**R25**

**SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY::PUTTUR**
**(AUTONOMOUS)**
Siddharth Nagar, Narayanavanam Road – 517583

**QUESTION BANK (DESCRIPTIVE)**

**Subject with Code: Operations Research (25MC9116)** **Course & Branch: MCA**
**Year & Sem: I-MCA & II-Sem** **Regulation: R25**

## UNIT –I
## Linear Programing Problem

| | | | |
|---|---|---|---|
| **1** | a) Formulation of Linear Programing Problem | [L3] [CO1] | **[6M]** |
| | b) Explain the procedure for Solving the LPP using Graphical method. | [L2] [CO1] | **[6M]** |
| **2** | Solve the following Linear Programming Problem using Graphical method.<br>Minimize $Z = 2x_1 + 3x_2$<br>Subject to<br>$x_1 + x_2 \geq 6$<br>$7x_1 + x_2 \geq 14$<br>$x_1 \; and \; x_2 \geq 0$ | [L3] [CO1] | **[12M]** |
| **3** | Solve the following Linear Programming Problem using Graphical method.<br>Maximixe $Z = 6x_1 + 8x_2$<br>Subject to<br>$5x_1 + 10x_2 \leq 60$<br>$4x_1 + 4x_2 \leq 40$<br>$x_1 \; and \; x_2 \geq 0$ | [L3] [CO1] | **[12M]** |
| **4** | Solve the following Linear Programming Problem using Graphical method.<br>Maximixe $Z = 100x_1 + 80x_2$<br>Subject to<br>$5x_1 + 10x_2 \leq 50$<br>$8x_1 + 2x_2 \geq 16$<br>$3x_1 - 2x_2 \geq 6$<br>$x_1, x_2 \geq 0$ | [L3] [CO1] | **[12M]** |
| **5** | Solve the following Linear Programming Problem using Graphical method.<br>Minimize $Z = 20x_1 + 10x_2$<br>Subject to<br>$x_1 + 2x_2 \leq 40$<br>$3x_1 + x_2 \geq 30$<br>$4x_1 + 3x_2 \geq 60$<br>$x_1$ and $x_2 \geq 0$ | [L3] [CO1] | **[12M]** |
| **6** | Explain the procedure for Solving the LPP using simplex method. | [L2] [CO1] | **[12M]** |
| **7** | Solve the following Linear Programming Problem using Simplex method.<br>Maximize $Z = 10x_1 + 15x_2 + 20x_3$<br>Subject to<br>$2x_1 + 4x_2 + 6x_3 \leq 24$<br>$3x_1 + 9x_2 + 6x_3 \leq 30$<br>$x_1, x_2 \; and \; x_3 \geq 0$ | [L3] [CO1] | **[12M]** |

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| **8** | Solve the following Linear Programming Problem using Simplex method.<br>Minimize $Z = 8x_1 - 2x_2$<br>Subject to<br>$-4x_1 + 2x_2 \leq 1$<br>$5x_1 - 4x_2 \leq 3$<br>$x_1 and\ x_2 \geq 0$ | [L3] [CO1] | **[12M]** |
| **9** | Solve the following Linear Programming Problem using Simplex method.<br>Maximize $Z = 3x_1 + 2x_2 + 5x_3$<br>Subject to<br>$x_1 + x_2 + x_3 \leq 9$<br>$2x_1 + 3x_2 + 5x_3 \leq 30$<br>$2x_1 - x_2 - x_3 \leq 8$<br>$x_1, x_2 and\ x_3 \geq 0$ | [L3] [CO1] | **[12M]** |
| **10** | Solve the following Linear Programming Problem using Simplex method.<br>maximize$z = 6x_1 + 8x_2$<br>subject to<br>$5x_1 + 10x_2 \leq 60$<br>$4x_1 + 4x_2 \leq 40$<br>$x_1 and\ x_2 \geq 0$ | [L3] [CO1] | **[12M]** |

