

INTERMEDIATE EXAMINATION

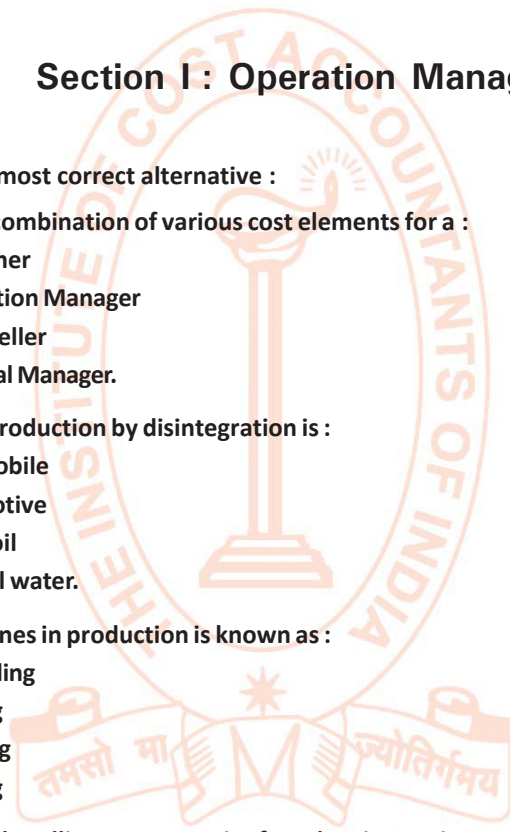
(REVISED SYLLABUS - 2008)

GROUP - II

Paper-9 : OPERATION MANAGEMENT AND INFORMATION SYSTEMS

Section I : Operation Management

Q. 1. (A) Choose the most correct alternative :

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- (i) Product is a combination of various cost elements for a :
 - (a) Consumer
 - (b) Production Manager
 - (c) Retail seller
 - (d) Financial Manager.
 - (ii) Example of production by disintegration is :
 - (a) Automobile
 - (b) Locomotive
 - (c) Crude oil
 - (d) Mineral water.
 - (iii) Fixing Flow lines in production is known as :
 - (a) Scheduling
 - (b) Loading
 - (c) Planning
 - (d) Routing
 - (iv) The material handling cost per unit of product in Continuous production is :
 - (a) Highest compared to other systems
 - (b) Lower than other systems
 - (c) Negligible
 - (d) Cannot say.
 - (v) Important factor in forecasting production is :
 - (a) Environmental changes
 - (b) Available capacity of machines
 - (c) Disposable income of the consumer
 - (d) Changes in preference of the consumer.

(vi) ABC analysis depends on the :

- (a) Quality of materials.
- (b) Cost of materials.
- (c) Annual consumption value of materials.
- (d) Quantity of materials used.

(vii) $(\text{Total station time} / \text{Cycle time} \times \text{Number of work stations}) \times 100$ is known as :

- (a) Line Efficiency
- (b) Line smoothness
- (c) Balance delay of line
- (d) Station efficiency

(viii) The class timetable is a good example of :

- (a) Route sheet
- (b) Follow up chart
- (c) Dispatcher's chart
- (d) Gantt chart.

(ix) Tempering is a process of :

- (a) Joining
- (b) Heat Treatment
- (c) Surface Treatment
- (d) Forming

(x) Buffer Stock is built to cater to :

- (a) Machine Breakdown
- (b) Import Substitution
- (c) Fluctuating load
- (d) Diversification

Q. 1. (B) Fill in the blanks with appropriate word/words :

- (i) Standard time is always more than _____ time.
- (ii) X chart is _____ chart.
- (iii) Plant layout is a _____ affair.
- (iv) Optimum Capacity is rate of output at which there is _____ to change the size of the plant.
- (v) Auxilury and support facilities required to operate main production unit are called _____.
- (vi) _____ is a process that bakes on a white, brittle finish.
- (vii) Kaizen is essential part of _____.
- (viii) Total output of all sectors is _____ total input of all sectors.
- (ix) A project implemented in the precincts of a working plant is known as _____ Project.
- (x) Production management is a _____ function.

