Q2 (a) For solving linear programming problems what are the assumptions made? Explain.

Answer

Assumptions of Linear Programming

Certainty

In all LP models it is assumed that, all the model parameters such as availability of resources, profit (or cost) contribution of a unit of decision variable and consumption of resources by a unit of decision variable must be known and constant.

Divisibility (Continuity)

The solution values of decision variables and resources are assumed to have either whole numbers (integers) or mixed numbers (integer or fractional). However, if only integer variables are desired, then Integer programming method may be employed.

Additivity

The value of the objective function for the given value of decision variables and the total sum of resources used, must be equal to the sum of the contributions (Profit or Cost) earned from each decision variable and sum of the resources used by each decision variable respectively. /The objective function is the direct sum of the individual contributions of the different variables

Linearity

All relationships in the LP model (i.e. in both objective function and constraints) must be linear.

Q2 (b) The objective function of a LPP is given by $Z = 10X_1 + 8X_2$. This objective function is required to be dealt as maximization problem with following constraints:

$$2X_1 + X_2 \leq 20$$
$$X_1 + 3X_2 \leq 30$$
$$X_1 - 2X_2 \geq -15$$
$$X_1, X_2 \geq 0$$

Solve this LPP using graphical method.

Answer

The first constraint $2X1 + X2 \leq 20$ can be represented as follows.

We set $2X1 + X2 = 20$

When $X1 = 0$ in the above constraint, we get,

$2 \times 0 + X2 = 20$

$X2 = 20$

Similarly when $X2 = 0$ in the above constraint, we get,

$2X1 + 0 = 20$

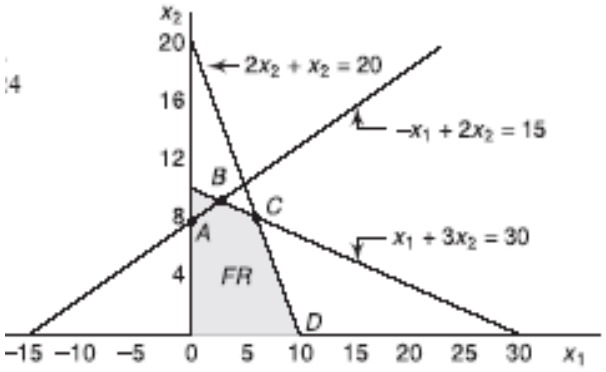
$X1 = 20/2 = 10$

The second constraint $X1 + 3X2 \leq 30$ can be represented as follows,

We set $X1 + 3X2 = 30$

When $X1 = 0$ in the above constraint, we get,

0 + 3X2 = 30
X2 = 30/3 = 10
Similarly when X2 = 0 in the above constraint, we get,
X1 + 3 x 0 = 30
X1 = 30
The third constraint X1 - 2X2 ≥ -15 can be represented as follows,
We set X1 - 2X2 = -15
When X1 = 0 in the above constraint, we get,
0 - 2X2 = -15
X2 = -15/2 = 7.5
Similarly when X2 = 0 in the above constraint, we get,
X1 – 2 x 0 = -15
X1 = -15



Point	X1	X2	Z = 10X1 + 8X2
0	0	0	0
A	0	7.5	Z = 10 x 0 + 8 x 7.5 = 60
B	3	9	Z = 10 x 3 + 8 x 9 = 102
C	6	8	Z = 10 x 6 + 8 x 8 = 124* Minimum
D	10	0	Z = 10 x 10 + 8 x 0 = 100

The Maximum profit is at point C
When X1 = 6 and X2 = 8
Z = 124

Q3 (a) When the dual simplex method is preferred for solving LPP? Explain the approach through which LPP can be solved using dual simplex method

Answer

Any LPP for which it is possible to find infeasible but better than optimal initial basic solution can be solved by using dual simplex method. Such a situation can be recognized by first expressing the constraints in '≤' form and the objective function in the maximization form. After adding slack variables, if any right hand side element is

negative and the optimality condition is satisfied then the problem can be solved by dual simplex method.

