

Q2 (a) Write the dual of the following LPP-

$$\text{minimise } z = 10x_1 + 20x_2$$

subject to

$$3x_1 + 2x_2 \geq 18$$

$$x_1 + 3x_2 \geq 8$$

$$2x_1 - x_2 \leq 6$$

$$x_1, x_2 \geq 0$$

Answer

Primal

$$\text{minimise } z = 10x_1 + 20x_2$$

subject to

$$3x_1 + 2x_2 \geq 18$$

$$x_1 + 3x_2 \geq 8$$

$$-2x_1 + x_2 \geq -6$$

$$x_1, x_2 \geq 0$$

Dual

$$\text{maximise } G = 18y_1 + 8y_2 - 6y_3$$

subject to

$$3y_1 + y_2 - 2y_3 \leq 10$$

$$2y_1 + 3y_2 + y_3 \leq 20$$

$$y_1, y_2, y_3 \geq 0$$

Q2 (b) Solve the following LPP using simplex method

Subject to

$$2x_1 + x_2 \leq 18$$

$$3x_1 + 2x_2 \geq 30$$

$$x_1 + 2x_2 = 26$$

$$x_1, x_2 \geq 0$$

Answer

(3)

Simplex Method

After introducing the necessary slack, surplus and artificial variables, the augmented problem is given by —

$$\max. Z = 2x_1 + 4x_2 + 0s_1 + 0s_2 - MA_1 - MA_2$$

Subject to

$$2x_1 + x_2 + s_1 = 18$$

$$3x_1 + 2x_2 - s_2 + A_1 = 30$$

$$x_1 + 2x_2 + A_2 = 26$$

$$x_1, x_2, s_1, s_2, A_1, A_2 \geq 0$$

Simplex table

Basis	$x_1$	$x_2$	$s_1$	$s_2$	$A_1$	$A_2$	$b_i$	$b/a_{ij}$
$s_1$ 0	2	1	1	0	0	0	18	18
$A_1$ -M	3	2	0	-1	1	0	30	15
$A_2$ -M	1	2*	0	0	0	1	26	13 ←
$C_j$	2	4	0	0	-M	-M		
Solution	0	0	18	0	30	26		
$\Delta_j$	4M+2	4M+4	0	-M	0	0		

↑

Simplex table 2

Basis	$x_1$	$x_2$	$s_1$	$s_2$	$A_1$	$A_2$	$b_i$	$b_i/a_{ij}$
$s_1$ 0	3/2	0	1	0	0	-1/2	5	10/3
$A_1$ -M	2*	0	0	-1	1	-1	4	2 ←
$x_2$ 4	1/2	1	0	0	0	1/2	13	26
$c_j$	2	4	0	0	-M	-M		
Solution	0	13	5	0	4	0		
$\Delta_j$	2M	0	0	-M	0	-2-2M		

Simplex table 3

Basis	$x_1$	$x_2$	$s_1$	$s_2$	$A_1$	$A_2$	$b_i$
$s_1$ 0	0	0	1	3/4	-3/4	1/4	2
$x_1$ 2	1	0	0	-1/2	1/2	-1/2	2
$x_2$ 4	0	1	0	1/4	-1/4	3/4	12
$c_j$	2	4	0	0	-M	-M	
Solution	2	12	2	0	0	0	
$\Delta_j$	0	0	0	0	-M	-M-2	

The optimal solution to the problem is  
 $x_1 = 2$  and  $x_2 = 12$   
 the objective function value is  
 $Z = 2 \times 2 + 4 \times 12 = 52$  Ans.

