Code No: R203103H **R20** SET - 1

III B. Tech I Semester Regular/Supplementary Examinations, December -2023
OPERATIONS RESEARCH
(Com to CE,EEE,ME,ECE,CSE)

Time: 3 hours Max. Marks: 70

Answer any **FIVE** Questions **ONE** Question from **Each unit**
All Questions Carry Equal Marks
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UNIT-I

1. a) Solve the following Linear programming problem graphically: [8M]
Maximize $Z=45X_1+80X_2$
Subject to
$5X_1+20X_2 \leq 400$;
$10X_1+15X_2 \leq 450$;
$X_1, X_2 \geq 0$.

b) What is operations research? State the areas of its applications. [6M]

(OR)

2. Solve the following LP problem by two phase method. [14M]
Maximize $Z = 5X_1+3X_2$
Subject to
$3X_1+2X_2 \geq 3$
$X_1+4X_2 \geq 4$
$X_1+X_2 \leq 5$
$X_1, X_2 > 0$

UNIT-II

3. a) A company has three plants A,B,C and three warehouses X,Y, and Z. Number of units, available at the plants are 60, 70 and 80 respectively. Demands at X,Y and Z are 50, 80 and 80 respectively. Unit costs of transportation are as follows: [7M]

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

Find the allocation so that total transportation cost is minimum.

b) Explain how an assignment problem can be solved by using Hungarian method. [7M]

(OR)

4. a) State clearly the assumptions used in the study of sequencing problems. [4M]

b) A company has six jobs which go through three machines X, Y and Z in the order XYZ. The processing time in minute for each job on each machine is as follows: [10M]

Machines	**Jobs**					
	1	**2**	**3**	**4**	**5**	**6**
X	18	12	29	36	43	37
Y	7	12	11	2	6	12
Z	19	12	23	47	28	36

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UNIT-III

5. a) A machine owner from his past records that the cost per year of maintaining a machine A whose purchase price is Rs. 6,000 are as given below: [8M]

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Maintenance Cost Rs.	1000	1200	1400	1800	2300	2800	3400	4000
Resale Price Rs.	3000	1500	750	375	200	200	200	200

At what age replacement is due?

b) Explain Maxi-Min and Mini-Max principles used in Game theory. [6M]

(OR)

6. a) Why is the replacement of items required? Distinguish between individual replacement and group replacement policies [6M]

b) Obtain the optimal strategies for both players and the value of the game for a person zero-sum game whose payoff matrix is given below. [8M]

	Player B	
Player A	**B1**	**B2**
A1	-6	7
A2	4	-5
A3	-1	-2
A4	-2	5
A5	7	-6

UNIT-IV

7. a) Arrivals at a telephone booth are considered to be Poisson, with an average time of 10 minutes between one arrival and the next. The length of a phone call is assumed to be distributed exponentially, with a mean of 3 minutes. Find the following: [8M]

   (i) What is the probability that a person arriving at the booth will have to wait

   (ii) What is the average length of the queues that form from time to time

   (iii) Find the average number of units in the system.

b) Describe various elements in Queuing models. [6M]

(OR)

8. Construct an activity network for a production schedule with the following information : [14M]

Activity (i — j)	Time in Hours	Activity (i — j)	Time in Hours
1 - 2	4	5 – 6	4
1- 3	1	5-8	8
2-4	1	6-8	1
3-4	1	7-8	2
3-5	6	8-10	5
4-9	5	9-10	7

Identify the critical path. Calculate the total completion time and determine the total float for each activity.