Negative element on the right hand side suggests that the corresponding slack variable is negative. This means that the problem starts with optimal but infeasible basic solution and we proceed towards its feasibility.

The dual simplex method is similar to the standard simplex method except that in the latter the starting initial basic solution is feasible but not optimum while in the former it is infeasible but optimum or better than optimum. The dual simplex method works towards feasibility while simplex method works towards optimality.

Q3 (b) Using Simplex Method, solve the following linear programming problem :

Maximize $Z = 10 X_1 + 15 X_2 + 20 X_3$

Subject to
$2 X_1 + 4 X_2 + 6 X_3 \leq 24$
$3 X_1 + 9 X_2 + 6 X_3 \leq 30$
$X_1, X_2, X_3 \geq 0$

Answer

The standard form of this problem is,

Maximize $Z = 10 X_1 + 15 X_2 + 20 X_3$

Subject to
$2 X_1 + 4 X_2 + 6 X_3 + S_1 = 24$
$3 X_1 + 9 X_2 + 6 X_3 + S_2 = 30$
$X_1, X_2, X_3, S1, S_2 \geq 0$

Where S_1, S_2 are slack variables.

Thus,

Maximize $Z = 10 X_1 + 15 X_2 + 20 X_3 + 0 S_1 + 0 S_2$

Subject to
$2 X_1 + 4 X_2 + 6 X_3 + S_1 = 24$
$3 X_1 + 9 X_2 + 6 X_3 + S_2 = 30$
$X_1, X_2, X_3, S1, S_2 \geq 0$

Initial Simple table:

CB_i	C_j	10	15	20	0	0	Solution	Ratio
	Basic Variable	X_1	X_2	X_3	S_1	S_2		
0	S_1	2	4	$\underline{6}$	1	0	24	4**
0	S_2	3	9	6	0	1	30	5
	Z_j	0	0	0	0	0	0	
	$C_j - Z_j$	10	15	20*	0	0		

All the vales of $C_j - Z_j$ are not less than or equal to zero, hence the initial solution is not optimum.

Here X_3 is the entering variable and S_1 is the leaving variable. Note in this case key element is $\underline{6}$

The next iteration is shown below:

Iteration 1

CB_i	C_j	10	15	20	0	0	Solution	Ratio
20	X_3	1/3	2/3	1	1/6	0	4	12
0	S_2	*1*	5	0	-1	1	6	6**
	Z_j	20/3	40/3	20	10/3	0	80	
	$C_j - Z_j$	10/3*	5/3	0	-10/3	0		

All the vales of $C_j - Z_j$ are not less than or equal to zero, hence the solution is not optimum.

Here X_1 is the entering variable and S_2 is the leaving variable. Note in this case key element is *1*

The next iteration is shown below:

Iteration 2

CB_i	C_j	10	15	20	0	0	Solution
	Basic Variable	X_1	X_2	X_3	S_1	S_2	
20	X_3	0	-1	1	1/2	-1/3	2
10	X_1	1	5	0	-1	1	6
	Z_j	10	30	20	0	10/3	100
	$C_j - Z_j$	0	-15	0	0	-10/3	

Since all the vales of $C_j - Z_j$ are less than or equal to zero, hence the solution is optimum.

Optimum Solution : $X_1 = 6, X_2 = 0, X_3 = 2$ and $Z_{optimum} = 100.$

Q4 (a) Explain the terms feasible solution and basic feasible solution while dealing with transportation problems

Answer

(i) Feasible solution:

A set of non-negative decision values x_{ij} (I = 1,2,3,….m; j = 1,2,3,….n) satisfies the constraint equations is called a ‘ Feasible solution’. A balanced transportation problem will always provide a feasible solution

(ii) Basic Feasible solution:

A feasible solution is said to be basic, if the number of positive allocations are m + n -1 (m-origin, n-destination). If the number of allocations are less than m + n – 1, it is called degenerate basic feasible solution

Q4 (b) ABC company has three warehouses from which it has to ship the goods to four retailers. The transportation cost (inRs.) per unit from each of the warehouse to retailer is shown in the table below as cell entries.