**Q3 (a) Solve the linear programming problem by Graphical method**

maximise  $z = 3x_1 + 5x_2$

Subject to :

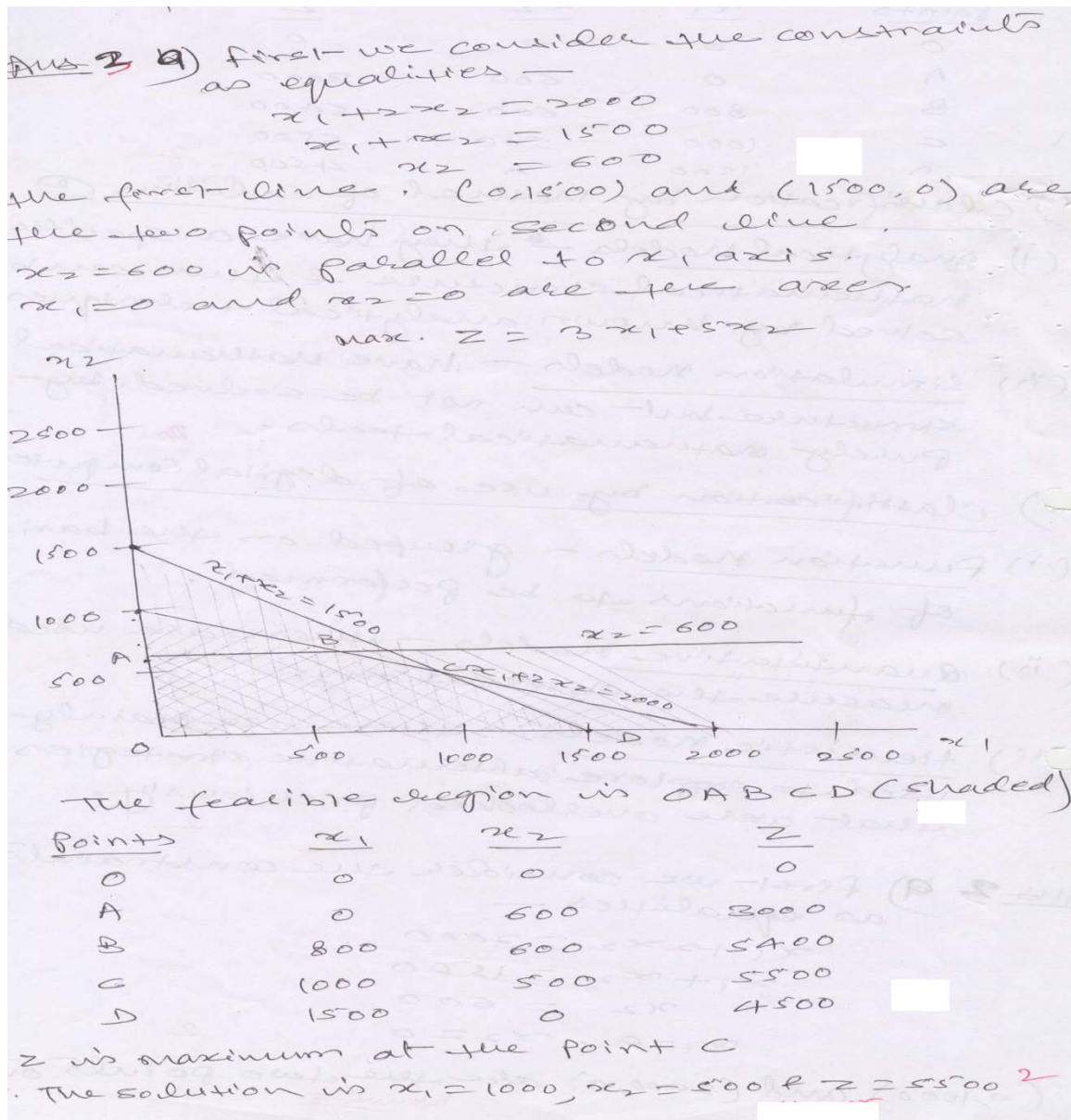
$x_1 + 2x_2 \leq 2000$

$x_1 + x_2 \leq 1500$

$x_2 \leq 600$

$x_1 \geq 0, x_2 \geq 0$

**Answer**





Q3 (b) Model building is the essence of the "O.R. approach", Discuss.

