Roll No. ☐☐☐☐☐☐☐☐☐☐☐   **Total No. of Pages : 05**

Total No. of Questions : 15

MBA (2012 & Onward) (Sem.–3)
APPLIED OPERATIONS RESEARCH
Subject Code : MBA-301
Paper ID : [C1169]

Time : 3 Hrs.   **Max. Marks : 60**

INSTRUCTIONS TO CANDIDATES :
1. **SECTION-A contains SIX questions carrying FIVE marks each and students has to attempt any FOUR questions.**
2. **SECTION-B consists of FOUR Subsections : Units-I, II, III & IV. Each Subsection contains TWO questions each carrying EIGHT marks each and student has to attempt any ONE question from each Subsection.**
3. **SECTION-C is COMPULSORY carrying EIGHT marks.**

SECTION-A

1. Define Operations Research. What are the applications of Operations Research?

2. Explain Linear Programming model for product-mix with the help of a suitable example.

3. Define Game Theory. Explain Two-person zero-sum games.

4. Define Queuing Theory. What is the M/M/I Queue model?

5. A company has two grades of inspectors 1 and 2, the members of which are to be assigned for a quality control inspection. It is required that at least 2,000 pieces be inspected per 8 hours day. Grade 1 inspectors can check pieces at the rate of 40 per hour, with an accuracy of 97 per cent. Grade 2 inspectors check at the rate of 30 pieces per hour with an accuracy of 95 per cent.

   The wage rate of a grade 1 inspector is Rs. 5 per hour while that of a Grade 2 inspector is Rs. 4 per hour. An error made by an inspector costs Rs. 3 to the company. There are only nine Grade 1 inspectors and eleven Grade 2 inspectors available to the company. The company wishes to assign work to the available inspectors so as to minimize the total cost of the inspection. Formulate this problem as a Linear Programming model.

6. A firm manufactures three types of products. The fixed and variable costs are given below :

Product	Fixed Cost (Rs.)	Variable Cost per unit(Rs.)
A	25,000	12
B	35,000	9
C	53,000	7

The likely demand (units) of the products is given below :

Poor demand : 3,000

Moderate Demand : 35,000

High Demand : 11,000

If the sale price of each type of product is Rs. 25, then prepare the payoff matrix.

SECTION-B

UNIT-I

7. Define Project Management. Explain PERT and CPM in details.

8. The following table gives data on normal time, and cost and crash time and cost for a project :

Activity	Normal		Crash	
	Time (weeks)	Cost (Rs.)	Time (weeks)	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	1,000	9	1,200

Indirect cost is Rs. 50 per week.

a) Draw the network diagram for the project and identify the critical path.

b) What is the normal project duration and associated costs?

c) Find out the total float associated each activity.

d) Crash the relevant activities systematically and determine the optimal project completion time and cost.

UNIT-II

9. What is sensitivity analysis? Obtain the dual of the following LP problem :

Minimize $Z = X_1 + 2X_2$

Subject to the constraints

i) $2X_1 + 4X_2 \leq 160$

ii) $X_1 - X_2 = 30$

iii) $X_1 \geq 10$

where $X_1, X_2 \geq 0$

10. Use Simplex method to solve the following problem :

Maximize $Z = 3X_1 + 5X_2 + 4X_3$

 Subject to the constraints

i) $2X_1 + 3X_2 \leq 8$

ii) $2X_2 + 5X_3 \leq 10$

iii) $3X_1 + 2X_2 + 4X_3 < 15$

where $X_1, X_2, X_3 \geq 0$

UNIT-III

11. What are Minimax and Maxmini principles of game theory? A company's management and the labour union are negotiating a new three year settlement. Each of these has 4 strategies :

I   Hard and aggressive bargaining

II Reasoning and logical approach

III Legalistic strategy

IV Conciliatory approach

The costs to the company are given for every pair of strategy choice.

Union strategy	I	II	III	IV
I	20	15	12	35
II	25	14	8	10
III	40	2	10	5
IV	−5	4	11	0

What strategy will be the two sides adopt? Also, determine the value of the game.

12. There are seven jobs, each of which has to go through the machines A and B in the order AB. Processing times in hours lows :

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

Determine a sequence of these jobs that will minimize the total elapsed time T. Also, find idle time for machine A and B.

UNIT-IV

13. A firm is considering the replacement of a machine, whose cost price is Rs. 12,200, and its scrap value is Rs. 200. From experience the running (maintenance and operating) costs are found to be as follows :

Year :	1	2	3	4	5	6	7	8
Running cost (Rs.) :	200	500	800	1,200	1,800	2,500	3,200	4,000

When should the machine be replaced.

14. In a railway marshalling yard, goods trains arrive at a rate of 30 trains per day. Assuming that the interarrival time follows an exponential distribution and service time (the time taken to hump a train distribution is also exponential with an average of 36 minute,

Calculate :

a) Expected queue size (line length)

b) Probability that queue size exceeds10.

c) If the input of trains increases to an average of 33 per day what will be the change in (a) and (b)

SECTION-C

15. Solve the following case study :

STATE ELECTRICITY BOARD

The state electricity board is planning to construct a new plant for the next 10 years. It is possible to construct four types of electric power facilities-steam plants using coal for energy, hydroelectric plants with no reservoir, hydroelectric plants with small reservoirs (enough water storage capacity to meet daily fluctuations in power demands

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and water flow), and hydroelectric plants with large reservoirs (with enough water storage to meet seasonal fluctuations in power demand and water flow).

The consumption of electricity is based on three characteristics. The first is the total annual usage the requirement in the area is estimated to be 4,000 million kilowatt-hours by the 10th year. The second characteristic is the peak usage of power-usually on a hot summer day at about 2 PM. Any plan should provide enough peaking capacity to meet a projected peak need of 3,000 million kilowatts in the 10th year. The third characteristic is guaranteed power output measured as the averaged daylight output in midwinter when the consumption is high and water levels for the hydroelectric power are low. The 10-year requirement for the 2,000 million kilowatts of guaranteed power.

The various possible power plants vary in terms of how they satisfy characteristics. For example, hydroelectric plants with reservoirs are able to provide substantial peaking capacity, whereas steam plants and hydroelectric plants with no reservoir are poor in this respect.

The characteristics of the various types of the plants are shown in Table below. Each is measured in terms of a unit of capacity. The unit of capacity is defined as to be the capacity to produce 1 billion kilowatt-hours per year. Note that the types of plants vary substantially in their investment costs. The annual operating costs of the various types of plants also vary considerably. For example, the cost of coal makes the annual costs of the steam plants quite high whereas the annual costs of operating the hydroelectric plants are relatively less. The final' column in the table shows the discounted total costs, including both the investment costs and discounted annual operating costs.

Table : Characteristics of electric plants per unit (1 billion kilowatt-hours) of Annual output

Type	Guaranteed output (millions of kilowatts)	Peak output (millions of kilowatt)	Investment costs (Rs. '000)	Discounted Total Cost (Rs. '000)
Steam	0.15	0.20	1200	2600
Hydroelectric : No reservoir	0.10	0.10	1600	1680
Hydroelectric : Small reservoir	0.10	0.40	2400	2560
Hydroelectric : Large reservoir	0.80	0.90	4000	4400

Answer the following questions :

a) Help the company in developing a 10-year plan that would detail the capacity of each type that it should build.

b) Develop an LP model and solve it to minimize the total discounted cost. However, there is a restriction that no more than Rs. 14,000 million can be used for investment in plants over 10 years.