		Retailer				
		1	2	3	4	Supply
Warehouse	1	3	1	7	4	300
	2	2	6	5	9	400
	3	8	3	3	2	500
Demand		250	350	400	200	

Obtain the initial basic feasible solution for this transportation problem using the Vogel's Approximation Method

Answer

Vogel's Approximation Method

To start with row penalties and column penalties are calculated and shown with given problem

Given Problem with Penalties

		Retailer					
		1	2	3	4	Supply	Penalty
Warehouse	1	3	1	7	4	300	2
	2	[250] 2	6	5	9	~~400~~ 150	3*
	3	8	3	3	2	500	1
Demand		~~250~~ 0	350	400	200		
Penalty		1	2	2	2		

Demand at retailer 1 is satisfied and hence this column is deleted.

Result after deleting column 1

		Retailer				
		2	3	4	Supply	Penalty
Warehouse	1	[300] 1	7	4	~~300~~ 0	3*
	2	6	5	9	150	1
	3	3	3	2	500	1
Demand		~~350~~ 50	400	200		
Penalty		2	2	2		

Now Supply at warehouse 1 is satisfied and hence this row is deleted.

Result after deleting row 1

		Retailer				
		2	3	4	Supply	Penalty
Warehouse	2	6	5	9	150	1
	3	3	3	200 2	~~500~~ 300	1
Demand		50	400	~~200~~ 0		
Penalty		3	2	7*		

Demand at retailer 4 is satisfied and hence this column is deleted.

Result after deleting column 4

		Retailer			
		2	3	Supply	Penalty
Warehouse	2	6	5	150	1
	3	50 3	3	~~300~~ 250	0
Demand		~~50~~ 0	400		
Penalty		3*	2		

Demand at retailer 2 is satisfied and hence this column is deleted.

Result after deleting column 2

		Retailer		
		3	Supply	
Warehouse	2	150 5	~~150~~	0
	3	250 3	~~300~~	0
Demand		~~400~~ 0		

Since only one column is left out, the supplies of the warehouses 2 and 3 are matched with the demand of the retailer 3 as shown above.

The set of basic feasible solution by applying the Vogel's Approximation Method is shown below:

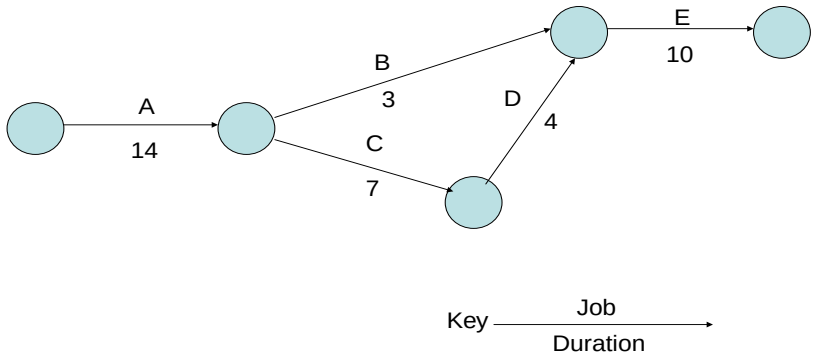
		Retailer				
		1	2	3	4	Supply
Warehouse	1	3	300 1	7	4	300
	2	250 2	6	150 5	9	400
	3	8	50 3	250 3	200 2	500
Demand		250	350	400	200	

The total cost of transportation is:
=1x300+2x250+5x150=3x50+3x250+2x200 = Rs.2850.