Answer

(1)

Ans 2 b) A model in OR is defined as a representation of an actual object or situation. It shows the relationship and inter-relationship of action and reaction in terms of cause and effect.

Since a model is an abstraction of reality, it thus appears to be less complete than reality itself. For a model to be complete, it must be a representative of those aspects of reality that are being investigated. The main objective of a model is to provide means for analysing the behaviour of the system for the purpose of improving its performance.

Models can be classified according to the following characteristics —

1) Classification by structure —

(i) Iconic Models — represent the system as it is by scaling it up or down.

(ii) Analogue Models — in which one set of properties is used to represent another set of properties.

(iii) Symbolic Models — is one which employs a set of mathematical symbols to represent the decision variables.

## 2) Classification by Purpose -

- (i) Descriptive Models - It describes some aspects of situation based on observations, survey, questionnaire results etc.
- (ii) Predictive Models - they can make predictions regarding certain events.
- (iv) Prescriptive Models - when a predictive model has been repeatedly successful, it can be used to prescribe a source of action.

## 3) Classification by Nature of Environment

- (i) Deterministic Models - it assume conditions of complete certainty & perfect knowledge.
- (ii) Probabilistic Models - these models usually handle such situations in which the consequences or payoff of managerial actions can not be predicted with certainty.

## 4) Classification by Behaviour -

- (i) Static Models - they do not consider the impact of changes that take place during the planning horizon.
- (ii) Dynamic Models - time is considered as one of the important variables.



c) Classification by Method of Solution <sup>11/3/10</sup> ②

- (i) Analytical Models - they have a specific mathematical structure & thus can be solved by known analytical techniques.
- (ii) Simulation Models - have mathematical structure but - can not be solved by purely mathematical tools.

d) Classification by use of digital computers

- (i) Function Models - grouped on the basis of functions to be performed.
- (ii) Quantitative Models - these are used to measure the observations.
- (iii) Heuristic Models - these are mainly used to explore alternative strategies that were overlooked previously.

Q4 (a) A Project has the following time schedule

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Activity:	1-2	1-3	1-4	2-5	3-6	3-7	4-6	5-8	6-9	7-8
Time in	2	2	1	4	8	5	3	1	5	4
Month:										

Activity 8-9

Time in 3

Months

---

Construct network diagram and compute

- (i) Total float for each activity
- (ii) Critical path and its duration

Answer



Ans. ) 4 a)

Network Diagram is

```

    graph LR
      1((1)) -- 2 --> 2((2))
      1 -- 2 --> 3((3))
      1 -- 1 --> 4((4))
      2 -- 4 --> 5((5))
      3 -- 5 --> 7((7))
      3 -- 8 --> 6((6))
      4 -- 3 --> 6((6))
      5 -- 1 --> 8((8))
      7 -- 4 --> 8((8))
      6 -- 5 --> 9((9))
      8 -- 3 --> 9((9))
    
```

Calculation of  $T_L$  and  $T_E$  Value for all events

i-j	Time	Earliest start	Earliest finish	Latest start	Latest finish	Total float
1-2	2	0	2	5	7	5
1-3	2	0	2	0	2	0
1-4	1	0	1	6	7	6
2-5	4	2	6	7	11	5
3-6	8	2	10	2	10	0
3-7	5	2	7	3	8	1
4-6	3	1	4	7	10	6
5-8	1	6	7	11	12	5
6-9	5	10	15	10	15	0
7-8	4	7	11	8	12	1
8-9	3	11	14	12	15	1
critical path is 1 → 3 → 6 → 9						
Duration 2 + 8 + 5 = 15 months.						

Q4 (b) Distinguish between PERT and CPM techniques.

Answer

Qus 4b)

PERT — There is high degree of uncertainty pertaining to completion time of certain activities. In such cases we can take probabilistic approach for each activity and define optimistic, most likely and pessimistic time estimates. Thus PERT is probabilistic tool that makes use of three estimates for completion of activities.

