

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI  
(END SEMESTER EXAMINATION)**

**CLASS: BTECH/BARCH  
BRANCH: BT/CHEMICAL/MECH/CSE/ECE/IT/ARCH**

**SEMESTER: VI  
SESSION: SP/2023**

**SUBJECT: PE332 OPERATION RESEARCH WITH PYTHON**

**TIME: 3 Hours**

**FULL MARKS: 50**

**INSTRUCTIONS:**

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

- |  | CO  | BL  |
|--|-----|-----|
| Q.1(a) Write a Python program to check if a given input of a year is a leap year or not.   | [5] | 1 3 |
| Q.1(b) Consider a small plant that makes two types of automobile parts, say A and B. It buys castings that are machined, bored, and polished. The capacity of machining is 25 per hour for A and 24 per hour for B, the capacity of boring is 28 per hour for A and 35 per hour for B, and the capacity of polishing is 35 per hour for A and 25 per hour for B. Castings for part A cost Rs 2 and sell for Rs 5 each and those for part B cost Rs 3 and sell for Rs 6 each. The three machines have running costs of Rs 20, Rs 14, and Rs 17.50 per hour. Assuming that any combination of parts A and B can be sold, formulate this problem as an LP model to determine the product mix which would maximize profit.                   | [5] | 2 3 |
| Q.2(a) A firm makes two products X and Y, and has a total production capacity of 9 tonnes per day. Both X and Y require the same production capacity. The firm has a permanent contract to supply at least 2 tonnes of X and at least 3 tonnes of Y per day to another company. Each tonne of X requires 20 machine hours of production time and each tonne of Y requires 50 machine hours of production time. The daily maximum possible number of machine hours is 360. All of the firm's output can be sold. The profit made is Rs 80 per tonne of X and Rs 120 per tonne of Y. Formulate this problem as an LP model and solve it by using the graphical method to determine the production schedule that yields the maximum profit. | [5] | 2 3 |
| Q.2(b) Use the Big-M method to solve the following LP problem.<br>Minimize $Z = 5x_1 + 3x_2$<br>Subjected to: $2x_1 + 4x_2 \leq 12$<br>$2x_1 + 2x_2 = 10$<br>$5x_1 + 2x_2 \geq 10$<br>$x_1, x_2 \geq 0$  | [5] | 2 3 |
| Q.3(a) A dairy firm has three plants located in a state. The daily milk production at each plant is as follows:<br>Plant 1: 6 million litres, Plant 2: 1 million litres, and Plant 3: 10 million litres<br>Each day, the firm must fulfil the needs of its four distribution centres. The minimum requirement of each centre is as follows:<br>Distribution centre 1: 7 million litres, Distribution centre 2: 5 million litres, Distribution centre 3: 3 million litres, and Distribution centre 4: 2 million litres<br>Cost (in hundreds of rupees) of shipping one million litre from each plant to each distribution centre is given in the following table:   | [5] | 3 3 |

		Distribution centres			
		D1	D2	D3	D4
Plants	P1	2	3	11	7
	P2	1	0	6	1
	P3	5	8	15	9

Find the initial basic feasible solution for given problem by using following methods:

- (a) North-west corner rule
- (b) Least cost method
- (c) Vogel's approximation method

- Q.3(b) A salesman wants to visit cities A, B, C, D, and E. He does not want to visit any city twice before completing his tour of all cities and wishes to return to the point of starting the journey. The cost of going from one city to another (in rupees) is shown in the table. Find the least-cost route. [5] 3 3

	A	B	C	D	E
A	0	2	5	7	1
B	6	0	3	8	2
C	8	7	0	4	7
D	12	4	6	0	5
E	1	3	2	8	0

- Q.4(a) Arrivals of machinists at a tool store are considered to be Poisson distributed at an average rate 6 per hour. The length of time the machinists must remain at the tool store is exponentially distributed, with an average time of 0.05 hours. [4] 4 3
- What is the probability that a machinist arriving at the tool crib will have to wait?
  - What is the average number of machinists at the tool store?
  - The company will install a second tool store when convinced that a machinist would have to spend 6 minutes in waiting and being served at the tool store. At what rate should the arrival of machinists to the tool store increase to justify the addition of a second store?

- Q.4(b) A warehouse has only one loading dock manned by three person crew. Trucks arrive at the loading dock at an average rate of 4 trucks per hour and the arrival rate is Poisson distributed. The loading of a truck takes 10 minutes on an average and can be assumed to be exponentially distributed. The operating cost of a truck is Rs 20 per hour and the members of the loading crew are paid Rs 6 each per hour. Would you advise the truck owner to add another crew of three persons? [6] 4 3

- Q.5(a) Reduce the following game by dominance property and solve it: [5] 5 3

		Player B				
		I	II	III	IV	V
Player A	I	1	3	2	7	4
	II	3	4	1	5	6
	III	6	5	7	6	5
	IV	2	0	6	3	1

- Q.5(b) Solve the following game by the method of subgames: [5] 5 3

		Player B		
		B1	B2	B3
Player A	A1	1	3	11
	A2	8	5	2