Code No: R1932031 **R19** **SET - 1**

III B. Tech II Semester Regular Examinations, June-2022

OPERATIONS RESEARCH

(Mechanical Engineering)

Time: 3 hours Max. Marks: 75

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

1. Minimize $Z = 3a + 2b + 1c$ [15M]
s.t.
$2a + 5b + 1c = 12$
$3a + 4b + 0c = 11$ and
a is unrestricted and b and c are ≥0,
Solve for optimal values of a, b and c.

(OR)

2. A company is interested in manufacturing of two products A and B. [15M]
A single unit of Product A requires 2.4 minutes of punch press time and 5 minutes of assembly time. The profit for product A is Rs. 6/− per unit. A single unit of product B requires 3 minutes of punch press time and 2.5 minutes of welding time. The profit per unit of product B is Rs. 7/−. The capacity of punch press department available for these products is 1,200 minutes per week. The welding department has the capacity of 600 minutes per week; the assembly department can supply 1500 minutes of capacity per week. Determine the quantity of product A and the quantity of product B to be produced so that the total profit is maximized.

UNIT-II

3. A company has four market segments open and four salesmen are to be assigned one to each segment to maximize the expected total sales. The salesmen differ in their ability and the segments also differ in their sales potential. The details regarding the expected sales in each segment by a typical salesman under most favourable condition are given below: [15M]
Segment A = Rs. 60,000, Segment B = Rs. 50,000, Segment C = Rs. 40,000 and Segment D = Rs. 30,000. It is estimated that working under same condition, the ability of salesmen in terms of proportional yearly sales would be as below:
Salesman W = 7, Salesman X = 5, Salesman Y = 5 and Salesman Z = 4. Assign segments to salesmen for maximizing the total expected sales.

(OR)

4. a) Solve the traveling salesman problem by using the data given below: [8M]
$C12 = 20$, $C13 = 4$, $C14 = 10$, $C23 = 5$, $C34 = 6$, $C25 = 10$, $C35 = 6$, $C45 = 20$ and $Cij = Cji$. And there is no route between cities ' i ' and ' j ' if a value for Cij is not given in the statement of the problem. (i and j are = 1, 2,...5)

   b) What are the assumptions made in sequencing? [7M]

UNIT-III

5. The following mortality tables have been observed for a certain type of light bulbs: [15M]

End of the week	1	2	3	4	5	6
Probability of failure due to date	0.09	0.25	0.49	0.85	0.97	1.00

There are a large number of such bulbs, which are to be kept in working order. If a bulb fails in service, it costs Rs. 3/- to replace but if all bulbs are replaced in the same operation it can be done for only Rs. 0.70 a bulb. It is proposed to replace all bulbs at fixed intervals, whether or not they have burnt out and to continue replacing burnt out bulbs as they fail.

(i) What is the best interval between group replacements?

(ii) At what group replacement price per bulb, would a policy of strictly individual replacement become preferable to the adopted policy?

(OR)

6. a) (i) A machine A costs Rs.9000/-. Annual operating costs are Rs. 200/- for the first year and then increases by Rs.2000/- every year. Determine the best age at which the machine A is to be replaced? If the optimum replacement policy is followed, what will be the average yearly cost of owning and operating the machine? Assume machine has no resale value when replaced and that future costs are not discounted. [8M]

   (ii) Machine B costs Rs. 10000/-. Annual operating costs are Rs. 400/- for the first year and then increases by Rs. 800/- every year. You have now a machine of type A, which is of one year old. Should you replace it with B, and if so, when?

   b) Discuss the applications of replacement models. [7M]

UNIT-IV

7. A transport company has a single unloading berth with vehicles arriving in a Poisson fashion at an average rate of three per day. The unloading time distribution for a vehicle with "*n*" unloading workers is found to be exponentially with an average unloading time (1/2) × n days. The company has a large labour supply without regular working hours, and to avoid long waiting lines, the company has a policy of using as many unloading group of workers in a vehicle as there are vehicles waiting in line or being unloaded. Under these conditions find (i) What will be the average number of unloading group of workers working at any time?, (ii) What is the probability that more than 4 groups of workers are needed? [15M]

(OR)

