

Department of Mechanical Engineering  
Chittagong University of Engineering and Technology (CUET)

Level 4, Term-II, Examination 2023

Course: ME 469	Full Marks: 210	Time: 3 hours
Course Title: Operations Research	Date: 02/06/2025	

The figures in the right margin indicate full marks. The questions are of equal value. There are 04 questions in each section. Answer any 03 questions from each section. Use separate script for each section.

*Section - A*

- Q.1(a) An individual wishes to invest \$5000 over the next year in two types of investment: investment A yields 5% and investment B yields 8%. market research recommends an allocation of at least 25% in A and at most 50% in B. Moreover, investment in A should be at least half the investment in B. Formulate this as a linear programming problem. 10
- (b) Solve the following LP problem using Simplex method 25

$$\begin{aligned}
 & \text{Maximize } z = 3x_1 + 2x_2 + x_3 \\
 & \text{Subject to } x_1 + x_2 + x_3 \leq 9 \\
 & \quad \quad \quad 2x_1 + 3x_2 + 5x_3 \leq 30 \\
 & \quad \quad \quad 2x_1 - x_2 - x_3 \leq 8 \\
 & \quad \quad \quad x_1, x_2, x_3 \geq 0
 \end{aligned}$$

- Q.2 Solve the LP model using Big-M 35

$$\begin{aligned}
 & \text{Minimize } z = 2x_1 + 3x_2 \\
 & \text{Subject to } x_1 + x_2 \geq 6 \\
 & \quad \quad \quad 7x_1 + x_2 \geq 14 \\
 & \quad \quad \quad x_1, x_2 \geq 0
 \end{aligned}$$

- Q.3 Solve the following LPP using dual simplex method: 35

$$\begin{aligned}
 & \text{Minimize } z = 2x_1 + 4x_2 \\
 & \text{Subject to } 2x_1 + x_2 \geq 4 \\
 & \quad \quad \quad x_1 + 2x_2 \geq 3 \\
 & \quad \quad \quad 2x_1 + 2x_2 \leq 12 \\
 & \quad \quad \quad x_1, x_2 \geq 0
 \end{aligned}$$

- Q.4 A Company has 2 production facilities  $S_1$  and  $S_2$  with production capacity of 100 and 110 units per week of a product, respectively. These units are to be shipped to 3 warehouses  $D_1$ ,  $D_2$  and  $D_3$  with requirement of 80, 70 and 60 units per week, respectively. The transportation costs (in \$) per unit between factories to warehouses are given in the table below:

Destination \ Sources	$D_1$	$D_2$	$D_3$	Supply
$S_1$	1	2	3	100
$S_2$	4	1	5	110
Demand	80	70	60	

Find initial basic feasible solution to the above transportation problem using North West Corner Method, then optimize the solution.

*Section - B*

- Q.5(a) Solve the following NLP using Lagrangean method: 18

$$\begin{aligned}
 & \text{Minimize } z = x_1^2 + x_2^2 + x_3^2 \\
 & \text{Subject to } x_1 + x_2 + 3x_3 = 2 \\
 & \quad \quad \quad 5x_1 + 2x_2 + x_3 = 5 \\
 & \quad \quad \quad x_1, x_2, x_3 \geq 0
 \end{aligned}$$

b) Using Kuhn-Tucker condition solve the following problem

17

$$\begin{aligned} \text{Maximize } z &= 8x_1 + 10x_2 - x_1^2 - x_2^2 \\ \text{Subject to } x_1 + x_2 + x_3 &= 9 \\ 3x_1 + 2x_2 &\leq 6 \\ x_1, x_2 &\geq 0 \end{aligned}$$

Q.6(a) The assignment cost of assigning any one operator to any one machine is given in the following Table: 20

		Operators			
		I	II	III	IV
Machines	A	10	5	13	15
	B	3	9	18	3
	C	10	7	3	2
	D	5	11	9	7

Find the optimal assignment.

(b) Find the values of  $p$  and  $q$  which will render the entry (2, 2) a saddle point for the game: 15

		Player B		
		1	2	3
Player A	1	2	4	5
	2	10	7	$q$
	3	4	$p$	6

Q.7(a) A self-service store employs one cashier at its counter. 9 customers arrive on an average every 5 minutes while the cashier can serve 10 customers in 5 minutes, Assuming Poisson distribution for arrival rate and exponential distribution for services, find i) Average number of customers in the system, ii) Average length of the queue, iii) Average time a customer spends in the system, and iv) Average time a customer waits before being served. 20

(b) A tourist car operator finds that during the past few months the car's use has varied so much that the cost of maintaining the car has varied considerably. During the past 200 days the demand for the car fluctuated as below: 15

Trips per week	Frequency
0	16
1	24
2	30
3	60
4	40
5	30

Using random numbers, simulate the demand for a 10-week period.