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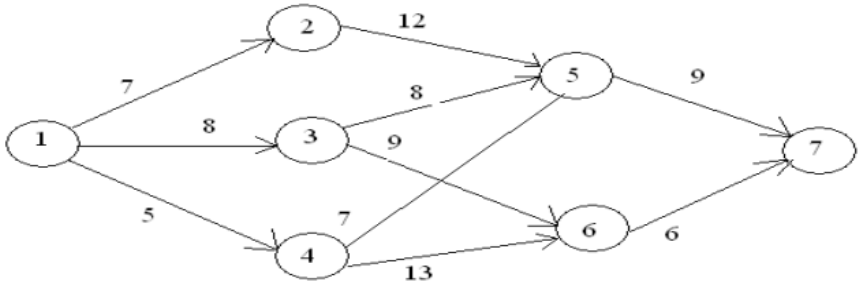
UNIT-V

9. Select the shortest highway route between two cities. The network in fig: provides the possible routes between the starting city at node 1 and destination city at node 7. [14M]



(OR)

10. a) Explain the various types of simulation. [7M]
    b) What is simulation? Discuss the applications of simulation? [7M]

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UNIT-I

1. a) What are the various phases of operations research problems? Explain them briefly [7M]

   b) Solve the following LPP by using simplex method. [7M]
   Maximize $Z = 2X_1+X_2$
   Subject to the constraints
   $4X_1+3X_2 \leq 12$,
   $4X_1+X_2 \leq 8$,
   $X_1, X_2 \geq 0$.

(OR)

2. Solve the following LPP by Big-M penalty method: [14M]
   Minimize $Z= 4X_1+X_2$
   Subject to $3X_1+X_2= 3$
   $4X_1+2X_2 \leq 4$
   $X_1+2X_2 \geq 4$
   $X_1,X_2 \geq 0$

UNIT-II

3. a) Solve the following travelling salesman problem. [7M]

--	3	6	2	3
3	--	5	2	3
6	5	--	6	4
2	2	6	--	6
3	3	4	6	--

   b) Discuss the practical applications of Transportation and Assignment Problem. [7M]

(OR)

4. a) How will you solve the sequencing problem of 2 jobs on m machines? [7M]

   b) Find the sequence that minimizes the total elapsed time required to complete the following jobs: [7M]

Job	1	2	3	4	5
Machine A	10	2	18	6	20
Machine B	4	12	14	16	8

UNIT-III

5. A computer contains 10000 resistors. When any resistor fails, it is replaced the cost of replacing a resistor individually is Rs.1 only. If all the resistors are replaced at the same time, the cost per resistor would be reduced to 35 paisa. The % of surviving resistors say S(t) at the end of month t and the P(t) the probability of failure during the month t is. [14M]

t	0	1	2	3	4	5	6
S(t)	100	97	90	70	30	15	0
P(t)	-	0.03	0.07	0.2	0.4	0.15	0.15

   What is the optimal replacement policy?

(OR)

|'''|'|'|''|'||'|||

6. a) Explain the graphical method of solving 2x n and mx2 games. [7M]

b) Use dominance rules to reduce the size of the following payoff matrix to (2x2) size and hence , find the optimal strategies and value of the game. [7M]

	Player B			
Player A	**B1**	**B2**	**B3**	**B4**
A1	3	2	4	0
A2	3	4	2	4
A3	4	2	4	0
A4	0	4	0	8

UNIT-IV

7. a) Consider a box office ticket window being manned by a single server. Customer arrives to purchase ticket according to Poisson input process with a mean rate of 30/hr. the time required to serve a customer has an ED with a mean of 90 seconds determine: [7M]
   (i) Mean queue length.
   (ii) Mean waiting time in the system.
   (iii) The probability of the customer waiting in the queue for more than 10min.
   (iv) The fraction of the time for which the server is busy.

b) Briefly explain the characteristics of the queuing system [7M]

(OR)

8. A project consists of the following activities and time estimates. [14M]

Activity	**Estimated duration weeks**		
	optimistic	**Most likely**	**pessimistic**
(1-2)	1	1	7
(1-3)	1	4	7
(1-4)	2	2	8
(2-5)	1	1	1
(3-5)	2	5	14
(4-6)	2	5	8
(5-6)	3	6	15

(i) Draw the network (ii) Find the expected time and variance for each activity (iii) what is the probability that the project will be completed 4 weeks earlier than expected time. (iv) what is the probability that the project will be completed 19 weeks.

