

**PG CBCS**  
**M.Sc. Semester-III Examination, 2022**  
**MATHEMATICS**  
**PAPER: MTM 306B**  
**(OPERATIONAL RESEARCH MODELLING-I)**

**Full Marks: 40****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.

**1. Answer any FOUR questions of the following: 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 following terms: Optimistic time, Most likely time.  
 c) State Bellman's principle of optimality.  
 d) What is present worth factor (PWF). Define lead time.  
 e) Explain a method to generate random numbers with example.  
 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.

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

- a) A machine costs Rs. 15,000. The running cost for the different years is given below.

Year	1	2	3	4	5	6	7
Running	2500	3000	4000	5000	6500	8000	10000

**[P. T. O]****[1]**



Find the optimum replacement period if the capital is worth 10 per cent per annum and has no salvage value.

- b) The following table gives the activities in construction project and time duration.

Activity	Preceding Activity	Normal time (days)
1-2	-	20
1-3	-	25
2-3	1-2	10
2-4	1-2	12
3-4	1-3,2-3	5
4-5	2-4,3-4	10

Draw the activity network of the project. Find the total float and free float for each activity.

- 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) Find the minimum value of

$$Z = y_1^2 + y_2^2 + y_3^2 + \dots + y_n^2$$

sub. to  $y_1, y_2, \dots, y_n = c (c \neq 0)$ ,  
 $y_1, y_2, \dots, y_n \geq 0$ .

[2]

[P. T. O]

- f) What is Random number, Pseudo-random numbers? Explain the Monte Carlo simulation.

3. Answer any TWO questions of the following: 8x2=16

- a) The owner of a chain of four grocery stores has purchased six boxes of fresh strawberries. The table gives the estimated profits at each store when it is allocated various number of boxes: (The owner does not wish to split boxes between stores but is willing to make zero allocations. Find the maximum profit.

No. of Boxes	Estimated Profits			
	Store 1	Store 2	Store 3	Store 4
0	0	0	0	0
1	4	2	6	2
2	6	4	8	3
3	7	6	8	4
4	7	8	8	4
5	7	9	8	4
6	7	10	8	4



- b) 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	$t_0$	$t_m$	$t_p$
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

- c) 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

[3]

[P. T. O]

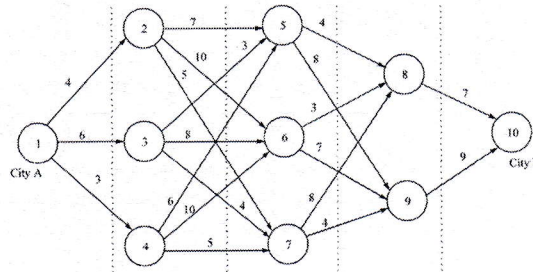
Category	Time Required (mins)	No. of Patient
Filling	45	40
Crown	60	15
Cleaning	15	15
Extracting	45	10
Check up	15	20



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.

- d) A salesman located in a city A decided to travel to city B. He knew the distances of alternative routes from city A to city B. He then drew a highway network map as shown in the following Figure. The city of origin A is city 1. The destination city B is city 10. Other cities through which the salesman will have to pass through are numbered 2 to 9. The arrow representing routes between cities and distances in kilometres are indicated on each route. The salesman's problem is to find the shortest route that covers all the selected cities from A to B.



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[4]