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## UNIT –II

| | | | |
|---|---|---|---|
| **1** | Solve the following LPP using the result of its dual problem<br>Minimize $Z = 24x_1 + 30x_2$<br>Subject to<br>$2x_1 + 3x_2 \geq 10$<br>$4x_1 + 9x_2 \geq 15$<br>$6x_1 + 6x_2 \geq 20$<br>$x_1 and\ x_2 \geq 0$ | [L2] [CO2] | **[12M]** |
| **2** | Solve the following LPP by using dual simplex method.<br>Maximum $Z = -4x_1 - 6x_2 - 18x_3$<br>Subject to<br>$x_1 + 3x_3 \geq 3$<br>$x_2 + 2x_3 \geq 5$<br>$x_1, x_2, x_3 \geq 0$ | [L2] [CO2] | **[12M]** |
| **3** | Obtain the initial basic feasible solution by using NWCR to the following Transportation Problem | [L2] [CO2] | **[12M]** |
| **4** | Obtain the initial basic feasible solution by using LCM to the following Transportation Problem | [L5] [CO2] | **[12M]** |
| **5** | Obtain the initial basic feasible solution by using VAM to the following Transportation Problem | [L5] [CO2] | **[12M]** |
| **6** | Find the intial basic feasible solution using NWCR,LCM,VAM and compare total costs | [L1] [CO2] | **[12M]** |

| | $D_1$ | $D_2$ | $D_3$ | Availability |
|---|---|---|---|---|
| $O_1$ | 2 | 7 | 4 | 5 |
| $O_2$ | 3 | 3 | 1 | 8 |
| $O_3$ | 5 | 4 | 7 | 7 |
| $O_4$ | 1 | 6 | 2 | 14 |
| Require | 7 | 9 | 18 | |

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | Availability |
|---|---|---|---|---|---|
| $O_1$ | 6 | 8 | 8 | 8 | 30 |
| $O_2$ | 5 | 9 | 7 | 9 | 40 |
| $O_3$ | 8 | 7 | 13 | 6 | 50 |
| Require | 35 | 28 | 32 | 25 | |

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | Supply |
|---|---|---|---|---|---|
| $O_1$ | 3 | 1 | 7 | 4 | 300 |
| $O_2$ | 2 | 6 | 5 | 9 | 400 |
| $O_3$ | 8 | 3 | 3 | 2 | 500 |
| Demand | 250 | 350 | 400 | 200 | |

| | M1 | M2 | M3 | M4 | M5 | Supply |
|---|---|---|---|---|---|---|
| P1 | 10 | 2 | 16 | 14 | 10 | 300 |
| P2 | 6 | 18 | 12 | 13 | 16 | 500 |
| P3 | 8 | 4 | 14 | 12 | 10 | 825 |
| P4 | 14 | 22 | 20 | 8 | 18 | 375 |
| Demand | 350 | 400 | 250 | 150 | 400 | |

**7** There are four jobs A,B,C and D these are Performed on 4 machines1,2,3,4. One job is allocated through a machine.the cost of each job on machine is given below in the following matrix [L5] [CO2] **[12M]**

| | I | II | III | IV |
|---|---|---|---|---|
| A | 15 | 14 | 12 | 16 |
| B | 23 | 22 | 25 | 24 |
| C | 31 | 34 | 32 | 33 |
| D | 21 | 32 | 44 | 53 |

**8** A company has four salesman targeted at four cities.the profit per day in rupees for each salesman in each city is given below.find the assignment of salesman to various cities. [L5] [CO2] **[12M]**

| | SALESMAN | | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| CITIES | A | 16 | 10 | 14 | 11 |
| | B | 14 | 11 | 15 | 15 |
| | C | 15 | 15 | 13 | 12 |
| | D | 13 | 12 | 14 | 15 |

**9** Solve the following assignment problem [L3] [CO2] **[12M]**

| | MACHINES | | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| JOBS | A | 18 | 24 | 28 | 32 |
| | B | 8 | 13 | 17 | 19 |
| | C | 10 | 15 | 19 | 22 |

**10** A travelling salesman has planned to visit 4 cities. He would like to start from a particular city,visit each city only one and return to the starting city the travelling cost in rupess is given in the table below find the least cost route to city. [L3] [CO2] **[12M]**

| | | To city | | | |
|---|---|---|---|---|---|
| | | A | B | C | D |
| From city | A | 0 | 25 | 75 | 45 |
| | B | 35 | 0 | 150 | 25 |
| | C | 35 | 40 | 0 | 15 |
| | D | 65 | 75 | 130 | 0 |