Q.8(a) A farmer wants to decide which of the three crops he should plant on his 100-acre farm. The profit from each is dependent on the rainfall during the growing seasons. The farmer has categorized the amount of rainfall as high, medium, low. His estimated profit for each is shown in the Table below: 20

Rainfall	Estimated Conditional Profit( Tk.)		
	Crop A	Crop B	Crop C
High	8000	3500	5000
Medium	4500	4500	5000
Low	2000	5000	4000

If the farmer wishes to plant only one crop, decide which will be his best crop using:

i) Maximax Criteria, ii) Maximin Criteria, iii) Hurwicz Criteria (farmer's degree of optimism being 0.6), and iv) Laplace Criteria

(b) Customers arrive at a service facility to get the required service. The inter-arrival and service times are constant and are 1.8 minutes and 4 minutes respectively. Simulate the system for 14 minutes. Determine the average waiting time of a customer and idle time of the service facility. 15

\*\*\*\*\* The End \*\*\*\*\*

**Department of Mechanical Engineering**  
**Chittagong University of Engineering and Technology (C U E T)**  
**Level 4, Term II Examination 2021**

Course No: ME 469	Full Marks: 210	Time: 03 hours
Course Title: Operations Research	Date: 05 / 02 / 2023	

The figures in the right margin indicate full marks. The questions are of equal value. There are 04 questions in each section. Answer any 03 questions from each section. Use separate script for each section.

**Section: A**

Marks

1. a) What is operation research? State any 2 models in operation research with at least one example. 8
- b) A firm manufactures 2 types of products A and B and sells them at a profit of \$2 on type A and \$3 on type B. Each product is processed on 2 machines C and D. Type A requires 1 minute of processing time on C and 2 minutes on D. Type B requires 1 minute on C and 1 minute on D. The machine C is available for not more than 6 hours 40 minutes while machine D is available 12 hours during any working day. Formulate the problem as a linear programming problem. 12
- c) Solve the following LP problem using graphical method 15

$$\begin{aligned} \text{Minimize } z &= 2x_1 + 3x_2 \\ \text{Subject to } x_1 + x_2 &\geq 6 \\ 7x_1 + x_2 &\geq 14 \\ x_1, x_2 &\geq 0 \end{aligned}$$

2. a) Solve the following LP problem using simplex method 18

$$\begin{aligned} \text{Minimize } z &= 10x_1 + 15x_2 + 20x_3 \\ \text{Subject to } 2x_1 + 4x_2 + 6x_3 &\leq 24 \\ 3x_1 + 9x_2 + 6x_3 &\leq 30 \\ x_1, x_2, x_3 &\geq 0 \end{aligned}$$

- b) Solve the following transportation problem using 17
- (i) Northwest corner cell method
- (ii) Least cost cell method.

		Destination				Supply
		1	2	3	4	
Source	1	3	1	7	4	300
	2	2	6	5	9	400
	3	8	3	3	2	500
Demand		250	350	400	200	1200

3. a) Solve the LPP using Big-m method 35

$$\begin{aligned} \text{Minimize } z &= 10x_1 + 15x_2 + 20x_3 \\ \text{Subject to } 2x_1 + 4x_2 + 6x_3 &\geq 24 \\ 3x_1 + 9x_2 + 6x_3 &\geq 30 \\ x_1, x_2, x_3 &\geq 0 \end{aligned}$$

4. a) Form the dual of the following primal problem 10

$$\begin{aligned} \text{Minimize } z &= 20x_1 + 40x_2 \\ \text{Subject to } 2x_1 + 20x_2 &= 10 \\ 20x_1 + 3x_2 &= 20 \\ 4x_1 + 15x_2 &= 30 \\ x_1 \text{ and } x_2 &\geq 0 \end{aligned}$$

- b) Use duality to solve the following LP problem 25

$$\begin{aligned} \text{Minimize } z &= 2x_1 + x_2 \\ \text{Subject to } x_1 + 2x_2 &\leq 10 \\ x_1 + x_2 &\leq 6 \\ x_1 - x_2 &\leq 2 \\ x_1 - 2x_2 &\leq 1 \\ x_1 \text{ and } x_2 &\geq 0 \end{aligned}$$

**Section: B**

5. a) Solve the following NLP using Lagrangian method 15  
 Minimize  $z = 5x_1 + x_2 - (x_1 - x_2)^2$   
 Subject to  $x_1 + x_2 = 24$   
 $x_1, x_2 \geq 0$
- b) Solve the following NLP using Kuhn – Tucker conditions 20  
 Minimize  $z = 8x_1 + 10x_2 - x_1^2 - x_2^2$   
 Subject to  $3x_1 + 2x_2 \leq 6$   
 $x_1, x_2 \geq 0$

6. a) Solve the TSP as to minimize the cost per cycle. 20

		To					
		City	1	2	3	4	5
From	1	$\infty$	10	25	25	10	
	2	1	$\infty$	10	15	2	
	3	8	9	$\infty$	20	10	
	4	14	10	24	$\infty$	15	
	5	10	8	25	27	$\infty$	

- b) For the game with pay off matrix 15

		Player B		
		1	2	3
Player A	1	-1	2	-2
	2	6	4	-6

7. a) The arrival rate of customers at a banking counter follows Poisson distribution with a mean of 45 per hour. The service rate of the counter person also follows Poisson distribution with a mean of 60 per hour. 16  
 (i) What is the probability of having 0 customers in the system?  
 (ii)  $P_5$   
 (iii) Find  $L_s, L_q, w_s$  and  $w_q$ .
- b) A tourist operator finds that during the past few month the car's uses has varied so much that the cost of maintaining the car has varied considerably. During the past 200 days the demand for the car fluctuated as below 19

