**Q.2** a. Explain the assumptions of terms:

(i) Certainty
(ii) Divisibility (Continuity)
(iii) Additivity
(iv) Linearity used while solving linear programming problems

**Answer:**

**Assumptions of the terms used in 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.

b. Solve the following LPP by graphical method

Maximize $Z = 2.80X_1 + 2.20X_2$

Subject to constraints:

$X_1 \leq 20{,}000$

$X_2 \leq 40{,}000$

$0.003X_1 + 0.001X_2 \leq 66$

$X_1 + X_2 \leq 45{,}000$

$X_1, X_2 \geq 0$

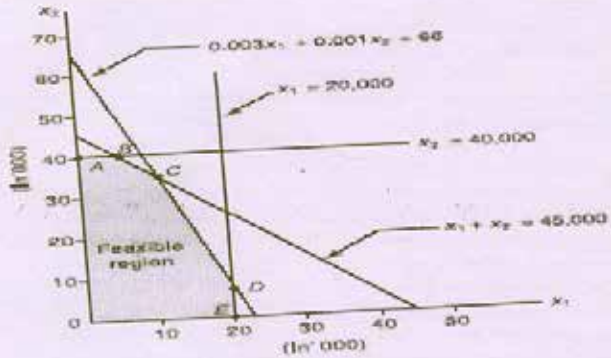
**Answer:**

**Solution:**

The first constraint $X1 \leq 20{,}000$ can be represented as follows.
We set $X1 = 20{,}000$
The second constraint $X2 \leq 40{,}000$ can be represented as follows,
We set $X2 = 40{,}000$

The third constraint $0.003X1 + 0.001X2 \leq 66$ can be represented as follows,
We set $0.003X1 + 0.001X2 = 66$
When $X1 = 0$ in the above constraint, we get,
$0.003 \times 0 + 0.001X2 = 66$
$X2 = 66/0.001 = 66{,}000$
Similarly when $X2 = 0$ in the above constraint, we get,
$0.003X1 + 0.001 \times 0 = 66$
$X1 = 66/0.003 = 22{,}000$

The fourth constraint $X1 + X2 \leq 45{,}000$ can be represented as follows,
We set $X1 + X2 = 45{,}000$
When $X1 = 0$ in the above constraint, we get,
$0 + X2 = 45{,}000$
$X2 = 45{,}000$
Similarly when $X2 = 0$ in the above constraint, we get,
$X1 + 0 = 45{,}000$
$X1 = 45{,}000$




| Point | X1 | X2 | Z = 2.80X1 + 2.20X2 |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| A | 0 | 40,000 | Z = 2.80 x 0 + 2.20 x 40,000 = 88,000 |
| B | 5,000 | 40,000 | Z = 2.80 x 5,000 + 2.20 x 40,000 = 1,02,000 |
| C | 10,500 | 34,500 | Z = 2.80 x 10,500 + 2.20 x 34,500 = 1,05,300* Maximum |
| D | 20,000 | 6,000 | Z = 2.80 x 20,000 + 2.20 x 6,000 = 69,200 |
| E | 20,000 | 0 | Z = 2.80 x 20,000 + 2.20 x 0 = 56,000 |

The Maximum profit is at point C
When X1 = 10,500 and X2 = 34,500
Z = 1,05,300

**Q.3** a. Write a note on dual simplex method.

**Answer:**

**Q.3. a. Write a note on dual simp...**

**Soln:**

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.

b. Using simplex method solve the following linear programming problem:
Minimize $Z = 8X_1 - 2X_2$
Subject to
$-4X_1 + 2X_2 \leq 1$
$5X_1 - 4X_2 \leq 3$
$X_1, X_2 \geq 0$

**Answer:** Page Number 93 of Text Book II

**Q.4** a. Define:
(i) Feasible solution
(ii) Basic feasible solution in 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

b. In a machine shop there are four machines A, B, C and D and four jobs I, II, III and IV are to be performed. The machines differ in efficiency and the jobs differ in there intrinsic difficulty. Estimate of the time each machine would take to perform each job is given below.

| | I | II | III | IV |
|---|---|---|---|---|
| A | 44 | 80 | 52 | 60 |
| B | 60 | 56 | 40 | 72 |
| C | 36 | 60 | 48 | 48 |
| D | 52 | 76 | 36 | 40 |