CPM — on the other hand CPM is a deterministic tool taking only a single estimate of time for completion of any activity in a project. It also allows for estimates of costs thereby being a tool that can control both time as well as costs.

**Q5 (a) Solve the following minimal assignment problem.**

		1	2	3	4
	I	12	30	21	15
J	II	18	33	9	31
o					
b	III	44	25	24	21
	IV	23	30	28	14

Answer

Ans: 5a)

Table 1

	1	2	3	4
I	0	18	9	3
II	9	24	0	22
III	23	4	3	0
IV	9	16	14	0

Table 2

	1	2	3	4
I	0	14	9	3
II	9	20	0	22
III	23	0	3	0
IV	9	12	14	0

Table 3

	1	2	3	4
I	0	14	9	3
II	9	20	0	22
III	23	0	3	<del>0</del>
IV	9	12	14	0

Job man

	I	II	III	IV
man	1	3	2	4

Ans



**Q5 (b) Find the initial solution for the transportation problem by Vogel's approximation method (VAM)**

To

		W1	W2	W3	Supply
From	F1	2	7	4	5
	F2	3	3	1	8
	F3	5	4	7	7
	F4	1	6	2	4
Demand		7	9	18	

Answer

Ans. ~~4) b)~~ 5b) VAM Table I

To

	W1	W2	W3	Supply	Difference
F1	<del>5</del>	<del>7</del>	<del>4</del>	5	(2) ←
F2	3	3	1	8	(2)
F3	5	4	7	7	(1)
F4	1	6	2	14	(1)
Demand	9	9	18		
Difference	(1)	(1)	(1)		

From

Table II

	W1	W2	W3	Supply	Diff.
F2	<del>3</del>	<del>3</del>	<del>1</del>	8	(2) ←
F3	5	4	7	7	(1)
F4	1	6	2	14	(1)
Demand	2	9	18	10	
Diff.	(2)	(1)	(1)		

Table III

	<del>w<sub>2</sub></del>	<del>w<sub>3</sub></del>		w <sub>1</sub>	w <sub>2</sub>	w <sub>3</sub>	Supply	Diff.
F <sub>1</sub>	<del>7</del>	<del>4</del>		5	4	<del>7</del>	7	(1)
F <sub>3</sub>	<del>4</del>	<del>7</del>				<del>10</del>	14	(1)
F <sub>4</sub>	<del>6</del>	<del>2</del>		1	6	<del>2</del>		
			Demand	2	9	10		
			Diff.	(4)	(2)	(5)		↑

Table IV

	w <sub>1</sub>	w <sub>2</sub>	Supply	Diff.
F <sub>3</sub>	<del>5</del>	4	7	(1)
F <sub>4</sub>	<del>2</del>	6	4	(5) ←
			Demand	2 9
			Diff.	(4) (2)

Table V

	w <sub>2</sub>	Supply
F <sub>3</sub>	<del>7</del>	4
F <sub>4</sub>	<del>2</del>	6
		Demand 9

Thus the solution is

	w <sub>1</sub>	w <sub>2</sub>	w <sub>3</sub>	
F <sub>1</sub>	<del>5</del> 2	7	4	5
F <sub>2</sub>	3	3	<del>8</del> 1	8
F <sub>3</sub>	5	<del>7</del> 4	7	7
F <sub>4</sub>	<del>2</del> 1	<del>2</del> 6	<del>10</del> 2	14
				7 9 18



Q6 (a) What do you understand by queue? Give some important applications of queuing theory?

Answer

Ans = <sup>64</sup> Queue

A group of items waiting to receive service and receiving service is known as waiting line or a queue. A queue is formed when the demand for a service exceeds the capacity to provide that service. Customers wait for service. The time thus lost by them is expensive. The costs associated with waiting in line are known as waiting time costs. Similarly if there are no queues, service stations will be idle. Cost associated with service or the facility are known as service cost. The object of queuing theory is to achieve an economic balance between these two types of costs.

