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

III B. Tech I Semester Regular Examinations, Dec/Jan -2022-23

OPERATIONS RESEARCH

(Common 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

*****

UNIT-I

1. Solve the following linear programming problem [14M]

Maximize $Z = 3x_1 + 2x_2$,

subject to

$$x_1 \leq 4$$
$$x_1 + 3x_2 \leq 15$$
$$2x_1 + x_2 \leq 10$$

and $x_1 \geq 0,\ x_2 \geq 0$

(**OR**)

2. Use duality to solve the following linear programming problem. [14M]

Minimize $Z=2x_1+2x_2$

subject to

$$2x_1+4x_2 \geq 1$$
$$-x_1-2x_2 \leq -1$$
$$2x_1+x_2 \geq 1$$

and $x_1,x_2 \geq 0$

UNIT-II

3. Solve the following transportation problem, where S_1,S_2,S_3 represents the sources and D_1,D_2,D_3,D_4 represents the destinations and the cell entries are the unit costs to transport the goods from each source to each destinations. [14M]

	D_1	D_2	D_3	D_4	Availability
S_1	6	8	8	5	30
S_2	5	11	9	7	40
S_3	8	9	7	13	50
Demand	35	28	32	25	

(**OR**)

4. Seven jobs are to be performed on two machines A and B in the order A → B. Each machine can process only one job at a time. The processing times (in hours) are as follows. [14M]

Job:	1	2	3	4	5	6	7
Machine A:	10	12	13	7	14	5	16
Machine B:	15	11	8	9	6	7	16

Find the optimum sequence, minimum elapsed time and idle time on A and B.

UNIT-III

5. Machine A costs Rs. 45,000 and the operating costs are estimated at Rs. 1000 for the first year, increasing by Rs. 10,000 per year in the second and subsequent years. Machine B costs Rs. 50,000 and operating costs are Rs. 2000 for the first year, increasing by Rs. 4000 in the second and subsequent years. If we now have a machine of type A, should we replace it with B? If so when? Assume that both machines have no resale value and future costs are not discounted. [14M]

(**OR**)

6. Solve the following game using graphical method. [14M]

	B1	B2	B3	B4
A1	2	2	3	-2
A2	4	3	2	6

UNIT-IV

7. a) In a railway yard, goods trains arrive at the rate of 30 trains per day. Assuming that the service time follows exponential distribution with an average of 36 minutes, find [7M]
(i) The probability that the number of trains in the yard exceeds 10.
(ii) The average number of trains in the yard.

b) Explain in brief the main characteristics of the queuing system. [7M]

(**OR**)

8. A small scale industrial unit consists of 6 activities as given below. [14M]

Activity	Time in days	Pre-operation
A	5	None
B	6	A
C	5	B
D	4	A
E	3	D
F	4	C,E

Draw the network diagram and calculate Earliest Start Time, Latest Start Time, Earliest Finishing Time, Latest Finishing Time and total float for each activity. Mark the critical path and find the total project duration.

UNIT-V

9. Use dynamic programming to solve the linear programming problem [14M]

$$\text{Maximize } Z = x_1 + 9x_2$$
$$2x_1 + x_2 \leq 25$$
$$x_2 \leq 11$$
$$and \quad x_1, x_2 \geq 0$$

(**OR**)

10. a) A company observes from past experience that the demand for a special product has the following probability distribution. [7M]

Daily demand	5	10	15	20	25	30
Probability	0.01	0.20	0.15	0.50	0.12	0.02

Simulate the demand for the next 10 days. Also find the average demand.

b) What do you understand by simulation? Explain briefly its limitations and advantages? [7M]

Code No: **R203103H** **R20** SET - 2

III B. Tech I Semester Regular Examinations, Dec/Jan -2022-23

OPERATIONS RESEARCH

(Common 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

*****

UNIT-I

1. Solve the following linear programming problem using simplex method. [14M]

Maximize $15x_1+6x_2+9x_3+2x_4$

Subject to the constraints

$2x_1 + x_2 + 5x_3 + 6x_4 \leq 20$

$3x_1 + x_2 + 3x_3 + 25x_4 \leq 24$

$7x_1 + x_4 \leq 70$

$x_1, x_2, x_3, x_4 \geq 0$

(**OR**)

