2025

COMMERCE

Paper : CC-203

(Operations Research)

Full Marks : 40

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer ***two*** questions from ***each Module***.

Module - I

1. (a) Realme Mobiles Ltd. plans to launch two new mobile phone models viz. Note 13 and Note 15 Pro in the upcoming three months. As a result, the existing production facilities must be expanded, which implies that the company will need additional working capital during the first production phase to cover various prime costs and expenses associated with sales and distribution. The sales revenue will not generate any cash inflows to the company in the first three-month period, as sales to dealers will be made on a three-month credit basis.

It has own internal funds of ₹ 50 lakh to finance the costs of this expansion plan. Furthermore, it has been able to secure a short-term loan of ₹ 100 lakh from IDFC Bank at an interest rate of 20% p.a. However, the bank will only release the funds if the sum of the internal funds and accounts receivable from two new mobile phone models is at least double the total outstanding loan amount together with interest due at the conclusion of the initial three-month term. In consultation with the marketing team, the production team has made the decision to produce at least 120 units of Note 13 and 60 units of Note 15 Pro to sufficiently test initial market reaction. The relevant costs and prices related to the models are shown below :

Model	Variable Cost per unit (₹)	Selling Price per unit (₹)
Note 13	14,000	18,000
Note 15 Pro	32,000	40,000

You are required to formulate a linear programming model to determine the number of units of each model to be produced with company's own funds and borrowed funds to maximise contribution of the company. You may assume that all units of each model are sold as they are produced and there is no closing stock of raw materials or semi-finished products in the initial three-month production phase.

(b) The Investment Corporation wants to study the investment projects based on three factors : market demand, profit per unit and investment required which were found as follows :

Profit per unit (₹)	**Probability**	**Annual Demand ('000 units)**	**Probability**	**Required Investment (₹ in thousand)**	**Probability**
5	0.1	20	0.05	1500	0.20
6	0.2	25	0.10	2000	0.50
8	0.3	30	0.10	2500	0.30
9	0.3	35	0.30		
10	0.1	40	0.25		
		45	0.15		
		50	0.05		

Consider the following random numbers :

Demand : 28, 57, 60, 17, 64, 20, 27, 58, 61, 30

Profit : 19, 07, 90, 02, 57, 28, 29, 83, 58, 41

Investment : 18, 61, 16, 71, 43, 68, 47, 24, 19, 97

Use Monte Carlo Simulation for 10 trials to estimate the percentage of return on investment (ROI%). Recommend an optimum investment strategy based on modal value of ROI%. 4+6

2. (a) Formulate the LPP of the following Game with the Pay-off matrix as follows :

	B_1	B_2	B_3	B_4
A_1	2	3	1	3
A_2	3	1	3	–1
A_3	–1	3	–1	6

Verify that if the game of A is primal, then the game of B is its dual.

(b) Solve the following linear programming problem by Simplex Method :

Maximise $Z = 3x_1 + 2x_2 + 3x_2$

Subject to,

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

$$3x_1 + 4x_2 + 2x_3 \geq 8$$

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

4+6

3. (a) The costs of transporting products per unit (₹ in thousand) from the warehouses to the sales outlets located across a city are listed below for Turbo Ltd. :

From \ To		Sales Outlet				Availability (Units)
		S_1	S_2	S_3	S_4 (Dummy)	
Warehouse	W_1	7	3	6	0	5
	W_2	4	6	8	0	10
	W_3	5	8	4	0	7
	W_4	8	4	3	0	3
Requirement (Units)		5	8	10	2	25

The supply chain and logistics manager of the company has introduced one dummy sales outlet to the above cost matrix to have a feasible solution and has worked out the following transportation schelude to minimise the company's transportation costs :

From W_1 to S_2 – 5 units	From W_3 to S_3 – 7 units
From W_2 to S_1 – 5 units	From W_4 to S_3 – 3 units
From W_2 to S_2 – 3 units	
From W_2 to S_4 – 2 units	

You are required to advise the company on the optimality of the schedule prepared by the supply chain and logistics manager. In case, the aforementioned schedule is not optimal, recommend the company an optimal transportation schedule.

(b) Two food manufacturers A and B are competing for an increased market share. The pay-off matrix shows the increase in market share for A and decrease in market share for B. Determine optimal strategies for both the players and the value of the game.

A \ B	Give Coupons	Decrease Price	Maintain Present Strategy	Increase Advertising
Give Coupons	6	–6	12	3
Decrease Price	18	3	36	9
Maintain Present Strategy	–9	6	0	18
Increase Advertising	6	–9	21	3

(1+5)+4

4. (a) A news-boy purchases newspapers everyday in bulk. The surplus at the end of the day is dead loss. A newspaper costs him ₹ 6 and it can be sold for ₹ 7 each. The distribution of demand for papers for last 200 days is as follows:

Demand	50	60	70	80	90
No. of Days	20	40	60	50	30

(i) Obtain the pay-off matrix for the news-boy.

(ii) Obtain the decision by Laplace and Hurwicz principles of decision making under uncertainty (with the index of optimism = 0.4).

(iii) Compute EPPI for the above problem.