Applications of Queuing Theory

The study of queuing theory is mainly applied in the following fields —

- 1) Business — queues formed in front of banks, supermarket, booking offices etc.
- 2) Industries — In servicing of machines, storage etc.
- 3) Engineering — Telephony, electronic, computers etc.
- 4) Transportation — In postal services, airports, harbours, railways etc.
- 5) Other fields — queues before cinema ticket window, barber shop, restaurants etc.

Q6 (b) What do you mean by-

- (i) Two person zero sum game
- (ii) Saddle point
- (iii) Pure and mixed strategies

Answer

Q6 (b) (6b)

Two Person zero Sum Game —

It is the simplest of game models. There will be two persons in the conflict and the sum of pay off of both together is zero. That is the gain of one is at the expense of the other. That is, in a zero sum game the amounts won by all winners is equal to the sum of the amounts lost by all losers.

eg. Let X and Y be two sheep owners. If X is able to attract two customers of Y by some advertisement, then Y loses two customers. So the sum of the payoffs

$$= 2 + (-2) = 0$$

Saddle Point — Saddle point is a position of such an element in the pay off matrix which is the minimum in its row and maximum in its column. Saddle point is the value of the game. If there are more than one saddle point, there will be more than one solution. A game for which,  $\text{Maximin for A} = \text{minimax for B}$ , is called a game with saddle point.



(ii)  
Pure strategy — A pure strategy is a decision (in advance of all players), always to choose a particular course of action.

Mixed strategy — A player is said to adopt mixed strategy when he does not adopt a single strategy all the time but would play different strategies each at a certain time. A mixed strategy is a decision (in advance of all plays) to choose a course of action for each play in accordance with some particular probability distribution. That is, if a player decides in advance to use all or some of his available course of action in some fixed proportion, he is said to use mixed strategy.

**Q7 (a) What are the different functions of management and what are the importance of these functions at various levels of management?**



Answer

PART B (8)

Ans 7(a)

Principal functions of management

These are four basic principal functions of management —

1) Planning — It is the function that determine in advance "what should be done." It is looking ahead and preparing for the future. In other words, it is the determination of what is to be done, how and where it is to be done, who is to do it and how results are to be evaluated.

2) Organising — To organise business is to provide it with everything useful to its functioning:— personnel, raw materials, tools, Capital. All this may be divided into two main sections — the human organisation and the material organisation. Once managers have established objectives and developed plans to achieve them, they must design and develop a human organisation that will

be able to carry out these plans successfully.

3) Directing — After plans have been made and the organisation has been established, the next step is to move towards its defined objectives. Directing involves three sub-functions — Communication, leadership and motivation.

4) Controlling — The manager must ensure that everything occurs in conformity with the plans adopted, the instructions issued and the principles established. Controlling involves three elements —

a) Establishing standards of performance.

b) Measuring and comparing the current performance.

c) Taking corrective actions.

These functions have different level of importance at various levels of management — top, middle and lower levels.

Plans made by top management for the organisation as a whole may cover periods as long as five or ten years. Plans made by middle or first line managers, cover much



shorter periods. Such plans may be for the next day's work. 113/10 (1)

Though all the management functions are carried out at all levels of management but planning is basically done at the top level. Organising is the function which is primarily carried out at top and middle levels of management and directing and controlling are the functions which are jointly carried out by middle and lower levels of management.

**Q7 (b) What is the organisation structure and how the organisation charts are helpful to provide a broad picture of positions of authorities and their relationships in the organisation structure.**



**Answer**

Ans 7(b) The usual way of depicting a formal organisation is by means of an organisation chart. It is a snapshot of an organisation at a particular point in time which shows the flow of authority, responsibility & communication among various departments which are located at different levels of the hierarchy. The connecting lines on this chart show who is accountable to whom and who is in charge of what department. There are three principal forms of organisation charts viz,

vertical, horizontal and circular. A vertical organisation chart reads from top to bottom. The horizontal organisation chart reads from left to right. It shows the chief executive at the left and all other successive levels of management horizontally rightwards. A circular organisation chart shows the position of the chief executive in the centre of various concentric circles of different radii, on which all other successive levels of management are shown. Following are the advantages of having an organisation chart —

- 1) It acquaints everybody with the make-up of a company such as its size, basis of division of activities, coordination etc.
- 2) It reveals whether or not the span of management is wide or narrow.
- 3) It reveals many of the deficiencies in the organisation structure such as one man might be reporting to two persons.
- 4) It reveals whether the organisation is evenly balanced.

