

QUESTION 1: (20 MARKS)

Petopia Ltd produces two types of dog treats; namely Camilove and Camilove Plus, which are sold on the Mauritian market in 100 gram sachet. Three types of vitamins (V_1 , V_2 and V_3) are used to produce these two dog food. Camilove requires 12, 4, and 2 grams respectively of the three types of vitamins. Camilove Plus requires 6, 10 and 3 grams respectively of the three types of vitamins. The total available vitamins in kilograms respectively is 6, 4, and 1.8. Camilove generate a profit of Rs 40 and Camilove Plus Rs100.

- (a) Summarize this information in the form of a table. (1 mark)
- (b) Formulate the problem of finding the quantities of each type of dog treats to be produced for maximum profit of Petopia Ltd as a linear programming problem. Take care in your answer to define the decision variables and to explain briefly how the objective function and the constraints are derived. (3 marks)
- (c) Solve the linear programming problem obtained in (b) graphically. Shade the feasible region with a pencil. Hence find the optimal solution for this problem and the maximum profit for Petopia Ltd. (8 marks)
- (d) Determine whether there are any unused resources at the optimal solutions, and by how much. (4 marks)
- (e) Suppose Petopia Ltd has to produce at most 200 sachets of Camilove to meet suppliers demand.
 - (i) What additional constraint must be added to the problem formulated in (b) to model this new problem? (1 mark)
 - (ii) Add the new constraint to the diagram and find the revised optimal solution. (3 marks)

QUESTION 2: (20 MARKS)

MJ Couture Ltd has four factories situated at different locations in Mauritius, all producing the same type of clothing which are sold at Rs 30 per unit. As the factories are of different size, the manufacturing cost and production capacities vary. The cost and capacities at the different locations are as follows:

Table 1: Production Cost and Production Capacity of different locations

	Factory			
	Town W	Town X	Town Y	Town Z
Production cost per unit (Rs.)	19	18	16	14
Monthly production capacity	150	250	100	70

MJ Couture Ltd supply its manufactured clothing to five shops on a monthly basis with different demands and transportation cost.

Table 2: Transportation cost per unit and demand of shops

Factory	Shop				
	A	B	C	D	E
Town W	5	7	1	10	2
Town X	8	9	5	5	3
Town Y	4	6	2	1	7
Town Z	1	5	6	7	8
Demand	100	200	120	80	70

- (i) Is this a balanced or an unbalanced transportation problem? Explain.
(1 mark)
- (ii) Develop a linear programming model for this transportation model to *maximize profit* of MJ Couture.
(9 marks)
- (iii) Use Vogel's Approximation Method to find an initial basic feasible solution for this *maximization transportation problem*.
(8 marks)
- (iv) Does the solution obtained in (iii) satisfy the conditions to be non-degenerate? Explain.
(2 marks)
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QUESTION 3: (20 MARKS)

(a) Life Label Ltd is a printing company specialized in label and sticker printing for the clothing and textile industries as well as for consumer goods. The management is planning to expand its business in another country and deciding whether to build a full size factory or a small factory that can be expanded later. A market research indicates that the probabilities of having a high and low demand over the next **10 years** are 0.75 and 0.25 respectively.

The management has listed the following alternatives for consideration:

1. The construction of a large factory that will cost Rs 5 million and continue the business for the next **ten** years.
2. The construction of a small factory that will cost Rs. 1 million. After two years, based on the demand, the management will decide to do any one of the following:
 - (i) On high demand: Expand the small factory with a cost of Rs 4.2 million, or the company may not expand the small factory with no additional investment.
 - (ii) On low demand: The company will not expand the small plant for the next **eight** years with no additional investment and continue its operation.

Estimates of annual income for each of the alternatives are given as follows:

- Full size factory and high demand will yield Rs. 1,000,000 annually.
- Full size factory and low demand will yield Rs. 300,000 annually.
- Small factory and low demand will yield Rs. 200,000 annually.
- Small factory and high demand will yield Rs. 250,000 annually.
- Expanded small factory with high demand will yield Rs. 900,000 annually.
- Expanded small factory with low demand will yield Rs. 200,000 annually.

(i) Draw a decision tree indicating the annual income for each possible outcome.
(5 marks)

(ii) Using the decision tree in (i), calculate the expected income for each alternative. You are required to state and justify clearly the decision you take at each decision node if any.
(5 marks)

(b) A project consists of 8 activities named A to H. The activity completion times in days and the precedence relationships are as follows:

Activity	Completion Time (days)	Immediate Predecessor Activities
A	3	-
B	6	A
C	7	A
D	5	A
E	13	B, C
F	8	C, D
G	11	D, F
H	6	G, E

(i) Draw a network diagram to represent this project, introducing dummy activity or activities where necessary.
(3 marks)

(ii) Calculate the earliest possible time and latest possible time for each activity in this project, entering these times in the appropriate boxes on your diagram. Hence find the minimum overall project completion time and identify which activities are critical.
(4 marks)

(iii) How is the project completion time affected if activity G is finished 7 days early?
(2 marks)