Solve this as an assignment problem

**Answer:**

1. CHECK THE OBJECTIVE FUNCTION ( GIVEN PROBLEMS IS MINIMISATION)
2. CHECK FOR THE BALANCE ( GIVEN PROBLEM IS BALANCED ONE)
3. NOW APPLY HUNGARIAN METHOD

| | I | II | III | IV |
|---|---|---|---|---|
| A | 44 | 80 | 52 | 60 |
| B | 60 | 56 | 40 | 72 |
| C | 36 | 60 | 48 | 48 |
| D | 52 | 76 | 36 | 40 |

ROW REDUCTION

| | I | II | III | IV |
|---|---|---|---|---|
| A | 0 | 36 | 8 | 16 |
| B | 20 | 16 | 0 | 32 |
| C | 0 | 24 | 12 | 12 |
| D | 16 | 40 | 0 | 4 |

COLUMN REDUCTION

| | I | II | III | IV |
|---|---|---|---|---|
| A | 0 | 20 | 8 | 12 |
| B | 20 | 0 | 0 | 28 |
| C | 0 | 8 | 12 | 8 |
| D | 16 | 24 | 0 | 0 |

ALLOCATION ACCORDING TO HUNGARIAN METHOD

| | I | II | III | IV |
|---|---|---|---|---|
| A | **0** | 20 | 8 | 12 |
| B | 20 | **0** | 0 | 28 |
| C | 0 X | 8 | 12 | 8 |
| D | 16 | 24 | **0** | 0 X |

Mark the unallocated rows ( i.e. C) and mark the columns where there are zer in the marked rows. (i.e.). Mark the rows where allocation is there in the marked columns (i.e. A). Now draw the lines through unmarked rows i.e.B and D and marked columns (i.e.)

Selected the minimum element(8) among uncovered elements ( where lines are not passing) and deduct it from the rest of the uncovered elements .Add the same where ever there is intersection of the lines i.e. cell (2,1) and cell (4,1)

The revised table is as follows with allocations

| | I | II | III | IV |
|---|---|---|---|---|
| A | **0** | 12 | 0 X | 4 |
| B | 20+8=28 | **0** | 0 X | 28 |
| C | 0 X | 0 X | 4 | **0** |
| D | 16+8=24 | 24 | **0** | 0 X |

THUS A –I , B – II, C—IV, D – III WITH COST OF ( 44+56+48+36)

**Q.5** a. State when the following approaches are used
(i) Competitive strategy models
(ii) Network analysis

**Answer:**

**Soln:**

**(i)** **Competitive strategy models**( Games theory) these models are used to determine the behavior of decision making under competition or conflict. Methods for solving such models have not been found suitable for industrial application, mainly because they are referred to idealistic world neglecting any essential features of reality.

**(ii)** **Network analysis**. These models are applicable in large projects involving complexities and interdependencies of activates. PERT and CPM are used for planning scheduling and controlling complex project which can be characterized by networks

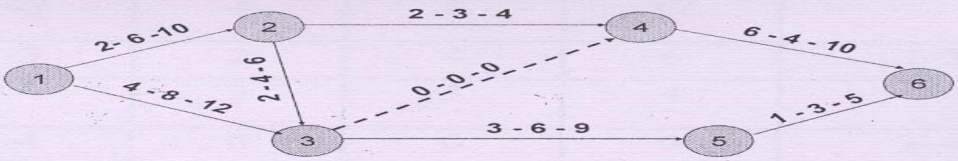
2

b. Construct the Network for the following Project and calculate the probability of completing the project in 25 days.

| Activity | to | tm | tp |
|---|---|---|---|
| 1-2 | 2 | 6 | 10 |
| 1-3 | 4 | 8 | 12 |
| 2-3 | 2 | 4 | 6 |
| 2-4 | 2 | 3 | 4 |
| 3-4 | 0 | 0 | 0 |
| 3-5 | 3 | 6 | 9 |
| 4-6 | 6 | 10 | 14 |
| 5-6 | 1 | 3 | 5 |

**Answer:**

**1.Construction of the Network**




**2. Calculation of Expected time for all the activities**

**Expected Time ( te):**
**'te' can be calculated by the following formula**
**te = (to + 4tm + tp) / 6**

**3. Determination of Critical Path**

Key $\frac{\text{to - tm - tp}}{t_e}$

**Expected Duration of the project Te = 20 days**

| Activity | to | tm | tp | Critical activities | σ2 = ((t p – t o) / 6)2 |
|---|---|---|---|---|---|
| 1-2 | 2 | 6 | 10 | 1-2 | 1.78 |
| 1-3 | 4 | 8 | 12 | - | |
| 2-3 | 2 | 4 | 6 | 2-3 | 0.44 |
| 2-4 | 2 | 3 | 4 | - | |
| 3-4 | 0 | 0 | 0 | 3-4 | 0 |
| 3-5 | 3 | 6 | 9 | - | |
| 4-6 | 6 | 10 | 14 | 4-6 | 1.78 |
| 5-6 | 1 | 3 | 5 | - | |
| | | | | | **Σ σ2 = 4.00** |