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## UNIT –III
## GAME THEORY

| | | | |
|---|---|---|---|
| **1** | a) Determine the optimal strategy for company A and company B<br><br>$$\begin{array}{c} \\ \text{Company A} \end{array}\begin{array}{c} \text{Company B} \\ \begin{array}{ccc} 1 & 2 & 3 \end{array} \\ \begin{array}{c} 1 \\ 2 \\ 3 \end{array}\begin{bmatrix} 20 & 15 & 22 \\ 35 & 45 & 40 \\ 18 & 20 & 25 \end{bmatrix} \end{array}$$ | [L1] [CO3] | **[6M]** |
| | b) Solve the following the game<br>$$\begin{array}{c} \\ player A \end{array}\begin{array}{c} \text{player B} \\ \begin{array}{cc} 1 & 2 \end{array} \\ \begin{array}{c} 1 \\ 2 \end{array}\begin{bmatrix} -5 & 2 \\ -7 & -4 \end{bmatrix} \end{array}$$ | [L1] [CO3] | **[6M]** |
| **2** | Consider the given payoff matrix with respect to player A and solve it optimally<br>Player B<br>$$\begin{array}{c} \\ player\ A \end{array}\begin{array}{c} \\ \begin{array}{cc} 1 & 2 \end{array} \\ \begin{array}{c} 1 \\ 2 \end{array}\begin{bmatrix} 6 & 9 \\ 8 & 4 \end{bmatrix} \end{array}$$ | [L5] [CO3] | **[12M]** |
| **3** | Consider the given payoff matrix with respect to player A and solve it optimally<br>Player B<br>$$\begin{array}{c} \\ player\ A \end{array}\begin{array}{c} \\ \begin{array}{cc} 1 & 2 \end{array} \\ \begin{array}{c} 1 \\ 2 \end{array}\begin{bmatrix} 3 & -1 \\ 2 & 4 \end{bmatrix} \end{array}$$ | [L1] [CO3] | **[12M]** |
| **4** | Player A and B play a game in which each player has three coins (20p,25p and 50p) each of them selects a coin without the knowledge of the other person.if the sum of the values of the coin is an even number,A wins B'scoin.if the sum of an odd number B wins A's coin<br>(a)Develop a payoff matrix with respect to player A<br>(b)Find the optimal strategies for the players | [L5] [CO3] | **[12M]** |
| **5** | Consider the payoff matrix of player A and slove it optimally using graphical method<br>Player B<br>$$\begin{array}{c} \\ Player\ A \end{array}\begin{array}{c} \\ \begin{array}{ccccc} 1 & 2 & 3 & 4 & 5 \end{array} \\ \begin{array}{c} 1 \\ 2 \end{array}\begin{bmatrix} 3 & 0 & 6 & -1 & 7 \\ -1 & 5 & -2 & 2 & 1 \end{bmatrix} \end{array}$$ | [L3] [CO3] | **[12M]** |
| **6** | Consider the payoff matrix of player A and slove it optimally using graphical method<br>Player B<br>$$\begin{array}{c} \\ Player\ A \end{array}\begin{array}{c} \\ \begin{array}{cc} 1 & 2 \end{array} \\ \begin{array}{c} 1 \\ 2 \\ 3 \\ 4 \end{array}\begin{bmatrix} 1 & 3 \\ 3 & 1 \\ 5 & -1 \\ 6 & -6 \end{bmatrix} \end{array}$$ | [L1] [CO4] | **[12M]** |
| **7** | Consider the 4×4 game played by palyers A and B by using dominance property<br>Player B<br>$$\begin{array}{c} \text{Player A} \end{array}\begin{array}{c} \begin{array}{cccc} 1 & 2 & 3 & 4 \end{array} \\ \begin{array}{c} 1 \\ 2 \\ 3 \\ 4 \end{array}\begin{bmatrix} 6 & 2 & 4 & 8 \\ 2 & -1 & 1 & 12 \\ 2 & 3 & 3 & 9 \\ 5 & 2 & 6 & 10 \end{bmatrix} \end{array}$$ | [L5] [CO4] | **[12M]** |

