Reg. No.																

Question Paper Code	14215

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

Fourth Semester

Computer Science and Business Systems

20BSMA405 - OPERATIONS RESEARCH WITH LABORATORY

Regulations - 2020

(Use of *Tables* is permitted)

Duration: 3 Hours | Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

		Marks	*K – Level*	*CO*
1.	The optimal value of the objective function is attained at the points (a) given by intersection of lines representing inequations with axes only (b) given by intersection of lines representing inequations with X-axis only (c) given by corner points of the feasible region (d) at the origin	*1*	*K1*	*CO1*
2.	Constraints means (a) limitations are expressed in mathematical equalities (or inequalities) (b) Assumption (c) goal is to be achieved (d) None of the above	*1*	*K1*	*CO1*
3.	In the optimal solution, more than one empty cells have their opportunity cost as zero, it indicates (a) The solution is not optimal (b) The problem has alternate solution (c) Something wrong in the solution (d) The problem will cycle	*1*	*K1*	*CO2*
4.	An optimal solution of an assignment problem can be obtained only if (a) Each row and each column has only one zero element (b) Each row and each column has at least one zero element (c) Each row and each column has at most one zero element (d) the number of assigned cells is equal to the number of rows/columns	*1*	*K1*	*CO2*
5.	EOQ is the order quantity that ----- over our planning horizon. (a) minimizes total ordering costs (b) minimizes total carrying costs (c) minimizes total inventory costs (d) the required safety stock	*1*	*K1*	*CO3*
6.	The price reductions offered to customers for large orders, to encourage them to purchase in large quantities is known as ___. (a) Freebies (b) Quantity discounts (c) Normal discounts (d) Premiums	*1*	*K1*	*CO3*
7.	Customer behavior in which the customer moves from one the queue to another in a multiple channel situation is (a) balking (b) reneging (c) jockeying (d) alternating	*1*	*K1*	*CO4*
8.	The expected length of the non-empty queue is given by (a) $L = \frac{\mu}{\mu-\lambda}$ (b) $L = \frac{s\mu}{s\mu-\lambda}$ (c) $L = \frac{\lambda}{\mu-\lambda}$ (d) $L = \frac{\lambda}{\mu-\lambda} + \frac{1}{\mu}$	*1*	*K1*	*CO4*
9.	The amount of time by which an activity can be delayed without affecting project completion time is (a) Free float (b) Total float (c) Independent float (d) Activity float	*1*	*K1*	*CO5*
10.	Pessimistic time and optimistic time of completion of an activity are given as 10 days and 4 days respectively. Then the variance of the activity will be (a) 1 (b) 6 (c) 12 (d)18	*1*	*K2*	*CO5*

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

11.	Explain the significance of the following variables with examples: (i) Slack variables (ii) Surplus variables	*2*	*K2*	*CO1*
12.	What is meant by degeneracy in LPP?	*2*	*K1*	*CO1*

13. Write the dual of min $z = x_1 + x_2$ s.t the constraints $2x_1 + x_2 \geq 4$, $x_1 + 7x_2 \geq 7$, $x_1, x_2 \geq 0$. *2 K2 CO2*
14. How does the problem of degeneracy arise in a transportation problem? *2 K1 CO2*
15. The annual demand for an item is 3200 units. The unit cost is Rs.6 and inventory carrying charges are 25% per annum. If the cost of the procurement is Rs.150, determine economic order quantity. *2 K2 CO3*
16. Write the EOQ formula under manufacturing model with shortages and without shortages. *2 K1 CO3*
17. For a single server model with average arrival rate of 8 per hour and average service time of 5 minutes, calculate idle time in 8 hours shift. *2 K2 CO4*
18. Write the meaning of (M / M / 1) : (∞ / FCFS). *2 K1 CO4*
19. Draw the network for the project whose activities with their predecessor relationship are given: A,C and D can start simultaneously; E > B,C ; F,G > D; H,I > E,F; J > I,G; K > H; B > A. *2 K2 CO5*
20. Define float. What are the different types of floats? *2 K1 CO5*
21. Find the cost time slope if normal duration is 10 hours, normal cost is Rs.100, crash duration is 5 hours and crash cost is Rs.400? *2 K1 CO5*
22. Write the EOQ formula under purchasing model with shortages and without shortages. *2 K1 CO3*

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

23. a) Solve the linear programming problem using simplex method: $Max\ Z = 4x_1 + 3x_2 + 6x_3$ *11 K3 CO1*

Subject to:.

$2x_1 + 3x_2 + x_3 \leq 440$

$4x_1 + 3x_3 \leq 470$

$2x_1 + 5x_2 \leq 430$

$x_1, x_2, x_3 \geq 0.$

OR

b) Use penalty method to solve the linear programming problem: $Max\ Z = 4x_1 + 5x_2 + 2x_3$ *11 K3 CO1*

Subject to:

$2x_1 + x_2 + x_3 \leq 10$

$x_1 + 3x_2 + x_3 \leq 12$

$x_1 + x_2 + x_3 = 6$

$x_1, x_2, x_3 \geq 0.$

24. a) Obtain the dual of the following L.P.P. Find the solution of the primal problem by solving its dual. *11 K3 CO2*