σNetwork = √Sum of variances along the Critical Path
= √ (σNetwork )2
= √ 4
= 2

Probability of completing the project within a given date
$Z = (TS - TE) / \sigma$
Where TS = Scheduled time for project completion
TE = Expected time for the project completion
$\sigma$ = Standard deviation for the Network
$= (25 - 20) / 2$
$= +2.5$

From the Normal distribution Table, we get the probability of completing the project in 25 days is 99.4% → 2

**Q.6** a. Briefly explain the General Structure of a Queuing System.

**Answer:**

Soln:
The general Structure of a Queuing System is classified as follows:

- Arrival Process
  - According to source
  - According to numbers
  - According to time
- Service System
  - Single server facility
  - Multiple, parallel facilities with single queue
  - Multiple, parallel facilities with multiple queues
  - Service facilities in a parallel
- Queue Structure
  - First come first served
  - Last come first served
  - Service in random order
  - Priority service

b. A warehouse has only the loading dock manned by a three person crew. Trucks arrive at the loading dock at an average rate of 4 trucks per hour and the arrival rate is Poisson distributed. The loading of a truck takes 10 minutes on an average and can be assumed to be exponentially distributed. The operating cost of a truck is Rs.20 per hour and the members of the crew are paid @ Rs.6 each per hour. Would you advice the truck owner to add another crew of three persons?

**Answer:**

Solutions: 1) $\lambda$=4 truck/ hr
$\mu$=10min=60/10=6truck/hr

No of trucks in system,

$Ls = \lambda / (\mu - \lambda)$
$= 4/6-4$
$= 2$ trucks → 2

Total cost = cost of maintaining trucks + cost of crew
$= 20*20 + 3*6$
$= 40 + 18$
= Rs.58 → 3

2) $\lambda$ =4trucks /hr
If we double the crew, $\mu$= 12 trucks/ hr

No of trucks in system,

$Ls = \lambda / (\mu - \lambda)$
$= 4/12-4$
$= 0.5$ trucks → 2

Total cost = cost of maintaining trucks + cost of crew
$= 0.5*20 + 6*6$
$= 10 + 36$
= Rs.46 → 3

We have to advice the owner to add 3 persons for loading cost the total cost for 3 extra persons is less than previous. → 2

**Q.7** a. Explain various functional areas of management.

**Answer:**

**Functional Areas of Management**

Management covers the following functional areas:-

***Financial Management:*** Financial management includes forecasting, cost control, management accounting, budgetary control, statistical control, financial planning etc.

***Human Resource Management:*** Personnel / Human Resource Management covers the various aspects relating to the employees of the organisation such as recruitment, training, transfers, promotions, retirement, terminations, remuneration, labour welfare and social security, industrial relations etc.

***Marketing Management:*** Marketing management deals with marketing of goods, sales promotion, advertisement and publicity, channels of distribution, market research etc.

***Production Management:*** Production Management includes production planning, quality control and inspection, production techniques etc.

***Material Management:*** Material management includes purchase of materials, issue of materials, storage of materials, maintenance of records, materials control etc.

***Purchasing Management:*** Purchasing management includes inviting tenders for raw materials, placing orders, entering into contracts etc.

***Maintenance Management:*** Maintenance Management relates to the proper care and maintenance of the buildings, plant and machinery etc.

***Office Management:*** Office management is concerned with office layout, office staffing and equipment of the office.

b. Draw a simple matrix management scheme. Elaborate project responsibilities within a matrix organization.

**Answer:** Page Number 57 of Text Book II

**Q.8** a. Define Forecasting. Explain different methods of forecasting.

**Answer:**

**Q.8.a. Define Forecasting. Explain**

Soln:

Forecasting is the process of predicting changing conditions and future events that may significantly affect the business of an organization.

1. Forecasting is important to both planning and decision making.
2. Forecasting is used in a variety of areas such as: production planning, budgeting, strategic planning, sales analysis, inventory control, marketing planning, logistics planning, and purchasing among others.

