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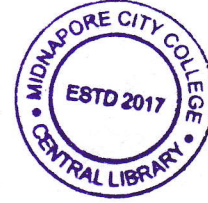**PG (CBCS)**
M.SC. Semester- III Examination, 2023
Mathematics
PAPER: MTM 306A
(OPERATIONAL RESEARCH MODELLING-I)

Full Marks: 50   **Time: 2 Hours**

The figures in the right-hand margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP-A

1. Answer any **FOUR** of the following questions: 4×2=8

   a) Define critical activity and critical path. Determine whether the following statement is true or false.
      In critical path method we determine the shortest path of a project network.
   b) Define the terms: Optimistic time, Most likely time, Pessimistic time.
   c) Define Direct cost, Indirect cost for project. What is Cost slope of project?
   d) What do you mean arrival rate and mean service rate.
   e) What is present worth factor (PWF). Define lead time.
   f) The cost pattern for two machines A and B, when money value is not considered, is given in the table below.

Year	Cost at the beginning of year (₹)	
	Machine A	Machine B
1	900	1400
2	600	100
3	700	700

   Find the cost pattern for each machine when money is worth 10 per cent per year and hence, find which machine is less costly.

GROUP-B

2. Answer any **FOUR** of the following questions: 4×4=16

   a) A company manufactures around 200 mopeds. Depending upon the availability of raw materials and other conditions, the daily production has been varying from 196 mopeds to 204 mopeds, whose probability distribution is as given below:
      Production/day: 196   197   198   199   200   201   202   203   204
      Probability: 0.05   0.09   0.12   0.14   0.20   0.15   0.11   0.08   0.06
      The finished mopeds are transported in a specially designed three-storied lorry that can accommodate only 200 mopeds. Using the following 15 random numbers: 82,   89, 78, 24, 53, 61, 18, 45, 23, 50, 77, 27, 54 and 10, simulate the mopeds waiting in the factory?
      (i) What will be the average number of mopeds waiting in the factory?

P.T.O

(ii) What will be the number of empty spaces in the lorry?

b) The cost of a machine is Rs. 61,000 and its scrap value is Rs. 1,000. The maintenance costs found from the past experiences are as follows:

Year	1	2	3	4	5	6	7	8
Maintenance Cost in Rupees	1000	2500	4000	6000	9000	12000	16000	20000

When should the machine be replaced?

c) Crash the following project schedule and determine the optimum project duration and the corresponding cost for the following data. Indirect cost is Rs. 70 per day.

Activity	Normal		Crash	
	Time (days)	Cost (₹)	Time (days)	Cost (₹)
1-2	8	100	6	200
1-3	4	150	2	350
2-4	2	50	1	90
2-5	10	100	5	400
3-4	5	100	1	200
4-5	3	80	1	100

d) A bakery keeps stock of a popular brand of cake. Previous experience shows the daily demand pattern for the item with associated probabilities, as given below:

Daily demand (number):	0	10	20	30	40	50
Probability:	0.01	0.20	0.15	0.50	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. Also estimate the daily average demand for the cakes based on the simulated data.

e) A telephone exchange has two long distance operators. The telephone company finds that, during the peak load, long distance all arrive in a Poisson fashion at an average rate of 15 per hour. The length of service on these calls is approximately distributed with mean length 5 minutes.

(i) What is the probability that a subscriber will have to wait for this long-distance call during the peak hours of the day?

(ii) If the subscriber waits and are serviced in turn, what is the expected waiting time.

f) Use Monte-Carlo simulation method to calculate the value of π.

GROUP-C

3. Answer any **TWO** of the following questions: 2×8=16

a) There are several activities in a project and the time estimates are as follows: Draw the project network. Calculate the expected completion time and variance of each activity. The earliest and latest expected completion times of each event and hence determine the critical path. Find the probability that the project is completed in 19 days.

Activity	Activity Name	t_o	t_m	t_p
1-2	A	4	6	8
1-3	B	2	3	10
1-4	C	6	8	16
2-4	D	1	2	3
3-4	E	6	7	8
3-5	F	6	7	14
4-6	G	3	5	7
4-7	H	4	11	12
5-7	I	2	4	6
6-7	J	2	6	10

b) A dentist schedules all his patients for 30-minute appointments. Some of the patients take more than 30 minutes and some less, depending on the type of dental work to be done. The following summary shows the various categories of work, their probabilities and time needed to complete the work:

Category	Time Required (mins)	No. of Patient
Filling	45	40
Crown	60	15
Cleaning	15	15
Extracting	45	10
Check up	15	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 a.m. Use the following random numbers for handling the above 40, 82, 11, 34, 25, 66, 17, 79.

c) Derive the steady state difference equation of the queueing model $(M/M/1):(N/FCFS/\infty)$.

d) (i) Define the following terms: total float, free float of a project network.

(ii) Clearly explain with suitable examples the different costs that are involved in the inventory problems.

(iii) A contractor has to supply 10,000 bearings per day to an automobile manufacturer. He finds that when he starts production run, he can produce 25,000 bearings per day. The cost of holding a bearing in stock for a year is Rs 200 and the set-up cost of a production run is Rs 1,800. Calculate EOQ and determine how frequently should production run be made? 2+2+4

[Internal Assessment- 10 Marks]

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