**Q8 (a) Explain the various techniques of business forecasting.**



Answer

(10)

Qus 8(a) Business Forecasting

Forecasting is a technique of anticipating future problems and events. It involves making a detailed analysis of the past and present to get an idea about probable events in the future.

There are essentially three types of forecasting techniques —

1) Qualitative and Judgemental methods —

The forecasting methods involve the use of subjective judgements and are appropriate in situations where essential data are not available. For instance, when a new product or technology is introduced, past experience is not available for estimating what the near-term effects will be. Jury of executive opinion, sales force composite and survey methods are very commonly used qualitative methods of forecasting.

2) Methods based upon past results —

In many situations, where the past has



been more or less, consistent and the future is expected to conform to the past, an efficient way to make a forecast is to extrapolate from past experience. Thus, if we want to forecast sales, we may draw a graph of the past sales and project the same into the future and then adjust it for any changes that are expected to occur.

### 3) Methods Based upon Mathematical Models

In some situations, it may be possible to develop mathematical models showing the relationships between the dependent factors and independent factors. Thus, we can say that the sale of cars is dependent upon personal income and consumer confidence.

**Q8 (b) Explain the process of decision making.**

**Answer**

Q8 (b) Decision making  
 Decision making is a key part of manager's activities. It permeates through all managerial functions such as planning, organisation, direction and control.  
 Following are the steps involved in the process of decision making —

1. Recognising the problem.
2. Deciding priorities among problems.
3. Diagnosing the problem.
4. Developing alternative solutions or course of action.
5. Measuring and comparing the consequences of alternative solutions.
6. Converting the decision into effective action and follow-up of action.

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graph LR
    A["Recognising Problems  
Deciding priorities"] --> B["Diagnosing the problem"]
    B --> C["Developing Alternative Solutions"]
    C --> D["Measuring & Comparing Consequences"]
    D --> E["Decision Implementation & follow up"]
    E --> A
    