UNIT-V

9. a) What sort of problems can be solved using dynamic programming. Illustrate with a case study. [8M]

b) Write short notes on dynamic programming and its applications. [6M]

(OR)

10. Records of 100 truck loads of finished jobs arriving in a department's check out area show the following: check out takes 5 minutes and checker takes care of only one truck at a time. the data is summarized in the following table. [14M]

Truck arrival time (Min)	1	2	3	4	5	6	7	8	9	10
Frequency	1	4	7	17	31	23	7	5	3	2

As soon as the trucks are check out, the truck drivers take them to the next department. Using Monto-Carlo simulation, determine:
(i) what is the average waiting time before service (ii) what is likely to be the longest wait.

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UNIT-I

1. a) Explain the graphical method of solving a linear programming problem with an example. [8M]
   b) What are the advantages and applications of OR. [6M]

(OR)

2. a) Form the dual of the following primal problem. [7M]
   Minimize $Z=20X_1 + 40X_2$
   Subject to $2X_1 + 20X_2 \geq 40$
   $20X_1 + 3X_2 \geq 20$
   $4X_1 + 15X_2 \geq 30$
   X_1 and $X_2 \geq 0$
   b) Describe the necessity of operations research in industry. [7M]

UNIT-II

3. a) Five men are available to do five different jobs. From past records, the time (in hours) that each men takes to do job is known and is given in the following table: [8M]

	Jobs					
		I	II	III	IV	V
Men	A	2	9	2	7	1
	B	6	8	7	6	1
	C	4	6	5	3	1
	D	4	2	7	3	1
	E	5	3	9	5	1

Find out how men should be assigned the jobs in way that will minimize the total time taken.

   b) Write short notes on the sequencing decision problem for 'n' jobs on '3' machines. [6M]

(OR)

4. a) We have 5 jobs, each of which must be processed on the two machines A and B in the order AB. Processing time in hours are given as follows: [7M]

Job	1	2	3	4	5
Machine A	5	1	9	3	10
Machine B	2	6	7	8	4

Determine a sequence for the 5 jobs and find the total elapsed time T.
   b) Discuss the steps involved in Hungarian method to solve assignment problems. [7M]

UNIT-III

5. a) Explain the terms: (i) Rectangular games (ii) type of Strategies [7M]

|'''|'|'|''|'||'|||

b) Solve the game graphically: [7M]

		Player B		
	2	2	3	-1
Player A	4	3	2	6

(OR)

6. a) Machine A costs Rs 9000. Annual operating cost is Rs 200 for the first year and then increases by Rs 2000 every year. Determine the year of replacement and the average total cost that year. Machine B costs Rs 10000. Annual operating cost is Rs 400 for the first year and then increases by Rs 800 every year. You have a machine A, which is one year old. Should you replace it with B? If so, when? [10M]

b) Distinguish between individual replacement and group replacement, [4M]

UNIT-IV

7. a) A tax-consulting firm has 3 counters in its office to receive people who have problems concerning their income, wealth and sales taxes. On an average 48 persons arrive in an 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, find (i) The Average number of customers in the system. (ii) Average time a customer spends in the system. (iii) Average waiting time for a customer in the queue. (iv) The probability that a customer has to wait before he gets service. [8M]

b) Explain the Kendall and Lee's notations for representing queuing models. [6M]

(OR)

8. A small maintenance project consists of the following jobs whose precedence relationships is given below: [14M]

Job	1-2	1-3	2-3	2-5	3-4	3-6	4-5	4-6	5-6	6-7
Duration (Days)	15	15	3	5	8	12	1	14	3	14

From the above information, you are required to: (i) Draw an arrow diagram representing the project. (ii) Find the total float for each activity. (iii) Determine the critical path and total project duration.