Q5 (a) Construct an arrow diagram for the following project

Job	Immediate predecessor	Duration
A	-	14 Days
B	A	3 Days
C	A	7 Days
D	C	4 Days
E	B,D	10 Days

Answer



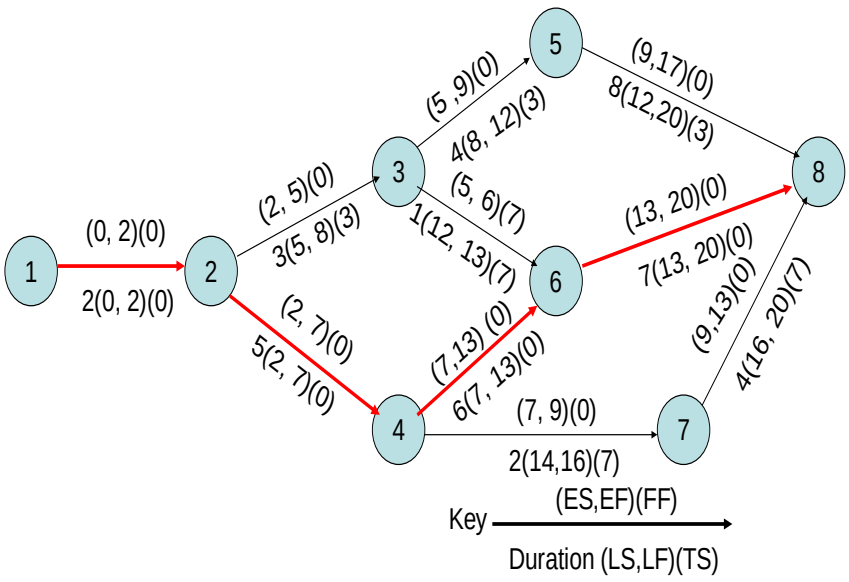
Q5 (b) Construct the Network for the following Project and determine the following

i) Critical Path
ii) ES, EF, LS, LF
iii) TF, FF

Activity	Duration
1-2	2
2-3	3
2-4	5
3-5	4
3-6	1
4-6	6
4-7	2
5-8	8
6-8	7
7-8	4

Answer

Construction of the network and determination of the critical path



Activity	Duration	ES	EF	LS	LF	TF	FF
1-2	2	0	2	0	2	0	0
2-3	3	2	5	2	8	3	0
2-4	5	2	7	5	7	0	0
3-5	4	5	9	8	12	3	0
3-6	1	5	6	12	13	7	7
4-6	6	7	13	7	13	0	0
4-7	2	7	9	14	16	7	0
5-8	8	9	17	12	20	3	0
6-8	7	13	20	13	20	0	0
7-8	4	9	13	16	20	7	0

Q6 (a) List the assumptions of Poisson-exponential single server model – infinite population

Answer

Assumptions:

- Arrivals are Poisson with a mean arrival rate of, say λ
- Service time is exponential, rate being μ
- Source population is infinite
- Customer service on first come first served basis
- Single service station

For the system to be workable, $\lambda \leq \mu$

Q6 (b) A repairman is to be hired to repair machines which breakdown at a n average rate of 6 per hour. The breakdowns follow Poisson distribution. The non-production time of a machine is considered to cost Rs. 20 per hour. Two repairmen Mr. X and Mr. Y have been interviewed for this purpose. Mr. X charges Rs.10 per hour and he service breakdown machines at the rate of 8 per hour. Mr. Y demands Rs.14 per hour and he services at an average of 12 per hour. Which repairman should be hired? (Assume 8 hours shift per day)

Answer

Given $\lambda = 6$ /hr

$\mu_x = 8$/hr

$\mu_y = 12$/hr

Given no of machine cost at idle = 20Rs/hr

No of machine in X $Ls_x = \lambda / \mu_x - \lambda$

$= 6/8-6$

$= 3$ machines

Total no of machines =3*8=24 machines
Total cost=hiring charges of x + cost of idle machine
=10*8 + 24*20
=Rs.560

No of machine in y $Ls_{y} = \lambda / \mu_{y} - \lambda$
=6/12-6
=1
Total no of machine = 1*8=8 machines
Total cost= hiring charges of y + cost of idle machine
= 14*8 + 20*8
= Rs.272
We chose Mr.Y since cost is lower than Mr. X

Q7 (a) Explain the concept of "Taylor's Scientific Management". List the various elements of Taylor's Scientific Management