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<table>
<tr>
<td>8</td>
<td>Solve the following 3×5 game using dominance property<br>
$$\begin{array}{c} \\ player\ A \end{array} \begin{array}{c} \begin{array}{ccccc} 1 & 2 & 3 & 4 & 5 \end{array} \\ \begin{bmatrix} 2 & 5 & 10 & 7 & 2 \\ 3 & 3 & 6 & 6 & 4 \\ 4 & 4 & 8 & 12 & 1 \end{bmatrix} \end{array} \begin{array}{l} \\ 1 \\ 2 \\ 3 \end{array}$$
Player B</td>
<td>[L1] [CO4]</td>
<td>[12M]</td>
</tr>
<tr>
<td>9</td>
<td>Draw the network diagram and identify critical path for the following data.
<table>
<tr><td>Activity</td><td>1-2</td><td>1-3</td><td>1-4</td><td>2-5</td><td>3-6</td><td>3-7</td><td>4-7</td><td>5-8</td><td>6-8</td><td>7-9</td><td>8-9</td><td>9-10</td></tr>
<tr><td>Time (weeks)</td><td>2</td><td>2</td><td>2</td><td>4</td><td>5</td><td>8</td><td>4</td><td>2</td><td>4</td><td>5</td><td>3</td><td>4</td></tr>
</table></td>
<td>[L5] [CO4]</td>
<td>[12M]</td>
</tr>
<tr>
<td>10</td>
<td>A project consists the following activities and different Estimate times
<table>
<tr><td>Activity</td><td>1-2</td><td>2-3</td><td>2-4</td><td>3-4</td><td>3-5</td><td>4-5</td><td>5-6</td></tr>
<tr><td>O</td><td>1</td><td>1</td><td>2</td><td>1</td><td>2</td><td>2</td><td>3</td></tr>
<tr><td>M</td><td>1</td><td>4</td><td>2</td><td>1</td><td>5</td><td>5</td><td>6</td></tr>
<tr><td>P</td><td>7</td><td>7</td><td>8</td><td>1</td><td>14</td><td>8</td><td>15</td></tr>
</table>
Draw PERT diagram and find the Critical path</td>
<td>[L1] [CO4]</td>
<td>[12M]</td>
</tr>
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## UNIT –IV
## QUEUING THEORY

| | | | |
|---|---|---|---|
| **1** | A service station receives customers at a rate of 12 per hour. The service rate is 15 customers per hour. Assuming an M/M/1 FIFO system, find:<br>(a)The average number of customers in the system (L)<br>(b)The average number of customers in the queue (Lq)<br>(c)The average waiting time in the queue (Wq)<br>(d)The probability that the server is idle. | [L2] [CO5] | **[12M]** |
| **2** | In a repair system, customers arrive at a rate of 5 per hour.The average service time is 10 minutes per customer.Assuming an M/M/1 FIFO system, find:<br>(a)Traffic intensity (ρ)<br>(b)The average number of customers in the queue (Lq)<br>(c)The average waiting time in the queue (Wq)<br>(d)The probability that the system is idle. | [L2] [CO5] | **[12M]** |
| **3** | A T.V repairman repair the sets in the order in which they arrive and expects that the time required to repair a set has an ED with mean 30mins. The sets arrive in a Poisson fashion at an average rate of 10/8 hrs a day.<br>(a) What is the expected idle time / day for the repairman?<br>(b) How many TV sets will be there awaiting for the repair? | [L2] [CO5] | **[12M]** |
| **4** | In a self service store with one cashier, 8 customers arrive on an average of every 5 mins. and the cashier can serve 10 in 5 mins. If both arrival and service time are exponentially distributed, then determine<br>a) Average number of customer waiting in the queue for average.<br>b) Expected waiting time in the queue<br>c) What is the probability of having more than 6 customers In the system | [L5] [CO5] | **[12M]** |
| **5** | Jobs arrive at an inspection station according to Poisson process at a mean rate of 2/hr and are inspect one at a time on a FIFO basis. The quality control engineer both inspects and makes minor adjustments. The total service time for the job appears to be ED with a mean of 25mins.Jobs that arrive but cannot be inspected immediately by the engineer must be stored until the engineer is free to take them. Each job requires 1 sq mts space determine<br>a) The waiting line length<br>b) The waiting time<br>c) %of idle time of the engineer<br>d) The floor space to be provided in the quality control room. | [L5] [CO5] | **[12M]** |
| **6** | A bank has 3 counters (servers).Customers arrive at a rate of 12 per hour.Each counter serves at a rate of 5 customers per hour.Find:<br>(a)Traffic intensity (ρ)<br>(b)Probability that system is idle ($P_0$ )<br>(c)Average number of customers in queue (Lq)<br>(d)Average waiting time in queue (Wq) | [L1] [CO5] | **[12M]** |
| **7** | In a hospital, there are 4 doctors (servers).Patients arrive at a rate of 20 per hour. Each doctor can treat 6 patients per hour.Find:<br>(a)Traffic intensity<br>(b)Probability of zero patients in system<br>(c)Average number of patients waiting<br>(d)Average waiting time | [L5] [CO5] | **[12M]** |