8. Two players *P* and *Q* play the game. Each of them has to choose one of the three colours: White (*W*), Black (*B*) and Red (*R*) independently of the other. Thereafter the colours are compared. If both *P* and *Q* have chosen white (*W*, *W*), neither wins anything. If player *P* selects white and Player *Q* black (*W*, *B*), player *P* loses Rs.2/- or player *Q* wins the same amount and so on. The complete payoff table is shown below. Find the optimum strategies for *P* and *Q* and the value of the game. [15M]

		Q		
		W	B	R
P	W	0	-2	7
	B	2	5	6
	R	3	-3	8

UNIT-V

9. A project consists of 4 activities. Their logical relationship and time taken is given along with crash time and cost details. If the indirect cost is Rs. 2000/- per week, find the optimal duration and optimal cost. [15M]

Activity	Predecessor	Normal		Crash	
		Time in days	Cost (Rs.)	Time in days	Cost (Rs.)
A	-	4	4000	2	12000
B	A	5	3000	2	7500
C	A	7	3600	5	6000
D	C	4	5000	2	10000

(OR)

10. A small project has 7 activities and the time in days for each activity is given below: [15M]

Activity	Duration in days
A	6
B	8
C	3
D	4
E	6
F	10
G	3

Given that activities *A* and *B* can start at the beginning of the project. When *A* is completed *C* and *D* can start. *E* can start only when *B* and *D* are finished. *F* can start when *B, C* and *D* are completed and is the final activity. *G* can start when *E* is finished and is the final activity. Draw the network and find the project completion time.

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Code No: R1932031 **R19** **SET - 2**

III B. Tech II Semester Regular Examinations, June-2022

OPERATIONS RESEARCH

(Mechanical Engineering)

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UNIT-I

1. You wish to export three products *A*, *B*, and *C*. The amount available is Rs. 4,00,000/–. Product *A* costs Rs. 8000/– per unit and occupies after packing 30 cubic meters. Product *B* costs Rs. 13,000/– per unit and occupies after packing 60 cubic meters and product C costs Rs. 15,000/–per unit and occupies 60 cubic meters after packing. The profit per unit of *A* is Rs. 1000/–, of B is Rs. 1500/– and of C is Rs. 2000/–. The shipping company can accept a maximum of 30 packages and has storage space of 1500 cubic meters. How many of each product should be bought and shipped to maximize profit? The export potential for each product is unlimited. Show that this problem has two basic optimum solutions and find them. Which of the two solutions do you prefer? Give reasons. [15M]

(OR)

2. Minimize $Z = 2x + 9y + 1z$ [15M]
s.t
$1x + 4y + 2z \geq 5$
$3x + 1y + 2z \geq 4$ and x, y, z all are ≥ 0, Solve for optimal solution. Also obtain the solution for the dual.

UNIT-II

3. A tourist organization is planning to arrange a tour to 5 historical places. Starting from the head office at *A* then going round *B*, *C*, *D* and *E* and then come back to *A*. Their objective is to minimize the total distance covered. Help them in sequencing the cities. *A*, *B*, *C*, *D* and E as the shown in the Fig.1. [15M]
The numbers on the arrows show the distances in Km.

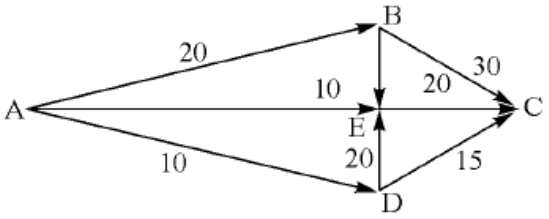

Fig.1

(OR)

4. a) There are 5 jobs each of which is to be processed on three machines *A*, *B*, and *C* in the order *ACB*. The time required to process in hours is given in the matrix below. Find the optimal sequence. [8M]

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

b) Write the LP formulation of an assignment problem. [7M]

UNIT-III

5. a) A taxi owner estimates from his past records that the costs per year for operating taxi whose purchase price when new is Rs.60000/- are as given below: [8M]

Age (Year)	1	2	3	4	5
Operating cost in Rs.	10000	12000	15000	18000	20000

After 5 years, the operating cost is Rs. 6000 × *k* Where *k* = 6, 7, 8, 9, 10, *i.e.* '*k*' denotes years. If the resale value decreases by 10% of purchase price each year, what is the best replacement policy? Cost of money is zero.

b) What is time value of money? Explain. [7M]

(OR)

6. Value of the money is assumed to be 10 % per year and suppose that machine *A* is replaced after every three years whereas machine *B* is replaced every 6 years. Their yearly costs are given as under: [15M]

Year	1	2	3	4	5	6
Machine A (Rs.)	1000	200	400	1000	200	400
Machine B (Rs.)	1700	100	200	300	400	500

Find which machine is to be purchased?

