Y is given by $f(x,y) = \begin{cases} \frac{8xy}{9}, 1 \le x \le y \le 2 \\ 0, \quad otherwise \end{cases}$ Find the conditional density functions of X and Y (8)	BTL -3	Applying
3	b)Identify the correlation coefficient for the following data. X: 105 104 102 101 100 99 98 9 93 92 Y: 101 103 100 98 95 96 104 92 97 94 (8)	BTL -1 93 97	Remembering 92 94
4	a)Two random variables X and Y have the joint density f(x,y) = $\begin{cases} 2 - x - y, 0 < x < 1, 0 < y < 1 \\ 0, \; otherwise \end{cases}$ Show that Correlation coefficient between X and Y is -1/11. (8)	BTL -1	Remembering
4	b)If X and Y are independent random variables with $f(x) = e^{-x}$ $x \ge 0 \; and \; f(y) = e^{-y}, y \ge 0$ respectively, find the joint density functions of $U = \frac{X}{X+Y}, V = X + Y$. Identify whether U and V independent. (8)	BTL -1	Remembering
5	a) X and Y are independent with a common pdf$f(x) = e^{-x}, x > 0$,0otherwise ,$f(y) = e^{-y}, y > 0$, otherwise .Find the PDF for $X - Y$. (8)	BTL -3	Applying
5	b) The regression equation of X on Y is $3Y - 5X + 108 = 0$ .If the mean of Y is 44 and the variance of X is 9/16 th of the variance of Y. Infer the mean value of X and the correlation coefficient. (8)	BTL -4	Analyzing
6	a) If X and Y are independent RVs with density function $f(x) = 1, 1 < x < 2$, 0 otherwise and $f(y) = \frac{y}{6}$, $2 < y < 4$, 0 otherwise .Find the density function of $Z = XY$ (8)	BTL -2	Understanding
6	b) Two RVs X and Y have the joint pdf given by $f(x,y) = k(1 - x^2 y), 0 < x < 1, 0 < Y < 1$, 0 otherwise. 1.Find the value of K 2.Obtain the marginal pdf of X and Y 3.Also find the correlation coefficient between them. (8)	BTL -5	Evaluating