Trips per week	Frequency
0	16
1	24
2	30
3	60
4	40
5	30

8. a) State 3 advantages and 3 disadvantages of decision tree approach. 9  
 b) Solve the following by cutting plane algorithm 26  
 Minimize  $z = 6x_1 + 2x_2$   
 Subject to  $3x_1 + 2x_2 = 5$   
 $x_1, x_2 \geq 0$  and integers

\*\*\*\*\*END OF QUESTION\*\*\*\*\*

Department of Mechanical Engineering  
Chittagong University of Engineering and Technology (CUET)

**Level 4, Self Study, Examination 2022**

Course: ME 469	Full Marks: 210	Time: 3 hours
Course Title: Operations Research	Date: 26/05/2024	

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*Section – A*

Q.1 (a) What is operations research? Why operations research is important in the field of Mechanical Engineering? 08

(b) Alumco manufacturers Aluminum sheets and Aluminum bars. The maximum production capacity is estimated at either 800 sheets or 600 bars per day. The maximum daily demand is 550 sheets and 560 bars. The profit per ton is \$40 per sheet and \$35 per bar. Formulate the problem as a linear programming problem. 12

(c) Use graphical method to solve the following problem 15

$$\begin{aligned} \text{Maximize } z &= 2x_1 + 3x_2 \\ \text{Subject to } x_1 + x_2 &\leq 1 \\ 3x_1 + x_2 &\leq 4 \\ x_1, x_2 &\geq 0 \end{aligned}$$

Q.2 Use Big M method to solve the following 35

$$\begin{aligned} \text{Minimize } z &= 4x_1 + x_2 \\ \text{Subject to } 3x_1 + x_2 &= 3 \\ 4x_1 + 3x_2 &\geq 6 \\ x_1 + 2x_2 &\leq 3 \\ x_1, x_2 &\geq 0 \end{aligned}$$

Q.3 Solve the following integer LPP using Gomory's cut, 35

$$\begin{aligned} \text{Maximize } z &= -4x_1 + 5x_2 \\ \text{Subject to } -3x_1 + 3x_2 &\leq 6 \\ 2x_1 + 4x_2 &\leq 12 \\ x_1, x_2 &\geq 0 \end{aligned}$$

Q.4 Solve the following problem using Branch and Bound method with neat sketch, 35

$$\begin{aligned} \text{Minimize } z &= 2x_1 + 3x_2 \\ \text{Subject to } 6x_1 + 5x_2 &\leq 25 \\ x_1 + 3x_2 &\leq 10 \\ x_1, x_2 &\geq 0 \end{aligned}$$

*Section – B*

Q.5 (a) Verify whether the following function is convex concave and find the maximum or minimum solution point, 18

$$f(x) = 4x_1^2 + 3x_2^2 + x_3^2 - 6x_1x_2 + x_1x_3 - \frac{x_1}{2} + 15$$

(b) Solve the following NLPP using Khun-Tucker conditions, 17

$$\begin{aligned} \text{Maximize } z &= 2x_1^2 - 7x_2^2 + 12x_1x_2 \\ \text{Subject to } 2x_1 + 5x_2 &\leq 98 \\ x_1, x_2 &\geq 0 \end{aligned}$$

Q.6 (a) Solve the following problem using simplex method

20

$$\begin{aligned} \text{Maximize } z &= 3x_1 + 2x_2 \\ \text{Subject to } x_1 + x_2 &\leq 4 \\ x_1 - x_2 &\leq 2 \\ x_1, x_2 &\geq 0 \end{aligned}$$

(b) Solve the game

15

		Player B		
		B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>
Player A	A <sub>1</sub>	1	3	11
	A <sub>2</sub>	8	5	2

Q.7 (a) A person repairing radios finds that the time spent on the radio sets has exponential distribution with mean 20 mins. If the radios are repaired in the order in which they come in and their arrival is approximately Poisson distribution with an average rate of 15 for 8 hr day, what is the repairman's expected idle time each day? How many jobs are ahead of the average set just brought in?

15

(b) A Xerox machine in an office is operated by a person who does other jobs also. The average service time for a job is 6 mins/customer. On an average, every 12 minutes, one customer arrives for Xeroxing. Find (i) the Xerox machine utilization (ii) the percentage of time that an arrival has not to wait (iii) average time spent by the customer (iv) average queue length (v) the arrival rate if the management is willing to deploy the person exclusively for Xeroxing when the average time spent by a customer exceeds 15 mins.

20

Q.8 A student has to take examination in 3 courses x, y, z and he has 3 days available for study. His estimates of grades he may get by studying as follows:

35

Study/Course	x	y	z
0	1	2	1
1	2	2	2
2	2	4	4
3	4	5	4

How should he plan to study so that he maximizes the sum of his grades?

\*\*\*The End\*\*\*\*