AOR-01

ASSIGNMENT BOOKLET

Bachelor's Degree Programme
(B.Sc./B.A./B.Com.)

OPERATIONS RESEARCH

(Valid from 1st January, 2022 to 31st December, 2022)

It is compulsory to submit the assignment before filling in the exam form.

School of Sciences
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Maidan Garhi
New Delhi-110068
(2022)

Dear Student,

Please read the section on assignments in the Programme Guide for Elective Courses that we sent you after your enrolment. A weightage of 30 per cent, as you are aware, has been earmarked for continuous evaluation, **which would consist of one tutor-marked assignment** for this course. The assignment is in this booklet.

Instructions for Formatting Your Assignments

Before attempting the assignment please read the following instructions carefully:

1) On top of the first page of your answer sheet, please write the details exactly in the following format:

ROLL NO.: ……………………………………………

NAME: ……………………………………………

ADDRESS: ……………………………………………

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COURSE CODE: …………………………….

COURSE TITLE: …………………………….

ASSIGNMENT NO.: ………………………….…

STUDY CENTRE: …………………………..….. **DATE:** ……………………………….……………...

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

2) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.

3) Leave 4 cm margin on the left, top and bottom of your answer sheet.

4) Your answers should be precise.

5) While solving problems, clearly indicate which part of which question is being solved.

6) **This assignment is valid only upto December, 2022**. If you have failed in this assignment or fail to submit it by the last date, then you need to get the assignment for the next cycle and submit it as per the instructions given in that assignment.

7) It is compulsory to submit the assignment before filling in the exam form.

We strongly suggest that you retain a copy of your answer sheets.

We wish you good luck.

ASSIGNMENT

(To be done after studying all the blocks)

Course Code: AOR-01
Assignment Code: AOR-01/TMA/2022
Maximum Marks: 100

1. Are the following statements true or false? Give reasons for your answers. (10)

   a) When the ordering quantity is the sa,e as EOQ, the ordering cost is equal to the holding cost.

   b) $x_1 = 1, x_2 = 2$ and $x_3 = 1$ is a basic feasible solution for the system of equations

   $$x_1 + x_2 + x_3 = 4$$
   $$2x_1 + x_2 + x_3 = 5.$$

   c) In an assignment problem, the optimal solution is always along the main diagonal.

   d) In order to shorten a project completion time, we must reduce the duration of non-critical activities.

   e) Little's formula relates the waiting time of a customer and the number of customers present in a service facility.

2. a) A farm is engaged in breeding horses. The horses are fed on various products grown on the farm. Because of the need to ensure that certain important nutrients α, β and γ, are present in the meal, it is necessary to buy the products A and/or B. The amount of each nutrient available per unit of either product is given below, along with the minimum requirement of each nutrient

Nutrient	Product		Min. amount of nutrient required
	A	B	
α	36	6	108
β	3	12	36
γ	20	10	100
Product cost (per unit)	20	40	

   Formulate the problem of deciding the amount of the products that should be purchased in order to meet the minimum requirements of nutrient at lowest cost, as an LP problem. (5)

   b) A petrol station sells 4000 litres of petrol every month. The parent company, whenever it refills the station's tank, charges the station Rs.50 besides the cost of petrol. The annual cost of holding a litre of petrol is Rs 0.30. Find out the economic order quantity. (5)

3. a) A factory has four machines. Four jobs are required to be processed on them. Each machine must be assigned exactly one job. The time (set-up and processing) requirement of each machine to complete any job is shown below. How should the

jobs be assigned to the machines so that the total time needed to complete the jobs is minimized? What is the total machine time for the optimal assignment? (5)

Machine	Time (hours)			
	Job 1	Job 2	Job 3	Job 4
1	14	5	8	7
2	2	12	6	5
3	7	8	3	9
4	2	4	6	10

b) Write down the dual (D) of the LPP, (P), given by he dual of the following LPP:

Maximize $80x_1 + 120x_2$

Subject to

$$2x_1 + 3x_2 \le 96$$
$$5x_1 + 6x_2 \le 200$$
$$3x_1 + 2x_2 \le 80$$
$$x_1, x_2 \ge 0.$$

Further, without actually solving the LPPs check whether $(x_1 = 20, x_2 = 10)$ is an optimal solution for the primal (P) and $(y_1 = 20, y_2 = 10, y_3 = 5)$ is an optimal solution for the dual, D. (5)

4. a) Consider a $4/2/F/F_{max}$ problem with the data: (4)

Job	Processing time (hours)	
	M_1	M_2
1	5	10
2	9	2
3	16	15
4	18	5

i) Obtain an optimal sequence of jobs.

ii) Find the total idle time of M_2 and the value of F_{max} for the optimal sequence.

b) For rail booking there are two reservation counters for customers who arrive according to a Poisson distribution at an average rate of 10 per hour. The service time for booking clerks at both the counters are exponentially distributed with a mean time of 5 minutes. The counters remain open for 12 hours per day.

i) Find the hours of the day for which all the clerks are busy.

ii) Find the probability that both the clerks are idle.

iii) Find the probability that one clerk is idle.

iv) Find the expected waiting time of customers in the queue. (6)