Answer
Taylor's Scientific Management: Started as an apprentice machinist in Philadelphia, USA. He rose to be the chief engineer at the Midvale Engineering Works and later on served with the Bethlehem Works where he experimented with his ideas and made the contribution to the management theory for which he is so well known. Frederick Winslow Taylor well-known as the founder of scientific management was the first to recognize and emphasis the need for adopting a scientific approach to the task of managing an enterprise. He tried to diagnose the causes of low efficiency in industry and came to the conclusion that much of waste and inefficiency is due to the lack of order and system in the methods of management. He found that the management was usually ignorant of the amount of work that could be done by a worker in a day as also the best method of doing the job. As a result, it remained largely at the mercy of the workers who deliberately shirked work. He therefore, suggested that those responsible for management should adopt a scientific approach in their work, and make use of "scientific method" for achieving higher efficiency. The scientific method consists essentially of
(a) Observation
(b) Measurement
(c) Experimentation and
(d) Inference.
He advocated a thorough planning of the job by the management and emphasized the necessity of perfect understanding and co-operation between the management and the workers both for the enlargement of profits and the use of scientific investigation and knowledge in industrial work. He summed up his approach in these words:

- Science, not rule of thumb
- Harmony, not discord
- Co-operation, not individualism
- Maximum output, in place of restricted output
- The development of each man to his greatest efficiency and prosperity.

Elements of Scientific Management: The techniques which Taylor regarded as its essential elements or features may be classified as under:
1. Scientific Task and Rate-setting, work improvement, etc.
2. Planning the Task.
3. Vocational Selection and Training
4. Standardization (of working conditions, material equipment etc.)
5. Specialization
6. Mental Revolution.

Q7 (b) List the essential managerial functions of a Manager. Explain.

Answer

A manager is called upon to perform the following managerial functions:
(1) Planning
(2) Organizing
(3) Staffing
(4) Directing
(5) Motivating
(6) Controlling
(7) Coordinating
(8) Communicating

The following figure explains the functions of Manager.

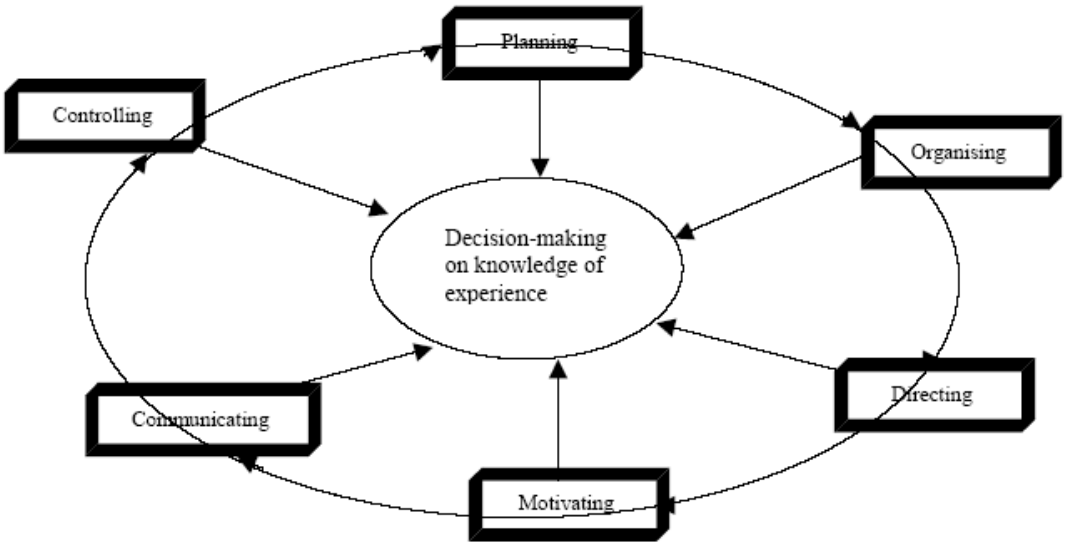


Figure: Functions of Manager

1. ***Planning:*** When management is reviewed as a process, planning is the first function performed by a manager. The work of a manager begins with the setting of objectives of the organisation and goals in each area of the business. This is done through planning. A plan is a predetermined course of action to accomplish the set

objectives. It is today's projection for tomorrow's activity. Planning includes objectives, strategies, policies, procedures, programmes, etc. As it involves making choices, decision-making is the heart of planning.