Max $z = 30x_1 + 23x_2 + 29x_3$

subject to $6x_1 + 5x_2 + 3x_3 \leq 26$

$4x_1 + 2x_2 + 5x_3 \leq 7$

$x_1 , x_2 , x_3 \geq 0$

OR

b) Solve the transportation problem *11 K3 CO2*

		Market					
		A	B	C	D	E	Available
Factory	P	4	1	2	6	9	100
	Q	6	4	3	5	7	120
	R	5	2	6	4	8	120
	Demand	40	50	70	90	90	

25. a) (i) An item is produced at the rate of 50 units per day. The demand occurs at the rate of 25 items per day. If the set up cost is Rs.100 per run and the holding cost is Rs.0.01 per unit of item, per day, find the economic lot size for one run, assuming that shortages are not permitted. Also find the time of the cycle and minimum cost for one run. *5 K3 CO3*

(ii) The probability of the demand for lorries for hiring on any day in a given district is as follows: *6 K3 CO3*

Number of lorries demanded:	0	1	2	3	4
Probability:	0.1	0.2	0.3	0.2	0.2

Lorries have a fixed cost of Rs.90 each day to keep the daily five charges (net of variable costs of running) Rs.200. If the lorry-hire company owns 4 lorries, what is its daily expectation? If the company is about to go into business and currently has no lorries how many lorries should it buy?

OR

b) (i) A manufacturer has to supply his customer with 600 units of his products per year. Shortages are not allowed and storage cost amounts to 60 paisa per unit per year. The set up cost is Rs.80.00 find i) EOQ ii) The minimum average yearly cost. iii) The optimum number of orders per year. iv) The optimum period of supply per optimum order. *5 K3 CO3*

(ii) Find the optimal order quantity for a product for which the price-break is as follows: *6 K3 CO3*

Quantity	Unit Cost (Rs.)
$0 < q_1 < 50$	10.00
$50 \leq q_2 < 100$	9.00
$100 \leq q_3$	8.00

The monthly demand for the product is 200 units, the cost of the storage is 25% of the unit cost and ordering cost is Rs.20.00 per order.

26. a) (i) One person barber shop has 6 chairs to accommodate people waiting for a haircut. Assume that customers who arrive when all the 6 chairs are full leave without entering the barber shop. Customers arrive at the average rate of 3 per hour and spend an average of 15 minutes in the barber's chair. *6 K3 CO4*

1. What is the probability that a customer can get directly into the barber's chair upon arrival?
2. What is the expected number of customers waiting for a haircut?
3. How much time can a customer expect to spend in the barber shop?

(ii) At a public telephone booth in a post office, arrivals are considered to be Poisson, with an average inter arrival time of 12 minutes. The length of the phone call may be assumed to be distributed exponentially with an average of four minutes. Calculate the following. a) What is the probability that a fresh arrival will not have to wait for the phone? b) What is the average length of the queue that forms from time to time? *5 K3 CO4*

OR

b) (i) An electricity band has 3 bill counters providing service exponentially distributed at the rate of 12 customers per hour. If he receives on the average 24 customers per hour in a Poisson distribution, determine *6 K3 CO4*

The probability that a customer will be sent immediately?

Find the probability that a customer will have to wait?

What is the average total time that a customer must spend at the bill counter?

(ii) On an average, 96 patients per 24 hour day require the service of an emergency clinic. Also, on an average a patient requires 10 minutes of active attention. Assume that the facility can handle only one emergency at a time. Suppose that it costs the clinic Rs.100 per patient treated, to obtain an average servicing time of 10 minutes and thus, each minute of decrease in this average time would cost Rs.10 per patient treated. How much would have to be budgeted by the clinic to decrease the average size of the queue from 1⅓ patients to 1/2 patients? *5 K3 CO4*

27. a) A project schedule has the following characteristics: *11 K3 CO5*

Activity	1-2	1-3	2-3	2-5	3-4	3-6	4-5	4-6	5-6	6-7
Duration (weeks)	15	15	3	5	8	12	1	14	3	14

Determine the critical path and project duration. Also calculate the total float, free float and independent float for the project.

OR

b) A project has the following activities and other characteristics: *11 K3 CO5*

Activity	Preceding Activity	Time in weeks		
		t_o	t_m	t_p
A	-	4	7	16
B	-	1	5	15
C	A	6	12	30
D	A	2	5	8
E	C	5	11	17
F	D	3	6	15
G	B	3	9	27
H	E, F	1	4	7
I	G	4	19	28

Draw the project network.
Identify the critical path and determine the project completion time.
Calculate the standard deviation and variance of the project length.
What is the probability that the project will be completed at least 4 weeks earlier than expected time?
What is the probability that the project will be completed no more than 4 weeks later than expected time?

28. a) Use dual simplex method to solve *11 K3 CO2*

Maximize $z = -2x_1 - x_3$

subject to $x_1 + x_2 - x_3 \geq 5$

$x_1 - 2x_2 + 4x_3 \geq 8$

$x_1 , x_2 , x_3 \geq 0.$

OR

b) The processing time in hours for the Jobs when allocated to the different machines are indicated below. Assign the machines for the Jobs so that the total processing time is minimum. *11 K3 CO2*

		Machines				
		M_1	M_2	M_3	M_4	M_5
Jobs	J_1	9	22	58	11	19
	J_2	43	78	72	50	63
	J_3	41	28	91	37	45
	J_4	74	42	27	49	39
	J_5	36	11	57	22	25