2. A firm is engaged in producing two products. A and B. Each unit of product A requires 2 kg of raw material and 4 labour hours for processing, where as each unit of B requires 3 kg of raw materials and 3 labour hours for the same type. Every week, the firm has an availability of 60 kg of raw material and 96 labour hours. One unit of product A sold yields Rs.40 and one unit of product B sold gives Rs.35 as profit. How many units of each of the products should be produced per week so that the firm can earn maximum profit? [14M]

UNIT-II

3. Three jobs are to be done by 4 machines. 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. [14M]

Jobs\Machines	**M_1**	**M_2**	**M_3**	**M_4**
J_1	18	24	28	32
J_2	8	13	17	19
J_3	10	15	19	22

What are the job assignments which will minimize the total cost? Which machine has to be declined?

(**OR**)

4. Two machines are used for doing six jobs. The time required for each job to be processed on each of the machines is given below. Using Johnson's algorithm, obtain the optimal sequence, which will minimize the time. [14M]

Job	Machine 1	Machine 2
1	5	4
2	2	3
3	13	14
4	10	1
5	8	9
6	12	11

UNIT-III

5. Draw and explain the Machine Life Cycle with the help of a graph. A firm is thinking of replacing a particular machine whose cost price is Rs. 12,200. The scrap price of this machine is only Rs. 200. The maintenance costs are found to be as follows. [14M]

Year	1	2	3	4	5	6	7
Maintenance cost	220	500	800	1200	1800	2500	3200

Determine the time as to when the firm should replace the machine.

(**OR**)

6. a) Solve the following game graphically. [7M]

	B1	B2	B3	B4
A1	2	1	0	-2
A2	1	0	3	2

b) Solve the following game. [7M]

	B		
A	1	7	2
	6	2	7
	5	1	6

UNIT-IV

7. A self-service store employs one cashier at its counter. Nine customers arrive on an average every 5 minutes while the cashier can serve 10 customers in 5 minutes. Assuming Poisson distribution for arrival rate and exponential distribution for service time, find [14M]
(i) Traffic density
(ii) Average number of customers in the system
(iii) Average number of customers in the queue or average queue length
(iv) Average time a customer spends in the system.
(v) Average time a customer waits before being served.

(**OR**)

8. A small project consists of seven activities, the details of which are given below: [14M]

Activity	Duration of days		
	Most Likely	Optimistic	Pessimistic
1-2	1	1	7
1-3	4	1	7
1-4	2	2	8
2-5	1	1	1
3-5	5	2	14
4-6	5	2	8
5-6	6	3	15

a) Find the expected duration and variance for each activity. What is the expected project length?

b) Calculate the Variance and standard deviation of the project length. What is the probability that the project will be completed :
   i. At least 4 weeks earlier than expected time
   ii. No more than 4 weeks later than expected time

UNIT-V

9. a) Write the dynamic programming algorithm. [7M]
   b) Enumerate the applications of dynamic programming [7M]

(**OR**)

10. At a sales depot, the arrival of customers and the service times follow the following probability distributions. [14M]
Estimate the average waiting time and percentage of idle time of the server, by simulation for 10 arrivals.

Arrival time (min)	Probability
0.5	0.02
1.0	0.06
1.5	0.10
2.0	0.25
2.5	0.20
3.0	0.14
3.5	0.10
4.0	0.07
4.5	0.04
5.0	0.02

Service time (min)	Probability
0.5	0.12
1.0	0.21
1.5	0.36
2.0	0.19
2.5	0.07
3.0	0.05

Random No's for arrival: 93,22,53,64,39,07,10,63,76,35
Random no's for service: 78,76,58,54,74,92,38,70,96,92