<table>
<tr><td>7</td><td>a) The joint pdf of a two dimensional RV is given by
$f(x,y) = 1/3(x + y), 0 < x, 1,) < y < 2$.Find the 1.Correlation coefficient
2.The equation of the two lines of regression lines. (8)</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>7</td><td>For a certain binary communication channel , the probability that a transmitted ‘0’ is received as a ‘0’ is 0.95and the probability that a transmitted ‘1’ is received as ‘1’ is 0.90. If the probability that a ‘0’ transmitted is 0.4 , find the probability that (i) a ‘1’ is received and (ii)a ‘1’was transmitted given that a ‘1’ was received. (8)</td><td>BTL -5</td><td>Evaluating</td></tr>
<tr><td>8</td><td>a) 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 $U = XY$. (8)</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>8</td><td>b) The equation of two regression lines obtained by in a correlation analysis is as follows :$3x + 12y = 19, 3y + 9x = 46$.Point out the correlation coefficient 2.Mean value of X and Y. (8)</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>9</td><td>a) If (X ,Y) is a two dimensional RV uniformly distributed over the triangular region R bounded by y =0 , x =3 and y = $\frac{4x}{3}$ Find the marginal density function of X and Y (8)</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>9</td><td>b)For the bivariate probability distribution of (X ,Y) given below
<table>
<tr><td>Y \ X</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1/32</td><td>2/3</td><td>2/3</td><td>3/32</td></tr>
<tr><td>1</td><td>1/16</td><td>1/1</td><td>1/8</td><td>1/8</td><td>1/8</td><td>1/8</td></tr>
<tr><td>2</td><td>1/32</td><td>1/3</td><td>1/64</td><td>1/6</td><td>0</td><td>2/64</td></tr>
</table>
Analyze the marginal distributions, conditional distributions of X given Y =1 and conditional distribution of Y given X = 0.(8)</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>10.</td><td>a)Find the correlation coefficient of X and Y , if the RV (X,Y) has the joint pdf $f(x,y) = \frac{x+y}{3}, 0 < x < 1, 0 < y < 2$. (8)</td><td>BTL -4</td><td>Analyzing</td></tr>
<tr><td>10</td><td>b) The joint pdf of two dimensional RV (X,Y) is given by
$f(x,y) = \frac{8}{9}xy, 0 \le x \le y \le 2$ and $f(x,y) = 0$,otherwise .Find the densities of X and Y and the conditional densities $f(x/y)$ and $f(y/x)$. (8)</td><td>BTL -3</td><td>Applying</td></tr>
<tr><td>11.</td><td>a) Identify the correlation coefficient r_{xy} for the bivariate RV (X,Y) having the pdf $f(x,y) = 2xy, 0 < x < 1, 0 < y < 1, 0$ otherwise. (8)</td><td>BTL -1</td><td>Remembering</td></tr>
<tr><td>11</td><td>b) Let X and Y be non-negative continuous random variables having the joint probability density function
$f(x,y) = \begin{cases} 4xy\, e^{-(x^2+y^2)}, & x > 0, y > 0 \\ 0, & otherwise \end{cases}$ find the pdf of U = $\sqrt{X^2 + Y^2}$ (8)</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>12.</td><td>a) If X and Y are random variables having the joint density function
$f(x,y) = k(6 - x - y), 0 < x < 2, 2 < y < 4$, find the value of k, the marginal densities and $P(X < 1/Y > 3)$ and $P(X + Y < 3)$ (8)</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>12</td><td>b) Three balls are drawn at random without replacement from a box containing 2 white, 3 red and 4 black balls. If X denotes the number of white balls drawn and Y denotes the number of red balls drawn. Find the joint probability distribution of (X,Y)(8)</td><td>BTL -6</td><td>Creating</td></tr>
<tr><td>13.</td><td>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 probability distributions. (8)</td><td>BTL -2</td><td>Understanding</td></tr>
<tr><td>13</td><td>b)Two independent random variables X and Y are defined by $f_X(x) = \begin{cases} 4ax: & 0 < x < 1 \\ 0: & otherwise \end{cases}$ And $f_Y(y) = \begin{cases} 4ay: & 0 < x < 1 \\ 0: & otherwise \end{cases}$ Show that U=X+Y and V=X-Y are correlated. (8)</td><td>BTL -1</td><td>Remembering</td></tr>
<tr><td>14.</td><td>a) If (X ,Y) is a two dimensional RV uniformly distributed over the triangular region R bounded by y = 0 , x = 3 and y = $\frac{4x}{3}$. Identify the marginal density</td><td>BTL -1</td><td>Remembering</td></tr>
</table>

	function of X and Y. Also the correlation coefficient between them. (8)		
14	b) Two random variables X and Y have the following joint probability density function $f(x,y) = \begin{cases} x+y; 0 \le x \le 1, 0 \le y \le 1 \\ 0,\ otherwise \end{cases}$. Formulate the probability density function of the random variable U = XY. (8)	BTL -6	Creating
	PART-C		
15	A bag contains 5 balls and it is not known that how many of them are white. Two balls are drawn at random from the bag are noted to be white . What is the chance that all the balls in the bag are white (15)	BTL -2	Understanding
16	An urn contains 10 white and 3 black balls. Two balls are drawn at random from the first urn and placed in the second and then 1ball is taken from the later .What is the probability that it is a white ball? (15)	BTL -2	Understanding
17	In a partially destroyed record of an analysis of correlation data, the following results only are legible. Variance of x=1. The egression equations are 3x+2y=26 and 6x+y = 31. What were (i) the mean values of X and Y? (ii)the standard deviation of Y and (iii) the correlation coefficient between X andY? (15)	BTL -3	Applying
18	The input to a binary communication system, denoted by a random variable X, takes one of the two values 0 or 1with probabilities ¾ and ¼ respectively. Because of error caused by noise in the system, the output Y differs from the input occasionally. The behavior of the communication system is modeled by the conditional probabilities given below $P(Y=1/x=1) = 3/4$, $P(Y=0/x=0) = 7/8$ .Find i) P(Y=1) (ii)P(Y=0) iii) P(X=1/Y=1) (15)	BTL -3	Applying

UNIT -V QUEUEING MODELS

Poisson Process – Markovian queues – Single and Multi-server Models – Little's formula - Machine Interference Model – Steady State analysis – Self Service queue.