**Methods of Forecasting:**

A. **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.

B. **Technological,** or **Qualitative, Forecasting** is aimed primarily at predicting long-term trends in technology and other important aspects of the environment
The focus is upon longer-term issues that are less amenable to numerical analysis as quantitative approaches.
The **Delphi method and Scenario analysis can be used as techniques.**

C. **Judgmental Forecasting** relies mainly on individual judgments or committee agreements regarding future conditions.
1. Judgmental forecasting methods are highly susceptible to bias.
2. The **jury of executive opinion** is one of the two judgmental forecasting model. It is a means of forecasting in which organization executives hold a meeting and estimate, as a group, a forecast for a particular item.
3. The **Sales-force composite** is a means of forecasting that is used mainly to predict future sales and typically involves obtaining the views of various salespeople, sales managers, and/or distributors regarding the sales outlook.

b. What is Strategic Management? Explain the purpose and importance of strategic management in an organization.

**Answer:**

Soln:

**Strategic management** is a process through which managers formulate and implement strategies geared to optimizing goal achievement, given available environmental and internal conditions. **Strategic management** is that set of managerial decisions and actions that determines the long-run performance of an organization. It entails all of the basic management functions—planning, organizing, leading, and controlling.

**Purposes of strategic management**

1. One reason strategic management is important is because it's involved in many of the decisions that managers make.
2. Another reason is that studies of the effectiveness of strategic planning and management have found that, in general, companies with formal strategic management systems had higher financial returns than those companies with no such systems.
3. Strategic management has moved beyond for-profit organizations to include all types of organizations, including not-for-profit.

**Strategic management is important to organizations because it**

1. Helps organizations identify and develop a **competitive advantage,** a significant edge over the competition in dealing with competitive forces.
2. Provides a sense of direction so that organization members know where to expend their efforts.

**Q.9** a. Write concept and assumptions used in the 'McGregor's Theory X and Theory Y of Motivation.

**Answer:**

Soln:

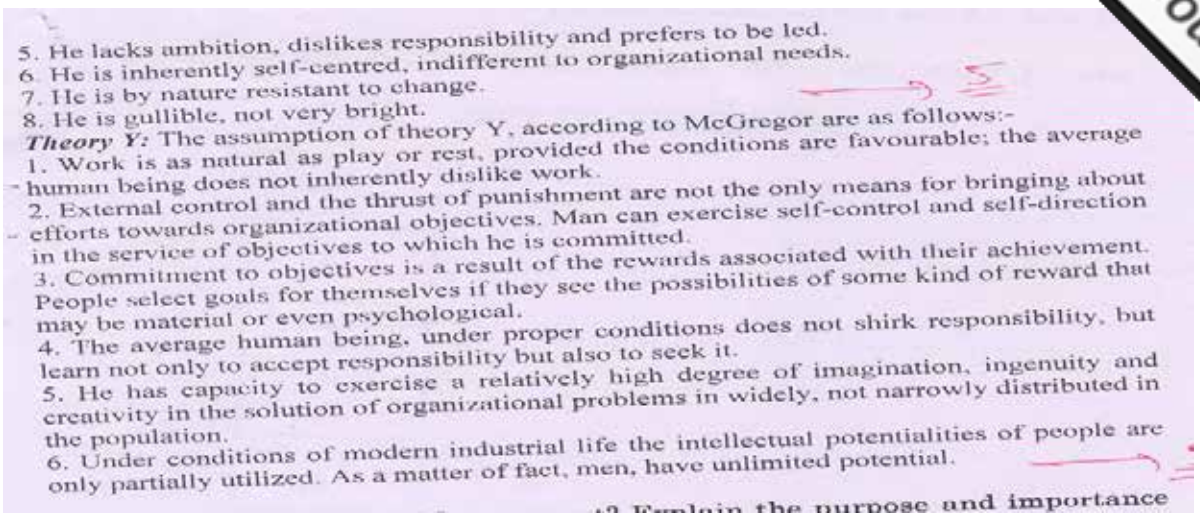
**McGregor's Theory X and Theory Y:**

Different styles of management have a different bearing on the motivation of workers in the organization. The style adopted by a manager in managing his subordinates is basically dependent upon his assumption about human behaviour. Theory X is negative, traditional and autocratic style while Theory Y is positive, participatory and democratic. Thus, these labels describe contrasting set of assumptions about human nature.

Douglas McGregor has classified the basic assumption regarding human nature into two parts and has designated them as 'theory X' and 'theory Y'.

***Theory X:*** This is the traditional theory of human behaviour, which makes the following assumptions about human nature:

1. Management is responsible for organizing the elements of productive enterprises - money, material, equipment, and people - in the interest of economic ends.
2. With reference to people it is a process of directing their efforts, motivating them, controlling their actions, modifying their behaviour in order to be in conformity with the needs of the organization.
3. Without this active intervention by management, people would be passive – even resistant to organizational needs. Hence they must be persuaded, rewarded, punished and properly directed.
4. The average human being has an inherent dislike of work and will avoid it if he can.