2. ***Organising:*** Organising includes putting life into the plan by bringing together personnel, capital, machinery, materials etc., to execute the plans. While, planning decides what management wants to do, organising provides an effective machine for achieving the plans.

3. ***Staffing:*** Staffing involves filling the positions needed in the organisation structure by appointing competent and qualified persons for the job. This needs manpower planning, scientific selection and training of personnel, suitable methods of remuneration and performance appraisal.

4. ***Directing:*** Direction involves managing managers, managing workers and the work through the means of motivation, proper leadership, effective communication as well as co-ordination. A manager must develop the ability to command and direct others.

5. ***Motivating:*** Motivation is a managerial function to inspire and encourage people to take required action. Motivation is the key to successful management of any enterprise. Motivation can set into motion a person to carry out certain activity.

6. ***Controlling:*** Control is the process of measuring actual results with some standard of performance, finding the reason for deviations of actual from desired result and taking corrective action when necessary. Thus, controlling enables the realisation of plans. A manager must adopt the following steps in controlling:

l Identify potential problems.
l Select mode of control.
l Evaluate performance in terms of planning.
l Spot significant deviations.
l Ascertain causes of deviations.
l Take remedial measures.

7. ***Co-ordination:*** Co-ordination is concerned with harmonious and unified action directed toward a common objective. It ensures that all groups and persons work efficiently, economically and in harmony. Co-ordination requires effective channels of communication. Person-to-person communication is most effective for coordination.

8. ***Communication:*** It means transfer of information and under-standing from person to person. Communication also leads to sharing of information, ideas and knowledge. It enables group to think together and act together.

Q8 (a) Explain the following Quantitative forecasting techniques (i) Time-series methods (ii) causal or explanatory models

Answer

Quantitative forecasting relies on numerical data and mathematical model to predict future conditions. There are two types of quantitative forecasting most frequently used.

1. **Time-series methods** used historical data to develop forecasts of the future.

a. The underlying assumption is that patterns exist and that the future will resemble the past.

b. Time-series methods do not in themselves predict the impact of present or future actions that managers might take to bring about change.
c. A trend reflects a long-range general movement is either an upward or a downward direction.
d. A seasonal pattern indicates upward or downward changes that coincide with particular points within a given year.
e. A cyclical pattern involves changes at particular points in time that span longer than a year.
f. Time-series are more valuable for predicting broad environmental factors than in predicting the impact of present or future actions.
g. Because time-series rely on past trends there can be a danger in their use if environmental changes are disregarded.

2. **Explanatory** or **causal models** attempt to identify the major variables that are related to or have caused particular past conditions and then use current measures of those variables (predictors) to predict future conditions.
a. Explanatory models allow managers to assess the probable impact of changes in the predictors.
b. Regression models are equations that express the fluctuations in the variable being forecasted in terms of fluctuations among one or more other variables.
c. Econometric models are systems of simultaneous multiple regression equations involving several predictor variables used to identify and measure relationships or interrelationships that exist in the economy.
d. Leading indicators are variables that tend to be correlate with the phenomenon of major interest but also tend to occur in advance of the phenomenon.

Q8 (b) Explain the various features of a Product Management Model

Answer
Product management has been carried out in different engineering disciplines, including mechanical, electrical, and software engineering. Accordingly, research has been conducted under different umbrellas, e.g., engineering data management, product data management, CAD frameworks, and software configuration management. As noticed in, the problems to be solved are largely domain independent. For example, this becomes evident when comparing work in the CAD domain to research in software engineering. The product management model developed integrates version control, configuration control, and consistency control for heterogeneous engineering design documents in a uniform conceptual framework:
• *Management of heterogeneous documents*
. Documents such as designs, manufacturing plans, or NC programs are managed which are created by heterogeneous development tools.
• *Representation of dependencies*
. Rather than managing collections of unrelated documents, product management represents their mutual dependency relationships.
• *Management of configurations*

Documents and their dependencies are aggregated into configurations which may be nested.