UNIT-IV

7. a) In a railway marshalling yard, goods train arrives at the rate of 30 trains per day. Assume that the inter arrival time follows an exponential distribution and the service time is also to be assumed as exponential with a mean of 36 minutes. Calculate: (i) The probability that the yard is empty, (ii) The average length assuming that the line capacity of the yard is 9 trains. [8M]

b) Solve the game by method of sub games whose payoff matrix is: [7M]

		B	
		I	II
A	I	6	5
	II	3	6
	III	8	4

(OR)

8. a) *A* and *B* play a game in which each has three coins, *a* 5 paise, 10 paise and 20 paise coins. Each player selects a coin without the knowledge of the other's choice. If the sum of the coins is an odd amount, *A* wins *B*'s coins. If the sum is even, *B* wins *A*'s coins. Find the optimal strategies for the players and the value of the game. [7M]

b) A product manufacturing plant at a city distributes its products by trucks, loaded at the factory warehouse. It has its own fleet of trucks plus trucks of a private transport company. This transport company has complained that sometimes its trucks have to wait in line and thus the company loses money paid for a truck and driver of waiting truck. The company has asked the plant manager either to go in for a second warehouse or discount prices equivalent to the waiting time. The data available is: [8M]
Average arrival rate of all trucks = 3 per hour.
Average service rate is = 4 per hour.
The transport company has provided 40% of the total number of trucks. Assuming that these rates are random according to Poisson distribution, Determine:
(i) The probability that a truck has to wait
(ii) The waiting time of a truck that has to wait
(iii) The expected waiting time of company trucks per day.

UNIT-V

9. a) A maintenance project has following estimates of times in hours and cost in rupees for jobs. Assuming that jobs can be done either at normal or at fast pace, but not any pace in between. Plot the relationship between project completion time and minimum project cost. [15M]

b) Assuring a relationship between job duration and job cost and with overhead cost of Rs. 25/- per hour, plot the cost – time relationship.

Activity	*Predecessor*	*Normal*		*Crash*	
		Time in days	Cost (Rs.)	Time in days	Cost (Rs.)
A	-	8	80	6	100
B	A	7	40	4	94
C	A	12	100	5	184
D	A	9	70	5	102
E	B,C,D	6	50	6	50

(OR)

10. The following table gives the activities in a construction project and the time duration of each activity: [15M]

Activity	Preceding Activity	Normal time (days)
A	-	16
B	-	20
C	A	8
D	A	10
E	B,C	6
F	D,E	12

(i) Draw the activity network of the project.
(ii) Find critical path.
(iii) Find the total float and free-float for each activity.

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Code No: R1932031 **R19** **SET - 3**

III B. Tech II Semester Regular Examinations, June-2022

OPERATIONS RESEARCH

(Mechanical Engineering)

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UNIT-I

1. 10 grams of Alloy A contains 2 grams of copper, 1 gram of zinc and 1 gram of lead. 10 grams of Alloy B contains 1 gram of copper, 1 gram of zinc and 1 gram of lead. It is required to produce a mixture of these alloys, which contains at least 10 grams of copper, 8 grams of zinc, and 12 grams of lead. Alloy B costs 1.5 times as much per Kg as alloy A. Find the amounts of alloys *A* and *B*, which must be mixed in order to satisfy these conditions in the cheapest way. Use the Simplex method. [15M]

(OR)

2. Minimize $Z = 1a - 2b - 3c$
s.t.
$-2a + 1b + 3c = 2$
$2a + 3b + 4c = 1$ and all a, b, and c are ≥ 0.
Also write the dual of the above and give the answer of dual from the answer of the primal. [15M]

UNIT-II

3. The demand pattern for a product at for consumer centers, *A*, *B*, *C* and *D* are 5000 units, 7000 units, 4000 units and 2000 units respectively. The supply for these centers is from three factories *X*, *Y* and *Z*. The capacities for the factories are 3000 units, 6000 units and 9000 units respectively. The unit transportation cost in rupees from a factory to consumer center is given below in the matrix. Develop an optimal transportation schedule and find the optimal cost. [15M]