(b) Moon Pharma Ltd. will sponsor international trips for its top five regional sales managers. The five international destinations are to be assigned to these managers in such a manner that ensures no destination is assigned more than once and each manager gets their most preferred vacation spot according to the choices they submit to the company. The offered international locations along with their codes are as follows:

Italy - Code 1, Switzerland - Code 2, Egypt - Code 3, Indonesia - Code 4, Maldives - Code 5.

Managers express their preferences according to their individual tastes, which may include factors such as, existence of mountains, a seaside, natural landscape, forests or historical and archaeological significance etc. Assuming these preferences are quantifiable, their preference ranks along with location codes are presented below (first and fifth rows indicate the highest and lowest preferences respectively) :

Manager 1	Manager 2	Manager 3	Manager 4	Manager 5
2	2	3	2	1
3	4	1	5	2
4	5	4	4	4
	1	5	3	
		2		

Some managers do not prefer all five locations as they either visited the same earlier or have some health issue for such place. Assign international destinations for the trip to each manager in a way so that their preferences in ranking can be maintained at the maximum level. (2+2+1)+5

Module - II

5. (a) Machine A costs ₹ 55,000 and operating costs are estimated as ₹ 1,000 for the first year, increasing by ₹ 10,000 per year in the second and subsequent years. Machine B costs ₹ 60,000 and operating cost are ₹ 2,000 for the first year; increasing by ₹ 4,000 in the second and subsequent years. If we now have a machine of type A, should we replace it with B? If so when? Assume that both machines have no resale value and their future costs are not discounted.

(b) A railway ticket counter operates with the following parameters :

- Arrival process : Poisson, at an average rate of 18 customers per hour
- Service process : Exponential, with a mean service time of 2.5 minutes per customer

- Costs :
  - Waiting cost in queue : ₹ 30 per customer per hour.
  - Service Counter operating cost : ₹ 150 per hour.

(i) What is the probability that the system is idle?

(ii) What is the average number of customers in the system?

(iii) What is the average time a customer spends in the system?

(iv) If the service rate is increased to 30 customers per hour by hiring a faster clerk at ₹ 250 per hour, should the change be made? 5+(1+1+1+2)

6. (a) Product manager has planned a list of activities culminating in the inaugurate launch of the new products. These are given in the table below :

Activity	PERT 3 time estimates days			Immediate Predecessor(s)
	Pessimistic	Most likely	Optimistic	
a	20	10	5	–
b	12	7	5	–
c	12	10	8	a
d	40	20	6	c
e	90	60	30	d
f	14	10	7	d
g	50	30	20	c
h	12	10	8	e, f, g
i	6	4	3	b
j	1	1	1	h, i

As a consultant, you are required to find :

(i) The critical path from the PERT network.

(ii) The non-critical activities.

(iii) The expected product launches completion time and its variance.

(iv) What is the probability that product manager will be able to complete the product launch within 80 days-time?

given z	0.35	1.645	2.33	2.77
area	0.1293	0.4495	0.4901	0.4972

(b) A manufacturing company processes seven jobs, each of which must pass through 3 machines A, B, C in the order ABC. Processing times (in hours) are given in the following table :

Jobs / Machines	J1	J2	J3	J4	J5	J6	J7
A	6	16	14	8	18	16	14
B	8	6	4	10	2	8	6
C	12	14	12	22	10	12	24

Find an order in which these seven items are to be processed so as to minimize the time taken to process all the jobs through all the stages. Find also the total elapsed time for the optimal sequences and idle time for machines. (2+1+2+1)+(2+2)

7. (a) A component manufacturing company has a product for which the assumptions of the inventory model with backorders are valid. Information obtained by the company is as follows :

Annual demand : 20,000 units

Inventory carrying charges : 20 percent per annum

Unit cost : ₹ 50

Ordering cost : ₹ 250 per order

Backorder cost : ₹ 30 per unit per year

Calculate :

(i) Economic Order Quantity

(ii) Maximum stock level

(iii) Optimum quantity to be backordered

(iv) Total relevant costs (with backorder)

(v) If the company decides to prohibit backorders and adopts the regular EOQ model, what effect will it have on total relevant cost?

(b) A large computer has 1,000 identical components which are subject to random failure over time. The failure pattern is given as follows :

Month End :	1	2	3	4	5	6
Failure :	3%	7%	20%	40%	15%	15%

Cost of individual replacement is ₹ 10 per unit. The Group replacement cost is ₹ 4 per unit. Find the optimal group replacement plan. (1+1+1+1+1)+5

8. (a)

Activity	Preceding Activity	Duration (weeks)
A	—	5
B	A	2
C	A	6
D	B	12
E	D	10
F	D	9
G	D	5
H	B	9
I	C, E	1
J	G	2
K	F, I, J	3
L	K	9
M	H, G	7
N	M	8

(i) Draw a network diagram for this project.

(ii) Find the various paths and the critical path.

(iii) Find out the total float, free float, independent float.

(b) Determine a decision rule using the basic purchasing EOQ model for an annual demand of 20,000 units, ordering cost of ₹ 200 per order and carrying cost of 10% per year. The basic price is ₹ 8.00 per unit. The price is in effect of all orders of less than 5,000 units. Orders for 5,000 or more but less than 10,000 units may be purchased for ₹ 7.50 per unit. Orders for 10,000 or more units may be purchased for ₹ 7.25 per unit. (2+1+2)+5