5. He lacks ambition, dislikes responsibility and prefers to be led.
6. He is inherently self-centred, indifferent to organizational needs.
7. He is by nature resistant to change.
8. He is gullible, not very bright.

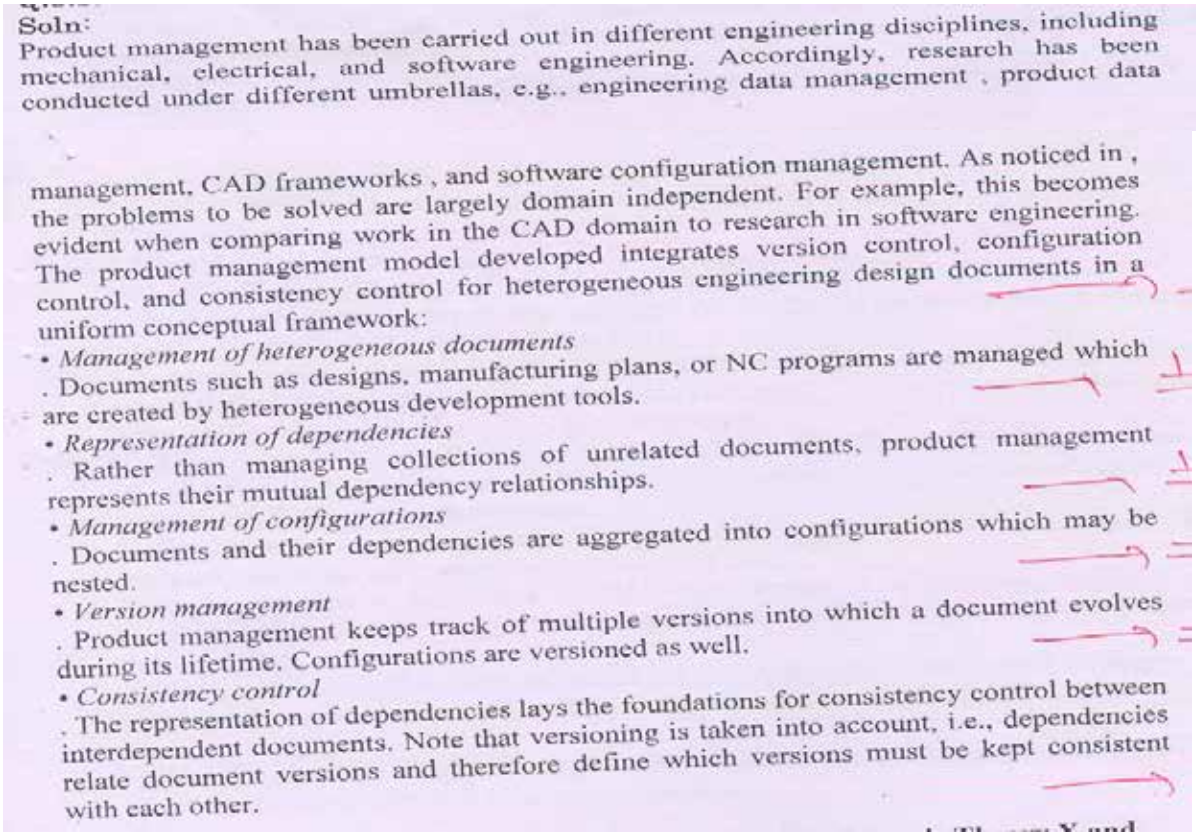
***Theory Y:*** The assumption of theory Y, according to McGregor are as follows:-

1. Work is as natural as play or rest, provided the conditions are favourable; the average human being does not inherently dislike work.
2. External control and the thrust of punishment are not the only means for bringing about efforts towards organizational objectives. Man can exercise self-control and self-direction in the service of objectives to which he is committed.
3. Commitment to objectives is a result of the rewards associated with their achievement. People select goals for themselves if they see the possibilities of some kind of reward that may be material or even psychological.
4. The average human being, under proper conditions does not shirk responsibility, but learn not only to accept responsibility but also to seek it.
5. He has capacity to exercise a relatively high degree of imagination, ingenuity and creativity in the solution of organizational problems in widely, not narrowly distributed in the population.
6. Under conditions of modern industrial life the intellectual potentialities of people are only partially utilized. As a matter of fact, men, have unlimited potential.

**2. Explain the purpose and importance**

b. Define Product Management. Explain the various components of it.

**Answer:**



**Soln:**

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 consisteney 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.

**3. Explain Theory X and**

## 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.