From	To			
	A	B	C	D
X	8	9	12	8
Y	3	4	3	2
Z	5	3	7	4

(OR)

4. a) The productivity of operators *A, B, C, D*, and *E* on different machines *P, Q, R, S*, and *T* are given in the matrix below. Assign machines to operators for maximum productivity. [8M]

Operators	P	Q	R	S	T
A	9	14	10	7	12
B	8	11	12	--	13
C	10	10	8	11	--
D	12	14	11	10	7
E	13	10	12	13	--

b) Find the optimal sequence and total elapsed time for processing two jobs on 5 machines: [7M]

Job 1	Time in hours	2	3	4	6	2
	Order of Machining	A	B	C	D	E
Job 2	Time in hours	4	5	3	2	6
	Order of Machining	B	C	A	D	E

UNIT-III

5. A company is considering purchasing a new grinder, which will cost Rs. 10000/-. The economic life of the machine is expected to be 6 years. The salvage value of the machine will be Rs. 2000/-. The average operating and maintenance costs are estimated to be Rs. 5000/- per annum. [15M]
   a) Assuming an interest rate of 10 %, determine the present value of future cost of the proposed grinder.
   b) Compare this grinder with the presently owned grinder that has an annual operating cost of Rs. 4000/- per annum and expected maintenance cost of Rs. 2000/-in the second year with an annual increase of Rs. 1000/- thereafter.

(OR)

6. a) A machine costs Rs.500/-. Operation and maintenance costs are zero for the first year and increase by Rs. 100/-every year. If money is worth 5 % every year, determine the best age at which the machine should be replaced. The resale value of the machine is negligibly small. What is the weighted average cost of owning and operating the machine? [10M]

   b) What is time value of money? Explain. [5M]

UNIT-IV

7. a) In a railway station only one train is handled at a time. The railway yard is sufficient for two trains to wait while other is given signal to leave the station. Trains arrive at a station at an average rate of 6 per hour and the railway station can handle them on an average rate of 12 per hour. Assuming Poisson arrivals and exponential service distribution, find the steady state probabilities of the various number of trains in the system. Also find the average number of trains in the system. [8M]

   b) Solve the following 2 × n sub game: [7M]

		B	
		I	II
A	I	1	8
	II	3	5
	III	11	2

(OR)

8. a) In a game of matching coins, player A wins Rs.2/-, if there are two heads, wins nothing if there are two tails and loses Re.1/- when there are one head and one tail. Determine the pay off matrix and best strategies and value of the game. [8M]

   b) A repairman is to be hired to repair machines, which break down at an average rate of 3 per hour. The breakdown follows Poisson distribution. Non - productive time of a machine is considered to cost Rs.16/- per hour. Two repairmen have been interviewed. One is slow but cheap while the other is fast but expensive. The slow worker charges Rs. 8/- per hour and the services breakdown machines at the rate of 4 per hour. The fast repairman demands Rs. 10/- per hour and services at an average rate of 6 per hour. Which repairman is to be hired? [7M]

UNIT-V

9. a) What are the differences between CPM and PERT? Explain. [8M]

   b) How do you perform project crashing? Explain. [7M]

(OR)

10. The following table gives data on normal time and cost and crash time and cost for a project. [15M]

(i) Draw the network and identify the critical path.
(ii) What is the normal project duration and associated cost?
(iii) Find out total float for each activity.
(iv) Crash the relevant activities systematically and determine the optimum project time and cost.

Activity	Normal		Crash	
	Time (week)	Cost (Rs.)	Time (week)	Cost (Rs.)
1-2	3	300	2	400
2-3	3	30	3	30
2-4	7	420	5	580
2-5	9	720	7	810
3-5	5	250	4	300
4-5	0	0	0	0
5-6	6	320	4	410
6-7	4	400	3	470
6-8	13	780	10	900
7-8	10	1000	9	1200

Indirect costs are Rs. 50 per week.

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Code No: R1932031 **R19** **SET - 4**

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OPERATIONS RESEARCH

(Mechanical Engineering)

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UNIT-I

1. Minimize $Z = 1a + 1b + 1c$ [15M]
s.t
$1a - 3b + 4c = 5$
$1a - 2b \leq 3$
$2a - 1c \geq 4$ and
a and b are ≥ 0 and c is unrestricted.