Code No: **R203103H** **R20** SET - 3

III B. Tech I Semester Regular Examinations, Dec/Jan -2022-23

OPERATIONS RESEARCH

(Common 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
*****

UNIT-I

1. Solve the following linear programming problem. [14M]

Minimize $Z = 3x_1 + 2x_2 + x_3$,
subject to

$$x_1 + x_2 = 7$$
$$3x_1 + x_2 + x_3 \geq 10$$

and

$$x_1 \geq 0, \ x_2 \geq 0, \ x_3 \geq 0$$

(**OR**)

2. Solve the following linear programming problem. [14M]
Minimize $Z=5x_1-6x_2-7x_3$
subject to

$$x_1+5x_2-3x_3 \geq 15$$
$$5x_1-6x_2+10x_3 \leq 20$$
$$x_1+x_2+x_3 = 5$$
$$x_1,x_2,x_3 \geq 0$$

UNIT-II

3. Solve the following transportation problem, where S_1,S_2,S_3 represents the sources and D_1,D_2,D_3,D_4 represents the destinations and the cell entries are the unit costs to transport the goods from each source to each destinations. [14M]

	D_1	**D_2**	**D_3**	**D_4**	**Availability**
S_1	21	16	25	13	11
S_2	17	18	14	23	13
S_3	32	27	18	41	19
Demand	6	10	12	15	

(**OR**)

4. Three machines are used for doing five jobs. The time required for each job to be processed on each of the machines is given below. Obtain the optimal sequence, which will minimize the time. [14M]

Job	Machine 1	Machine 2	Machine 3
1	8	5	4
2	10	6	9
3	6	2	8
4	7	3	6
5	11	4	5

UNIT-III

5. The probability distribution of the failure time of a certain type of electric bulb is given below. [14M]

Week	1	2	3	4	5	6	7	8
Probability of failure	0.05	0.13	0.25	0.43	0.68	0.88	0.96	1.0

The cost of individual replacement is Rs. 40 per bulb. The cost of group replacement is Rs. 10 per bulb. If there are 1000 bulbs in use, find the optimal replacement policy under,

a. Individual replacement
b. Group replacement

(**OR**)

6. Solve the following game. [14M]

	B	
A	-6	7
	4	-5
	-1	-2
	-2	5
	7	-6

UNIT-IV

7. Patients arrive at a clinic at the rate of 30 patients per hour. The waiting hall cannot accommodate more than 14 patients. It takes 3 minutes on the average to examine a patient. [14M]

a. Find the probability that an arriving patient need not wait.
b. Find the probability that an arriving patient finds a vacant seat in the hall.
c. What is the expected duration of time a patient spends in the clinic?

(**OR**)

8. a) A company plans the following activities. [7M]

Activity	Time (weeks)	Preceding activity
A	6	-
B	4	A
C	7	B
D	2	A
E	4	D
F	10	E
G	2	-
H	10	G
I	6	H,J
J	13	-
K	9	A
L	3	C,K
M	5	I,L

i)Draw the network diagram.

ii)Determine the critical path and duration of completion.

b) Distinguish between PERT and CPM. [7M]

UNIT-V

9. a) State and explain the Bellman's principle of optimality [7M]

b) Solve using dynamic programming. [7M]

Maximize z = 3x1 + 2x2

subject to the constraints

x1 + x2 ≤ 300

2x1 + 3x2 ≤ 800

x1, x2 ≥0

(**OR**)

10. A dentist schedules all his patients for 30-minute appointments. Some of the patients take more or less than 30 minutes depending on the type of dental work to be done. The following summary shows the various categories of work, their probabilities and time actually needed to complete the work. [14M]

Category of service	*Time required (minutes)*	*Probability of category*
Filling	45	0.40
Crown	60	0.15
Cleaning	15	0.15
Extraction	45	0.10
Check up	15	0.20

Simulate the dentist's clinic for four hours and determine the average waiting time for the patients as well as the idleness of the doctor. Assume that all the patients show up at the clinic at exactly their scheduled arrival time starting at 8.00 AM. Use the following random numbers for handling the above problem: 40, 82, 11, 34, 25, 66, 17, and 79.