5. a) We have a project with the activities: A, B, …, F. The following table gives the immediate predecessor(s) and duration of each activity:

Activity	Immediate predecessor(s)	Duration (days)
A	–	4
B	A	5
C	A	4
D	B	3
E	C	3
F	B, E	4

i) Draw the corresponding network diagram.
ii) Find the critical path.
iii) What is the shortest completion time of the project? (6)

b) At a certain iteration, the simplex table of a maximization problem looks like this:

P_B	Basic Variables	-2 x_1	-4 x_2	5 x_3	0 x_4	0 x_5	-3 x_6	solution
-2	x_1	1	-1	3	0	2	0	10
-3	x_6	0	2	1	0	-2	1	4
0	x_4	0	-1	-2	1	-2	0	5

Determine the leaving and entering variables and hence find the values of the new basic variables. (5)

6. a) Suppose that an average of 10 customers per hour arrive at a single-server bank teller. The average service time for each customer is 4 minutes. Assume that both, inter-arrival times and service times, are exponentially distributed.
i) What is the probability that the teller is idle?
ii) Find the average number of waiting customers.
iii) Determine the average amount of time a customer spends in the bank (including time in service). (4)

b) Consider the following integer linear programming problem:
Maximise

$$2x_1 + x_2 + x_3$$

Subject to

$$x_1 + x_2 + x_3 \leq 5$$

$$2x_1 + 3x_2 + x_3 \leq 7$$

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

where x_1, x_2 and x_3 are integers. The final table for the LP relaxation is given below:

	Basic Variables	2 x_1	1 x_2	1 x_3	0 x_4	0 x_5	Solution
0	x_4	0	$-\frac{1}{2}$	$\frac{1}{2}$	1	$-\frac{1}{2}$	$\frac{3}{2}$
2	x_1	1	$\frac{3}{2}$	$\frac{1}{2}$	0	$\frac{1}{2}$	$\frac{7}{2}$
		0	-2	0	0	-1	-7

Use the branch and bound algorithm to find the optimal solution of the integer linear programming problem. (5)

7. a) The proportion of defective pieces of a certain product in a manufacturing process is $0 \cdot 10$. Call a piece D (for defective) if it is defective, G (for good) otherwise. Simulate the outcomes (D or G) of 10 pieces from the given process using the random numbers: $0 \cdot 57, 0 \cdot 76, 0 \cdot 49, 0 \cdot 09, 0 \cdot 95, 0 \cdot 35, 0 \cdot 68, 0 \cdot 22, 0 \cdot 86, 0 \cdot 54$. (4)

b) The following table shows all the necessary information on the availability of supply to each warehouse, the requirement of each market and unit transportation cost (in Rs.) from each warehouse for each market:

		Market				
		P	Q	R	S	Supply
Warehouse	A	6	3	5	4	22
	B	5	9	2	7	15
	C	5	7	8	6	8
	Demand	7	12	17	9	45

The shipping clerk has worked out the following schedule from experience:
12 units from A to Q, 1 unit from A to R,
9 units from A to S, 15 units from B to R,
7 units from C to P and 1 unit from C to R.

Check if the clerk has the optimal schedule. If the schedule is not optimal, find the optimal schedule and minimum transportation cost. (6)

8. a) Use Vogel's approximate method, to solve the following transportation problem of minimization: (5)

	D_1	D_2	D_3	D_4	Capacity
R_1	5	7	13	10	700
R_2	8	6	14	13	400
R_3	12	10	9	11	800
Requirement	300	600	700	400	

b) A company manufactures around 200 mobiles. The daily production varies from 196 mobiles to 204 mobiles with the following probability distribution:

Production / day	Probability
196	0.05
197	0.09
198	0.12
199	0.14
200	0.20
201	0.15
202	0.11
203	0.08
204	0.06

The finished mobiles are transported in box with a capacity of only 200. Using the random numbers

82, 89, 78, 24, 53, 61, 18 and 45,

simulate the mobiles which could not be transported. Determine the average number of such mobiles. (5)

9. a) Use dual simplex method to solve the following LPP:
Minimize $z = x_1 + x_2$
Subject to
$2x_1 + x_2 \geq 4,\ x_1 + 7x_2 \geq 7,\ x_1,\ x_2 \geq 0.$ (5)

b) A T.V. repairman finds that the time spent on his jobs has an exponential distribution with mean 30 minutes. He repairs sets in the order in which they arrive. If the arrival of sets has Poisson distribution with an average rate of 10 per day, (taking 8 hours in a day), then what is the repairman's expected idle time each day? How many jobs are in the queue when a new set is brought for repair? (5)

10. a) Use two-phase simplex method to solve the following LPP:
Maximize $z = 3x_1 + 2x_2$
Subject to
$2x_1 + x_2 \leq 2,\ 3x_1 + 4x_2 \geq 12,\ x_1,\ x_2 \geq 0.$ (5)

b) An item is produced at the rate of 50 items per day. The demand occurs at the rate of 25 items per day. If the set-up cost is Rs.100, and the holding cost is Rs.0.01 per unit of item per day, find the economic lot size for one run, assuming that the shortages are not permitted. Also, find the time of cycle and total minimum cost for one run. (5)