(OR)

2. A company manufactures two products *A* and *B*. These are machined on machines *X* and *Y*. *A* takes one hour on machine *X* and one hour on Machine *Y*. Similarly product *B* takes 4 hours on Machine *X* and 2 hours on Machine *Y*. Machine *X* and *Y* have 8 hours and 4 hours as idle capacity. The planning manager wants to avail the idle time to manufacture *A* and *B*. The profit contribution of *A* is Rs. 3/– per unit and that of *B* is Rs.9/– per unit. Find the optimal product mix using the Simplex method. [15M]

UNIT-II

3. a) Given the set up costs below, show how to sequence the production so as to minimize the total setup cost per cycle: [8M]

Jobs	A	B	C	D	E
A	-	2	5	7	1
B	6	-	3	8	2
C	8	7	-	4	7
D	12	4	6	-	5
E	1	3	2	8	-

b) Write the LP formulation of a transportation problem. [7M]

(OR)

4. Find the optimal sequence for the given two jobs, which are to be processed on four machines in the given technological order: [15M]

Job1	Order	A	B	C	D
	Time in hours	2	3	3	4
Job2	Order	D	C	B	A
	Time in hours	2	3	3	4

UNIT-III

5. a) A manufacturer is offered two machines *A* and *B*. *A* has the cost price of Rs. 2,500/- its running cost is Rs. 400 for each of the first 5 years and increase by Rs.100/- every subsequent year. Machine B having the same capacity as *A*. and costs Rs. 1250/-, has running cost of Rs.600/- for first 6 years, increasing thereby Rs. 100/- per year. Which machine should be purchased? Scrap value of both machines is negligible. Money value is 10% per year. [8M]

b) Explain the model for group replacement of items. [7M]

(OR)

6. A unit of electrical equipment is subjected to failure. The probability of distribution of the age at failure is as follows: [15M]

Age at failure (weeks)	2	3	4	5
Probability	0.2	0.3	0.4	0.1

Initially 10000 new units are installed and a new unit replaces any unit, which fails, at the end of the week in which it fails.

(i) Calculate the expected number of units to be replaced in each of weeks 1 to 7. What rate of failure can be expected in the long run?

(ii) Among the 10000 installed units at the start of week 8, how many can be expected to be aged zero week, 1 week, 2 weeks, 3 weeks or 4 weeks? Compare this with the expected frequency distribution in long run.

(iii) Replacement of individual units on failure costs Rs. 0.05 each. An alternative policy is to replace all units after a fixed number of weeks at a cost of Rs. 300/- and to replace any unit failing before the replacement week at the individual cost of 5 paise each. Would this preventive policy be adopted? If so, after how many weeks should all units be replaced?

UNIT-IV

7. a) Solve the game given in the pay off matrix below: [8M]

		B		
		1	2	3
A	1	3	-4	2
	2	1	-3	-7
	3	-2	4	7

b) A car park contains 5 cars. The arrival of cars is Poisson at a mean rate of 10 per hour. The length of time each car spends in the car park is exponential distribution with a mean of 5 hours. How many cars are in the car park on an average? [7M]

(OR)

8. a) Two armies are at war. Army *A* has two air bases, one of which is thrice as valuable as the other. Army *B* can destroy an undefended air base, but it can destroy only one of them. Army *A* can also defend only one of them. Find the strategy for *A* to minimize the losses. [8M]

b) Trains arrive at the yard every 15 minutes and the service time is 33 minutes. If the line capacity of the yard is limited to 4 trains, find (i) the probability that the yard is empty and (ii) The average number of trains in the system. [7M]

UNIT-V

9. Madras Construction Company is bidding on a contract to install a line of microwave towers. It has identified the following activities, along with their expected time, predecessor restrictions, and worker requirements: [15M]

Activity	Duration (Weeks)	Predecessor	Crew Size (Workers)
A	4	-	4
B	7	-	2
C	3	A	2
D	3	A	4
E	2	B	3
F	2	B	3
G	2	D,E	3
H	3	F,G	4

The contract specifies that the project must be completed in 14 weeks. This company will assign a fixed number of workers to the project for its entire duration, and so it would like to ensure that the minimum number of workers is assigned and that the project will be completed in 14 weeks. Find a schedule which will do this.

(OR)

10. Illustrate with an example how you perform resource leveling. [15M]

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