Q.No.	**Question**	**Bloom's Taxonomy Level**	**Domain**
	PART-A		
1.	Write down Kendall's notation for queuing model	BTL -1	Remembering
2.	Define traffic intensity of an M/M/1 queuing model .What is the condition for steady state in terms of the traffic intensity?	BTL -1	Remembering
3.	In a given M/M/1 /∞ /FCFS queue ,ρ = 0.6 ,what is the probability that the queue contains 5 or more customers?	BTL -2	Understanding
4.	If a customer has to wait in a (M/M/1):(∞ /FIFO) queueing system , what is his average waiting time in the queue , if λ= 8 per hour and μ= 12per hour	BTL -2	Understanding
5.	What is the probability that a customer has to wait more than 15 minutes in an $(M/M/1):(\infty/FIFO)$queueing model with $\lambda = 6$ per hour and $\mu = 10$ per hour?	BTL -2	Understanding
6.	Point out the effective arrival rate in an (M/M/1):(K/FIFO) model?	BTL -4	Analyzing
7.	What do you mean by steady state and transient state in queuing theory?	BTL -1	Remembering
8.	For an M/M/1 queuing system if $\lambda = 6\ perhourand\mu = 8$ per hour, Point out the probability that at least 10 customers in the system?	BTL -4	Analyzing
9.	Write Little's formula for infinite capacity queuing system	BTL -1	Remembering

10.	Obtain the steady state probabilities of an (M/M/1):(∞ /FIFO) queuing model	BTL -6	Creating
11.	There are 3 typists in an office .Each can type an average 6 letters per hour. If the letters arrive for being typed at the rate of 15 letters per hour What fraction of time all the typists will be busy?	BTL -2	Understanding
12.	For an (M/M/S) (N/FIFO) queuing system Infer the formula for 1)Average number of customers in queue 2) Average waiting time of customers in queue.	BTL -5	Evaluating
13.	If people arrive to purchase cinema tickets at the average rate of 6 per minute, it takes an average of 7.5 seconds to purchase a ticket. If a person arrives 2 minutes before the picture starts and it takes exactly 1.5 minutes to reach the correct seat after purchasing the ticket. Can he expect to be seated for the start of the picture?	BTL -6	Creating
14.	What is meant by Balking?	BTL -1	Remembering
15.	Point out the probability that an arrival to an infinite capacity 3 server Poisson queue with $\frac{\lambda}{c\mu} = \frac{2}{3} and P_0 = \frac{1}{9}$ enters the server without waiting?	BTL -4	Analyzing
16.	Consider an M/M/C queuing system .Infer the probability that an arriving customer is forced to join the queue.	BTL -5	Evaluating
17.	Suppose that customers arrive at a Poisson rate of one per every twelve minutes, and that the service time is exponential at a rate of one service per 8 minutes a) What is the average no. of customers in the system? b) What is the average time of customers spends in the system?	BTL -3	Applying
18.	In the usual notation of an M/M/1 queuing system, if λ = 3 per hour and μ = 4/hour,Interpret P (X≥ 5) where X is the number of customers in the sytem.	BTL -3	Applying
19.	What is the probability that a customer has to wait more than 15 minutes to get his service (M/M/l):(°° /FIFO) queue system if λ= 6 per hour and μ= *10* per hour?	BTL -3	Applying
20.	Define the effective arrival rate for M | M | 1/N FCFS queueing system	BTL -1	Remembering
	PART-B		
1.	a) Arrivals at a telephone booth are considered to be Poisson with an average time of 12 min.between one arrival and the next .The length of a phone call is assumed to be distributed exponentially with mean 4 min. 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) What is the probability that it will take him more than 10 min altogether to wait for the phone and complete his call? 4) Estimate the fraction of the day when the phone will be in use 5) The telephone department will install a second booth ,when convinced that an arrival has to wait on the average for atleast 3 min. for phone .By how much the flow of arrivals should increase in order to justify a second booth? 6)What is the average length of the queue that forms from time to time? (8)	BTL -2	Understanding
1	b) There are three 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, a)What fraction of the time all the typists will be busy ? b)What is the average number of letters waiting to be typed? c)What is the average time a letter has to spend for waiting and for being typed ? d)What is the probability that a letter will take longer than 20 min waiting to be typed ? (8)	BTL -1	Remembering
2.	a) Arrivals at a telephone booth are considered to be Poisson with an average time of 10 min. between one arrival and the next The length of a phone call is assumed to be distributed exponentially with mean 3 min 1) Produce 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	BTL -6	Creating