UNIT-V

9. a) What are the features of simulation languages? Explain? [6M]

b) State the Bellman's principle of optimality in dynamic programming and give a mathematical formulation of a dynamic programming problem [8M]

(OR)

10. a) Solve the following LPP with dynamic programming: [8M]
Max $Z=3X_1+4X_2$
S/to
$2X_1+X_2 \leq 40$
$2X_1+5X_2 \leq 180$
$X_1, X_2 \geq 0$

b) What is simulation? Explain the phases of simulation? [6M]

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UNIT-I

1. a) Discuss the characteristics and the limitations of OR. [7M]
   b) Use the graphical method to solve the following LP Problem [7M]
   Maximize $Z = 3x_1+4x_2$
   subject to the constraints
   $x_1 - x_2 = -1$
   $-x_1 + x_2 \leq 30$
   $x_1, x_2 \geq 0$.

(OR)

2. a) Explain the primal-dual relationship. [7M]
   b) Solve the given problem by using Big-M method [7M]
   Maximize $z = -2x_1-x_2$
   Subject to constraints $3x_1+x_2=3$
   $4x_1+3x_2 \geq 6$
   $x_1+2x_2 \leq 4$
   $x_1, x_2 \geq 0$

UNIT-II

3. a) A product is produced by 4 factories F_1, F_2, F_3 and F_4. Their unit production costs are Rs.2, 3, 1 and 5 respectively. Production capacity of factories are 50, 70, 30 and 50 respectively. The product is supplied to 4 stores S_1, S_2, S_3 and S_4. The requirements which are 25, 35, 105and 20 respectively. Unit costs of transportation are given below [7M]

Factories/stores	**S_1**	**S_2**	**S_3**	**S_4**
F_1	2	4	6	11
F_2	10	8	7	5
F_3	13	3	9	12
F_4	4	6	8	3

   b) We have five jobs each of which must go through two machines in the order AB, processing times are given in the table below: [7M]

Job No	1	2	3	4	5
Machine A	10	2	18	6	20
Machine B	4	12	14	16	8

   Determine a sequence for the five jobs that will minimize the total elapsed time.

(OR)

4. a) What are the assumptions made for the processing of 'n' jobs through two machines? [7M]
   b) Explain the difference between a transportation problem and an assignment problem. [7M]

|'''|'|'|''|'||'|||

UNIT-III

5. a) The initial price of an equipment is Rs.5000. The running cost (R.C) varies as shown below: [7M]

Year	1	2	3	4	5	6	7
R.C	400	500	700	1000	1300	1700	2100

Taking a discount rate of 0.90, find out the optimum replacement interval.

b) Briefly explain the limitations of game theory. [7M]

(OR)

6. a) Briefly explain what do you mean by individual and group replacement policy in replacement analysis [7M]

b) Two players A and B match coins. If the coin matches, then A wins one unit of value, if the coins do not match, then B wins one unit of value. Determine optimum strategies for the players and the value of the game. [7M]

UNIT-IV

7. a) A self service store employee one cashier at it counter. Nine customers arrive on an average every five minutes while the cashier can serve 10 customers in 5 minutes. Assuming poison distribution for arrival rate find [7M]
   a) Average number of customers in the system.
   b) Average number of customers in queue.
   c) Average time a customer spends in the system.

   Average time a customer waits before served.

b) Compare and contrast CPM and PERT. Under what conditions would you recommend the scheduling by PERT? Justify your answer with reasons. [7M]

(OR)

8. a) State some of the important distributions of arrival intervals and service time. [7M]

b) The following table use the activities in a construction projects and relevant information [7M]

Activity	1-2	1-3	2-3	2-4	3-4	4-5
Duration (in days)	22	27	12	14	6	12

Draw the network for the project, calculate the earliest start time, earliest finish time, latest start time and latest finish time of each activity and find the critical path. Compute the project duration.

UNIT-V

9. a) What are the situations warranting the use of dynamic programming? [7M]

b) Explain how simulation technique can be used in solving queuing problems. [7M]

(OR)

10. a) Use dynamic programming to solve LPP [7M]

$$\text{Max } Z = 4x + 3y$$

Subject to. $x+y \leq 400$

$2x+3y \leq 700$

$x , y \geq 0$

b) Name some simulation languages. Discuss the characteristic of any one such languages [7M]