• *Version management*

. Product management keeps track of multiple versions into which a document evolves during its lifetime. Configurations are versioned as well.

• *Consistency control*

. The representation of dependencies lays the foundations for consistency control between interdependent documents. Note that versioning is taken into account, i.e., dependencies relate document versions and therefore define which versions must be kept consistent with each other.

Q9 (a) Explain the following with respect to decision making approaches: (i) Group decision making (ii) directive, analytic, conceptual and behavioral decision making styles

Answer

Group Decision making:

A. Decisions on all levels of organization are frequently made by groups.
Group decision making has several advantages and disadvantages over individual decision making.

1. Some advantages of group decision making include:

a) Groups bring more diverse information and knowledge to bear on the question under consideration.
b) An increased number of alternatives can be developed.
c) Greater understanding and acceptance of the final decision are likely.
d) Members develop knowledge and skill for future use.

2. Group decision making has several disadvantages when compared to individual decision making.

a) Group decision making is more time consuming.
b) Disagreements may delay decisions and cause hard feelings.
c) The discussion may be dominated by one or a few group members.
d) Groupthink is the tendency in cohesive groups to seek agreement about an issue at the expense of realistically appraising the situation.

Decision-Making Styles

Managers have different styles when it comes to making decisions and solving problems. One perspective proposes that people differ along two dimensions in the way they approach decision making.

1. One dimension is an individual's way of thinking—rational or intuitive. The other is the individual's tolerance for ambiguity—low or high.

2. These two dimensions lead to a two by two matrix with four different decision-making styles.
a. The directive style is one that's characterized by low tolerance for ambiguity and a rational way of thinking.
b. The analytic style is one characterized by a high tolerance for ambiguity and a rational way of thinking.
c. The conceptual style is characterized by an intuitive way of thinking and a high tolerance for ambiguity.
d. The behavioral style is one characterized by a low tolerance for ambiguity and an intuitive way of thinking.

3. Most managers realistically probably have a dominant style and alternate styles, with some relying almost exclusively on their dominant style and others being more flexible depending on the situation.

Q9 (b) Explain (i) McGregor's Theory X and Theory Y (ii) Motivation-hygiene theory

Answer
McGregor's Theory X and Theory Y were developed by Douglas McGregor and describe two distinct views of human nature.
1. Theory X was the assumption that employees dislike work, are lazy, seek to avoid responsibility, and must be coerced to perform.
2. Theory Y was the assumption that employees are creative, seek responsibility, and can exercise self-direction.
3. Theory X assumed that lower-order needs (Maslow's) dominated individuals, and Theory Y assumed that higher-order needs dominated.

Motivation-hygiene theory is the theory developed by Frederick Herzberg that suggests that intrinsic factors are related to job satisfaction and motivation, and extrinsic factors are associated with job dissatisfaction. The basis of Herzberg's theory is that he believed that the opposite of satisfaction was not dissatisfaction. Removing dissatisfying characteristics from a job would not necessarily make the job satisfying. Frederick Herzberg's two-factor theory states that there are only two categories of needs. Hygiene factors are factors that eliminate dissatisfaction. They include things such as supervision, company policy, salary, working conditions, security and so forth—extrinsic factors associated with job context, or those things surrounding a job.

Hygiene factors are necessary to keep workers away from feeling dissatisfied. There are several hygiene factors.

a. Pay
b. Working conditions

c. Supervisors
d. Company policies
e. Benefits

Motivators are factors that increase job satisfaction and hence motivation. They include things such as achievement, recognition, responsibility, advancement and so forth—intrinsic factors associated with job content, or those things within the job itself.
Motivator factor can only lead workers to feel satisfied and motivated.

a. Achievement
b. Responsibility
c. Work itself
d. Recognition
e. Growth and achievement

Text Books

1. Operations Research, An Introduction, Hamdy A. Taha, Eight Edition, PHI, 2007

2. Engineering Management, Fraidoon Mazda, Low Price Indian Edition, Addison-Wesley.