	queue? C3) What is the probability that it will take him more than 10 min altogether to wait for the phone and complete his call? 4) Estimate the fraction of the day when the phone will be in use 5) The telephone department will install a second booth, when convinced that an arrival has to wait on the average for at least 3 min. for phone. By how much the flow of arrivals should increase in order to justify a second booth? 6) What is the average length of the queue that forms from time to time? (8)		
2	b) Abank has two tellers working on savings accounts. The first teller handles withdrawals only. The second teller handles deposits only .It has been found that the service time distributions for both deposits and withdrawals are exponential with mean time of 3 min per customer. Depositors are found to arrive in Poisson fashion throughout the day with mean arrival rate of 16 per hour Withdrawers also arrive in a Poisson fashion with mean arrival rate 14 per hour. What would be the effect on the average waiting time for the customers if each teller handles both withdrawals and deposits? What would be the effect, if this could only be accomplished by increasing the service time to 3.5 min? (8)	BTL -4	Analyzing
3	a) Customers arrive at a one man barber shop according to a Poisson with a mean inter arrival time of 20 min Customers spend an average of 15 min in the barber's chair 1) What is the expected number of customers in the barber shop ?In the Queue? 2) What is the probability that a customer will not have to wait for a hair cut? 3) How much can a customer expect to spend in the barbershop? 4) What are the average time customers spend in the queue? 5) What is the probability that the waiting time in the system is greater than 30 min? 6) What is the probability that there are more than 3 customers in the system? (8)	BTL-2	Understanding
3	b) A 2 – person barber shop has 5 chair to accommodate waiting customers.Potential customers ,who arrive when all 5 chairs are full,leave without entering barber shop .Customers arrive at the average rate of 4 per hour and spend an average of 12 min in the barber's chair .Compute P_0, P_1,P_7,$E(N_q)$ and **$E(w)$.** (8)	BTL -3	Applying
4	a) In a given M / M / 1 queueing system, the average arrivals is 4 customers per minute, ρ= 0.7. What are 1) mean number of customers L_s in the system 2) mean number of customers L_q in the queue 3) probability that the server is idle 4) mean waiting time W_s in the system. (8)	BTL -2	Understanding
4	b) Apetrol pump station has 4 pumps. The service times follow the exponential distribution with a mean of 6 min and cars arrive for service in a Poisson process at the rate of 30 cars per hour. 1)What is the probability that an arrival would have to wait in line? 2) Find the average waiting time, average time spent in the system and the average number of cars in the system 3) For what percentage of time would a pump be idle on an average? (8)	BTL -1	Remembering
5.	a)Customers arrive at a watch repair shop according to a Poisson process at a rate of one per every 10 minutes , and the service time is exponential random variable with 8 minutes 1)Find the average number of customers L_s in the shop 2)Find the average number of customers L_q in the queue' 3)Find the average time a customer spends in the system in the shop W_s 4)What is the probability that the server is idle ? (8)	BTL -4	Analyzing
5	**b) A** car servicing station has 2 bays where service can be offered simultaneously .Because of space limtation,only 4 cars are accepted for servicing . The arrival pattern is Poisson with 12 cars per day.The service time in both bays is exponentially distributed with	BTL -1	Remembering