Code No: **R203103H** | **R20** | SET - 4

III B. Tech I Semester Regular Examinations, Dec/Jan -2022-23

OPERATIONS RESEARCH

(Common 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
*****

UNIT-I

1. Solve the following linear programming problem using Big-M method. [14M]

Maximize $Z=3x_1+2x_2$
Subject to $2x_1+x_2 \le 2$
$3x_1+4x_2 \ge 12$
and $x_1, x_2 \ge 0$.

(**OR**)

2. Find the non-negative values of x_1, x_2 and x_3 which [14M]

Maximize $Z= 3x_1+2x_2+5x_3$
Subject to $x_1+4x_2 \le 420$
$3x_1+2x_3 \le 460$
$x_1+2x_2+x_3 \le 430$
x_1, x_2 and $x_3 \ge 0$.

UNIT-II

3. A salesman estimates that the following would be the cost on his route, visiting the six cities as shown in the table below: [14M]

To city

		1	**2**	**3**	**4**	**5**	**6**
From city	**1**	-	20	23	27	29	34
	2	21	-	19	26	31	24
	3	26	28	-	15	36	26
	4	25	16	25	-	23	18
	5	23	40	23	31	-	10
	6	27	18	12	35	16	-

The salesman can visit each of the cities once and only once. Determine the optimum sequence he should follow to minimize the total distance traveled. What is the total distance traveled?

(**OR**)

4. Two machines are used for doing six jobs. The time required for each job to be processed on each of the machines is given below. Using Johnson's algorithm, obtain the optimal sequence, which will minimize the time. [14M]

Job	Machine 1	Machine 2
1	5	4
2	2	3
3	13	14
4	10	1
5	8	9
6	12	11

UNIT-III

5. The maintenance cost and the resale price of a machine are given below. [14M]

Year	1	2	3	4	5	6	7	8
Maintenance cost	1000	1300	1700	2200	2900	3800	4800	6000
Resale price	4000	2000	1200	600	500	400	400	400

The purchase price of the machine is Rs. 8000. Determine the time at which it is profitable to replace the machine.

(**OR**)

6. Solve the following game. [14M]

	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) Discuss the characteristics of a queuing system. [7M]

b) In a car wash station, cars arrive for service according to Poisson distribution, with a mean of 4 per hour. The average service time of a car is 10 min. [7M]

i. Determine the probability that an arriving car has to wait.

ii. Find the average time a car stays in the station.

iii. If the parking space cannot hold more than 6 cars, find the probability that an arriving car has to wait outside.

(**OR**)

8. For the project represented by the following network, find the probability that the project will be completed. (i) two weeks earlier than expected. (ii) two weeks later than expected. [14M]

Activity	Estimated duration in weeks		
	Optimistic	Most likely	Pessimistic
(1-2)	6	7	8
(1-3)	7	9	11
(2-3)	2	4	6
(2-4)	8	12	16
(3-4)	0	0	0
(3-5)	11	14	17
(4-6)	3	4	5
(5-7)	10	13	16
(5-8)	6	7.5	12
(6-8)	5	9	13
(7-9)	4	7	10
(8-9)	6	9	12
(9-0)	8	13	18

UNIT-V

9. Solve using dynamic programming. [14M]

Maximize z = 3x1 + 4x2
subject to the constraints
2x1 + 5x2 ≥ 120
2x1 + x2 ≤ 40
x1 , x2 ≥ 0

(**OR**)

10. A bakery keeps stock of popular brand of cake. Previous experience shows that the daily demand pattern for the item with associated probabilities is given below: [14M]

Daily demand (Nos) : 0 10 20 30 40 50
Probability: 0.01 0.2 0.15 0.5 0.12 0.02

Use the following sequence of random numbers to simulate the demand for next 10 days. (Random numbers: 25, 39, 65, 76, 12, 05, 73, 89, 19, 49.)

(a) Find out the average demand per day.

(b) Find the stock situation, if the owner of the bakery decides to make 35 cakes every day.

*****