```

\* students should give some detailing of the above points.

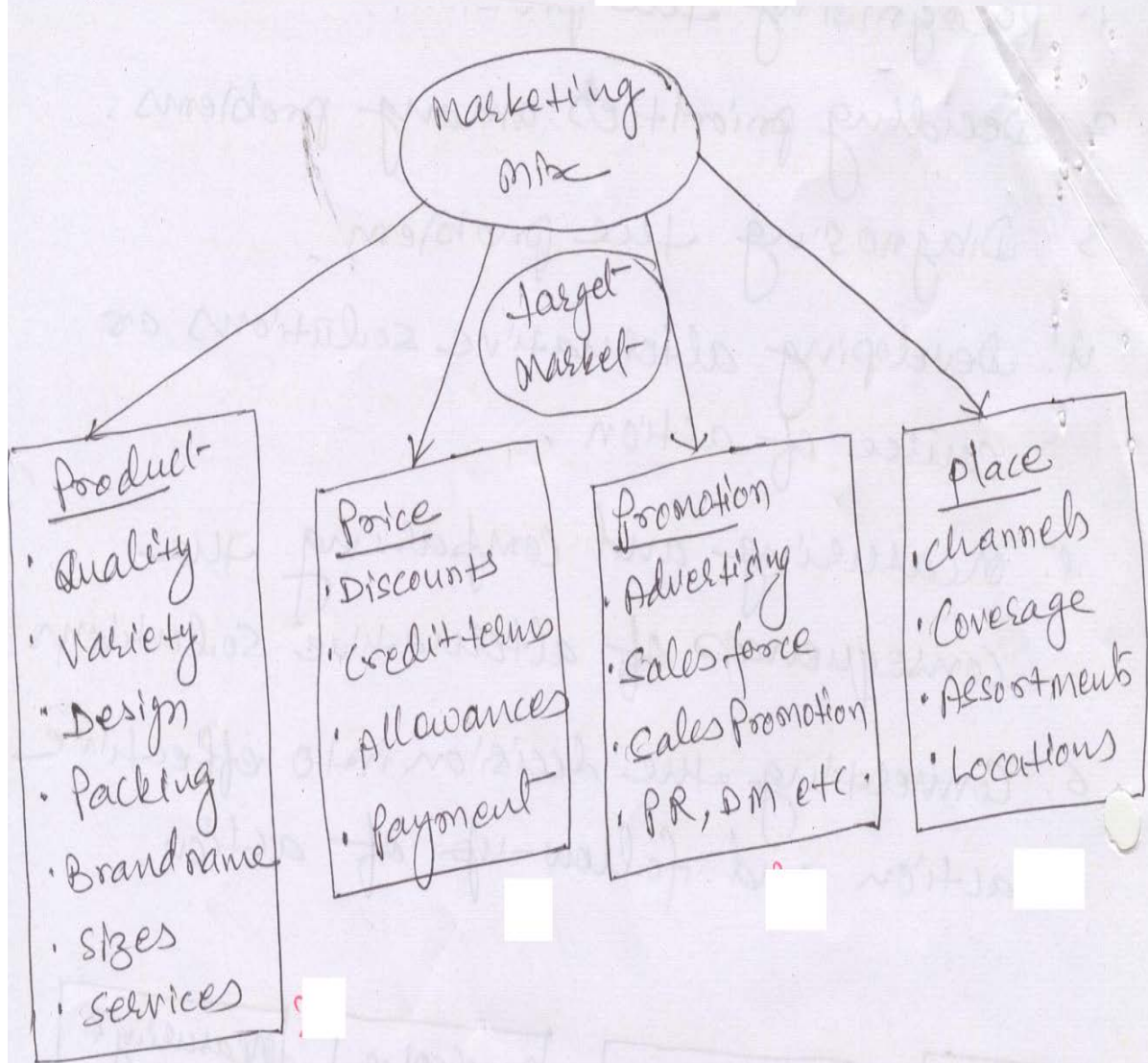
**Q9 (a) What do you understand by marketing mix?**



Answer

Ans. q (a) . Elements of marketing mix

marketing mix consisting of four Ps —  
Product, Price, place and promotion.



\* students should give some brief description of product, price, promotion & place,



Q9 (b) Define leadership and explain leadership characteristics.

Answer

Ans 9(b) Leadership -

According to Peter Drucker, "Leadership is the lifting of man's visions to higher sights, the raising of man's performance to a higher standard, the building of man's personality beyond its normal limitations"

Leadership characteristics -

Some important characteristics of leadership are as follows -

- 1) Leadership implies the existence of followers - We appraise the quality of person's leadership in practice by studying his followers. Leaders within the organisation are also followers.
- 2) Leadership involves a community of interest between the leader and his followers - The objective of both the leader and his men are one and the same. If the leader strives for one purpose and his team of workers for some other purpose, it is no leadership.
- 3) Leadership involves an unequal distribution of authority among leaders and group members - Leaders can direct some of the activities of group members i.e. the group members are compelled or are willing to obey most of the leader's directions.

f) Leadership implies that leaders can influence their followers or subordinates in addition to being able to give their followers legitimate directions.  
Leaders not only tell their subordinate what to do by way of command but also influence by their behaviours and conduct.

#### Text Books

1. Operations Research, An Introduction, Hamdy A. Taha, 8<sup>th</sup> Edition, PHI, 2007.
2. Engineering Management, Fraidon Mazda, Low price Indian Edition, Addison-Wesley.