	μ = 8 cars per day per bay. Write the average number of cars in the service station , the average number of cars waiting for service time a car spends in the system. (8)		
6	a) A repairman is to be hired to repair machines which breakdown at the average rate of 3 per hour The breakdown follow Poisson distribution .Non –productive time of machine is considered to cost Rs 16/hour. Two repair men have been interviewed. One is slow but cheap while the other is fast and expensive. The slow repairman charges Rs.8 per hour and he services at the rate of 4 per hour The fast repairman demands Rs .10 per hour and services at the average rate 6 per hour. Which repairman should be hired? (8)	BTL -4	Analyzing
6	b) On average 96 patients per 24 hour day require the service of an emergency clinic .Also an average a patient requires 10 minutes of active attention. Assume that the facility can handle only one emergency at a time .Suppose that it costs the clinic Rs.100 per patient treated to obtain an average service time of 10 minutes, and that each minute of decrease in this average time would cost Rs . 10 per patient treated .How much would have to be budgeted by the clinic to decrease the average size of the queue from 1 1/3 patients to ½ patient? (8)	BTL -4	Analyzing
7.	a) A telephone company is planning to install telephone booths in a new airport It has established the policy that a person should not have to wait more than 10 % of the times he tries to use a phone. The demand for use is estimated to be Poisson with an average of 30 per hour. The average phone call has an exponential distribution with a mean time of 5 min. how many phone should be installed? (8)	BTL -4	Analyzing
7	b) A super market has two girls attending to sales at the counters. If the service time for each customer is exponential with mean 4 min and if people arrive in Poisson fashion at the rate of 10 per hour a) What is the probability that a customer has to wait for service? b) What is the expected percentage of idle time for each girl? c) If the customer has to wait in the queue, what is the expected length of the waiting time? (8)	BTL -2	Understanding
8.	a) In a single server queueing system with Poisson input and exponential service times,if the mean arrival rate is 3 calling units per hour ,the expected service time is 0.25 h and the maximum possible number of calling units in the system is 2, Point out P_n $(n \geq 0)$,average number of calling units in the system and in the queue and the average waiting time in the system and in the queue . (8)	BTL -4	Analyzing
8	b) A self service stores employs one cashier at its counter. Nine customers arrive on an average of 5 minutes, while the cashier can serve 10 customers in 5 minutes. Assuming Poisson distribution for arrival rate. Write (i)average number of customers in the system (ii)average number of customers in the queue (iii) average time customers waits before being served (iv)average time a customer spends in the system (v) How much time can a customer expect to spend in the barber shop? (vi) What fraction of potential customers are turned away? (8)	BTL -1	Remembering
9.	a) Patients arrive at a clinic according to Poission distribution at a rate of 30 patients per hour. The waiting room does not accomodate more than 14 patients. Examination time per patient is exponential with mean rate of 20 per hour. 1) What is the probability that an arriving patient will not wait? 2) What is the expected waiting time until the patient is discharged from the clinic? (8)	BTL -2	Understanding
9	b) A petrol pump station has 2 pumps. The service times follow the exponential distribution with a mean of 4minutes and cars arrive for service in a Poisson process at the rate of 10 cars perhour. Estimate the probability that a customer has to wait for service. What proportion of time the pumps remain idle? (8)	BTL -3	Applying

10.	a) A TV repairman finds that the time spend on his jobs has an exponential distribution with mean 30 minutes.If he repairs sets in the order in which they came in, and if the arrival of sets is approximately Poisson with an average rate of 10 per8 – hour day. What is the repairman's expected idle time in each day? Tell how many jobs are ahead of the average set just brought in? (8)	BTL -1	Remembering
10	b) Suppose people arrive to purchase tickets for a basketball game at the average rate of 4 *min.* It takes an average of 10 *seconds* to purchase a ticket. If a sports fan arrives 2 *min* before the game starts and if it takes exactly 1 ½ *min* to reach the correct seat after the fan purchased a ticket, then i) Can the sports fan expect to be seated for the start of the game? ii)What is the probability that the sports fan will be seated for the start of the game? iii)How early must the fan arrive in order to be 99% sure of being seated for the start of the game? (8)	BTL -3	Applying
11.	a) The railway marshalling yard is sufficient only for trains (there being 11 lines, one of which is earmarked for the shunting engine to reverse itself from the crest of the hump to the rear of the train). Trains arrive at the rate of 25 trains per day, inter – arrival time and service time follow exponential with an average of 30 minutes. Estimate the probability that the yard is empty. average queue length . (8)	BTL -5	Evaluating
11	b) Assuming that customers arrive in a Poisson fashion to the counter at a supermarket at an average rate of 15 per hour and the service by the clerk has an exponential distribution, Describe and determine at what average rate must a clerk work in order to ensure a probability of 0.90 that the customer will not wait longer than 12 *minutes?* (8)	BTL -5	Evaluating
12.	a) At a port there are 6 unloading berths and 4 unloading crews. When all the berths are full, arriving ships are diverted to an overflow facility 20 kms.down the river. Tankers arrive according to a Poisson process with a mean of 1 for every 2 hours. It takes for an unloading crew, on the average, 10 *hours* to unload a tanker, the unloading time follows an exponential distribution Develop and Determine(i)how many tankers are at the port on the average? 9ii)how long does a tanker spend at the port on the average? (iii)what is the average arrival rate at the overflow facility? (8)	BTL -6	Creating
12	b) Derive p_0, L_s, L_q, W_s, W_q *for* $(M/M/1):(\infty/FIFO)$ queueing model. (8)	BTL -1	Remembering
13.	a) Customers arrive at a watch repair shop according to a Poisson process at a rate of one per every 10 minutes, and the service time is exponential random variable with 8 minutes a) Find the average number of customers L_s in the shop b)Find the average number of customers L_q in the queue c)Find the average time a customer spends in the system in the shop W_s,d) What is the probability that the server is idle? (8)	BTL -2	Understanding
13.	b)A tax consulting firm has three counters in its office to receive people who have problems concerning their income, wealth and sales taxes. On the average 48 persons arrive in a 8- hour day. Each tax advisor spends 15 minutes on the average on an arrival .If the arrivals are Poisson distributed and service times are according to exponential distribution ,Write i) Average number of customers in the system ii) Average number of customers waiting to be serviced iii) Average time customer spends in the system	BTL -1	Remembering