| | | | |
|---|---|---|---|
| **8** | A service station has 2 servers.Customers arrive at 8 per hour.Service rate per server is 6 per hour.Find:<br>(a)System utilization<br>(b)Probability system is empty<br>(c)Average queue length<br>(d)Average waiting time | [L5] [CO5] | **[12M]** |
| **9** | A call center has 5 operators.Calls arrive at a rate of 25 calls per hour.Each operator handles 6 calls per hour.Find:<br>(a)Traffic intensity<br>(b)Average queue length<br>(c)Average time spent in queue<br>(d)Average number in system | [L3] [CO5] | **[12M]** |
| **10** | A computer center has 3 technicians.Jobs arrive at 15 per hour.Each technician services 7 jobs per hour.Find:<br>(a)Traffic intensity<br>(b)Probability of idle system<br>(c)Average number of jobs waiting<br>(d)Average waiting time in system | [L3] [CO5] | **[12M]** |

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## UNIT –V
## SIMULATION

| | | | |
|---|---|---|---|
| **1** | Simulate a single server queue using event list method for the following data<br>Inter arrival time is **2,3,4**<br>Service times is **3,2,3**<br>To Construct the event list table | [L2] [CO6] | **[12M]** |
| **2** | Simulate a single server queue using event list method for the following data<br>Inter arrival time is **1,4,2**<br>Service times is **3,2,4**<br>To Construct the event list table | [L2] [CO6] | **[12M]** |
| **3** | Using LCG method Generate 6 pseudorandom numbers for the following data<br>$\boldsymbol{x_0 = 7, a = 5, c = 3, m = 16}$ and also calculate $R_n = \frac{X_n}{m}$ | [L4] [CO6] | **[12M]** |
| **4** | Using LCG method Generate 5 pseudorandom numbers for the following data<br>$\boldsymbol{x_0 = 4, a = 5, c = 3, m = 16}$ and also calculate $R_n = \frac{X_n}{m}$ | [L4] [CO6] | **[12M]** |
| **5** | Using LCG method Generate 6 pseudorandom numbers for the following data<br>$\boldsymbol{x_0 = 3, a = 7, c = 5, m = 16}$ and also calculate $R_n = \frac{X_n}{m}$ | [L4] [CO6] | **[12M]** |
| **6** | Using Multiplicative congruential method Generate 5 pseudorandom numbers for the following data<br>$\boldsymbol{x_0 = 3, a = 5, m = 16}$ and also calculate $R_n = \frac{X_n}{m}$ | [L4] [CO6] | **[12M]** |
| **7** | Using Multiplicative congruential method Generate 5 pseudorandom numbers for the following data<br>$\boldsymbol{x_0 = 5, a = 7, m = 20}$ and also calculate $R_n = \frac{X_n}{m}$ | [L4] [CO6] | **[12M]** |
| **8** | Using Multiplicative congruential method for the following data<br>$\boldsymbol{x_0 = 5, a = 7, m = 32}$ Find<br>1. $X_1 \; To \; X_{10}$<br>2. Corresponding $R_n = \frac{X_n}{m}$<br>3.identify cycle length | [L4] [CO6] | **[12M]** |
| **9** | Using Transformation method for the following data<br>$\boldsymbol{U = 0.2, 0.5, 0.8}$<br>$F(x) = 1 - e^{-3x}$<br>Find random variable x | [L4] [CO6] | **[12M]** |
| **10** | Using Transformation method for the following data<br>$\boldsymbol{U = 0.1, 0.6, 0.9}$<br>$F(x) = \frac{x-2}{6}, 2 \leq x \leq 8$<br>Find<br>1.Inverse function<br>2.corresponding X values | [L4] [CO6] | **[12M]** |