	iv) Average waiting time for the customer in the queue e) The number of hours each week a tax adviser spends performing his job f) The expected number of idle tax advisers at any specified time g) The probability that a customer has to wait before he gets service. (8)		
14.	a)Assume that the goods trains are coming in a yard at the rate of 30 trains per day and suppose that the inter arrival times follow an exponential distribution. The service time for each train is assumed to be exponential with an average of 36 minutes. If the yard can admit 9 trains at a time. Calculate the probability that the yard is empty and the average queue length. (8)	BTL -3	Applying
14	b)Automatic car servicing station has 2 bays where service can be offered simultaneously .Because of space limtation,only 4 vcars are accepted for servicing . The arrival pattern is Poisson with 12 cars per day.The service time in both bays is exponentially distributed with μ = 8 cars per day per bay.Identify the average number of cars in the service station . (8)	BTL -1	Remembering
	PART-C		
15	A duplicating machine maintained for office use is operated by an office assistant who earns Rs. 5 per hour. The time to complete each job varies according to an exponential distribution with mean 6mimutes.Assume a Poisson input with an average arrival rate of 5 jobs per Poisson input with an average arrival rate o5 jobs per hour. If an 8-h day is used as a base, determine (i) The percentage idle time of the machines (ii) the average time a job is in the system (iii) the average earning per day of the assistant. (15)	BTL -1	Remembering
16	A group of engineers has 2terminals available to aid in their calculations. The average computing job requires 20 minutes of terminal time and each engineer requires some computations about every half an hour. Assume that these are distributed according to exponential distribution. If there are 6 engineers in the group find (i) the expected number of engineers waiting to use one of the terminals and in the computing center (ii)the total lost per day (15)	BTL -3	Applying
17	Customers arrive at a one-window drive in bank according to Poisson distribution with mean 10 per hour , service time per customer is exponential with mean five minutes. The space in front of the window including that for the service can accommodate a maximum of three cars. Others can wait outside the space (1) What is the probability that an arriving customer can drive directly to the space in front of the window .(2) What is the probability an arriving customer will have to wait outside the indicated space? (3)How long is an arriving customer expected to wait before starting service? (15)	BTL -1	Remembering
18	A one person barber shop has 6 chairs to accommodate people waiting for a haircut. Assume that customers who arrive when all the 6 chairs all full leave without entering the shop. Customers arrive at the average rate of 3 per hour and spend an average of 15 minutes in the barber's chair.(i) what is the probability that a customer can get directly into the barber's chair?(ii) What is the expected number of customers waiting for a haircut ? (iii) How much time can a customer expect to spend in the barber shop (iv) What fraction of potential customers are turned away? (15)	BTL -3	Applying

VALLIAMMAI ENGINEERING COLLEGE

SRM

PART-C

UNIT-1

15)Decompose the matrix $\begin{pmatrix} 1 & -1 & 4 \\ 1 & 4 & -2 \\ 1 & 4 & 2 \\ 1 & -1 & 0 \end{pmatrix}$ using QR factorization method

16)Find the singular value decomposition of the matrix $\begin{pmatrix} 3 & 2 & 2 \\ 2 & 3 & -2 \end{pmatrix}$

17)Find the closest line to the points $(0,6), (1,0), and\ (2,0)$

18)Find a least square solution to the inconsistent system given by Ax=b where $A = \begin{pmatrix} 2 & 0 \\ 0 & 1 \\ 2 & 2 \end{pmatrix}$and $\begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$

UNIT-2

15)Three grades of coal A,B and C contain phosphorous and ash as impurities .In particular Industrial process, fuel up to 100 ton (maximum) is requires which shouldcontain ash not more than 3% and phosphorous not more than 0.03%. It is desired to maximize the profit while satisfying these conditions. There is an unlimited supply of each grades .The percentage of impurities and the profits of grades are given below

Coal	Phosphorous (%)	Ash (%)	Profit (Rs per ton)
A	0.02	2	12
B	0.04	3	15
C	0.03	5	14

Find the proportion in which the three grades be used

16)A firm uses lathes, milling machines and grinding machines to produce two machine parts. The table below represents the machining times required for each part , the machining times available on different machines and the profit on each machine part .

Type of Machine	Machine time for the machine part (minute)		Maximum time Available / week (minutes)
	I	II	
Lathes	12	6	3000
Milling	4	10	2000
Grading	2	3	900
Profit per unit	Rs 40	Rs 100	

Find the number of parts I and II to be manufactured per week to maximize the profit by graphical method

17)A company has three plants A,B,C and 3warehouses X,Y,Z. The number of units available at the plants are 60,70,80 and the demand at X,Y,Z is 50,80,80 respectively. The unit cost of the transportation is given in the following table

	X	Y	Z
A	8	7	3
B	3	8	9
C	11	3	5

Find the allocation so that the total transportation cost is minimum

18)A marketing manager has 5sales man and three are 5 sales districts. Considering the capabilities of the salesman and the nature of districts the estimates made by the marketing manager for the sales per month (in 1000 Rs)for each salesman in each in each district would be as follows

	A	B	C	D	E
1	32	38	40	28	40
2	40	24	28	21	6
3	41	27	33	30	37
4	22	38	41	36	36
5	29	33	40	35	39

Find the assignment of salesman to the districts that will result in the maximum sales.

UNIT-3

15)Discuss the stability of the RungeKutta method of fourth order

16)Obtain the orthogonal collocation solutions to for the isothermal TRAM $\frac{1}{6}y'' - y' - 2y^2 = 0$ with $y' = 6(y - 1)$at x = 0 $y' = 0$ at x=1 using N=2

17)Solve the simultaneous differential equations $\frac{dy}{dx} = 2y + z, \frac{dz}{dx} = y - 3$;y(0)=0 ;z(0)=0.5 for y(0.1) and z(0.1) using RK method of the fourth order

18)An Isothermal tubular reactor with axial mixing with an irreversible ,second order reaction taking place is describes in chemical engineering by$\frac{1}{Pe}\frac{d^2y}{dx^2} - \frac{dy}{dx} - Day^2 = 0, 0 \le x \le 1$ with boundary conditions $\frac{dy}{dx} = Pe(y - 1)at\ x = 0, \frac{dy}{dx} = 0at\ x = 1$.Solve this equation by finite difference method with n=3

UNIT-4

15)A bag contains 5 balls and it is not known that how many of them are white. Two balls are drawn at random from the bag are noted to be white . What is the chance that all the balls in the bag are white

16)An urn contains 10 white and 3 black balls. Two balls are drawn at random from the first urn and placed in the second and then 1ball is taken from the later .What is the probability that it is a white ball?

17)In a partially destroyed record of an analysis of correlation data, the following results only are legible. Variance of x=1. The egression equations are 3x+2y=26 and 6x+y = 31. What were (i) the mean values of X and Y? (ii)the standard deviation of Y and (iii) the correlation coefficient between X andY?

18)The input to a binary communication system, denoted by a random variable X, takes one of the two values 0 or 1with probabilities ¾ and ¼ respectively. Because of error caused by noise in the system, the output Y differs from the input occasionally. The behavior of the communication system is modeled by the conditional probabilities given below $P(Y = 1/x = 1) = 3/4$,
$P\left(Y = \frac{0}{X} = 0\right) = 7/8$ .Find i) P(Y=1) (ii)P(Y=0) iii) P(X=1/Y=1)

UNIT-5

15)A duplicating machine maintained for office use is operated by an office assistant who earns Rs. 5 per hour. The time to complete each job varies according to an exponential distribution with mean 6mimutes.Assume a Poisson input with an average arrival rate of 5 jobs per Poisson input with an average arrival rate o5 jobs per hour. If an 8-h day is used as a base, determine (i) The percentage idle time of the machines (ii) the average time a job is in the system (iii) the average earning per day of the assistant.

16)A group of engineers has 2terminals available to aid in their calculations. The average computing job requires 20 minutes of terminal time and each engineer requires some computations about every half an hour. Assume that

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