Answer 1. (A)

- (i) (d) **Financial Manager**
As Financial manager is responsible for profitability of the product.
- (ii) (c) **Crude oil**
By separating the contents of crude oil the desired fuel oils are produced.
- (iii) (d) **Routing**
Routing decision involves deciding the division of work into operations, the sequence in which each operation is to be done, division of each operation into elements.
- (iv) (b) **Lower than other systems**
Since machines are so located as to minimize distances between consecutive operations.
- (v) (b) **Available capacity of machines**
Capacity of machines is one of the limiting factor for deciding production volume, other factors given help in forecasting the demand.
- (vi) (c) **Annual consumption value of materials**
The ABC analysis suggests that inventories of an organization are not of equal value. 'A' items are very important for an organization. 'B' items are important, but of course less important, than 'A' items and more important than 'C' items. Therefore 'B' items are intergroup items. 'C' items are marginally important.
- (vii) (a) **Line efficiency**
Line efficiency = Total minutes produced by the line/total minutes attended by all operators.
- (viii) (d) **Grant chart**
This chart illustrate the start and finish dates of the terminal elements and summary elements of a project. Similar is the case with class time table which shows the routine for each day and start and finish time of each period.
- (ix) (b) **Heart Treatment**
Tempering is the process of reheating which will reduce the brittleness and soften the steel.
- (x) (c) **Fluctuating load**
Buffer stock is a supply of inputs held as a reserve to safeguard against unforeseen shortages or demands.

Answer 1. (B)

- (i) **normal**
Standard time = Normal time + Allowances.
- (ii) **mean**
By this chart, it is found whether the mean of the characteristic can be determined by the following formula:

$$\text{Central Line} = \bar{X} = \frac{\sum (\bar{x}_1, \dots, \bar{x}_k)}{k}$$

$$\bar{X} = \text{Mean of samples}$$

$$\sum \bar{X} = \text{Sum of sample means.}$$

k is the number of subgroups
- (iii) **dynamic**
Good layout should have flexibility for change of layout, expansion due to changes in product design, process.

(iv) **no incentive**

It is the production capacity at which cost per unit is minimized.

(v) **utilities**

Utilities are significant inputs such as power, steam, water, compressed air which are used in manufacturing process but donot form part of final product.

(vi) **Enamelling**

It is a surface treatment process.

(vii) **TQM i.e. Total Quality Management**

Kaizen, Japanese for “improvement”, or “change for the better” refers to philosophy or practices that focus upon continuous improvement of processes in manufacturing.

(viii) **equal to**

Output of one sector serves as input of another sector.

(ix) **Brown Field**

Brownfield sites are abandoned or underused industrial and commercial facilities available for re-use.

(x) **line**

Line function refers to decision making areas of an organization associated with its daily operations such as purchasing, production, selling.

Q. 2. (A) Match each item in Column A with appropriate item in Column B :**Column A**

- (i) USP
- (ii) ISO
- (iii) KANBAN
- (iv) VAM
- (v) EDD
- (vi) Tail Stock
- (vii) Payback period
- (viii) FCFS
- (ix) Fractionalization
- (x) Broaching

Column B

- (a) Job sequencing
- (b) Scheduling
- (c) Investment decision
- (d) Standardisation
- (e) Job holding service
- (f) Prioritisation
- (g) Marketing strategy
- (h) Transportation application
- (i) Gilbreth
- (j) Metal Cutting

Q. 2. (B) Expand the following acronyms :

- (i) DMAIC
- (ii) CPFR
- (iii) GOLF
- (iv) CRAFT
- (v) MSE
- (vi) VMI
- (vii) WBS
- (viii) UPC
- (ix) QFD
- (x) DFA

Q. 2. (C) Indicate whether the following statements are True/False.

- (i) For a consumer the product is one which is available to him at cheap cost.
- (ii) Games theory deals with games which business executives play during lunch interval.
- (iii) Surface hardening is an example of production by service.
- (iv) Material handling is an integral part of sales process.
- (v) The time horizon selected for forecasting depends on time required for production cycle.
- (vi) Rucker plan is a group incentive plan.
- (vii) One of the aims of dispatching is to dispatch products to different places.
- (viii) The card, which shows the number of rejected products from total quantity produced is quality control card.
- (ix) Assignment problem is solved by Johnson and Bellman method.
- (x) Preventive maintenance is useful in reducing inspection cost.

Answer 2. (A)

- (i) — (g)
- (ii) — (d)
- (iii) — (b)
- (iv) — (h)
- (v) — (a)
- (vi) — (e)
- (vii) — (c)
- (viii) — (f)
- (ix) — (i)
- (x) — (j)

Answer 2. (B)

- (i) DMAIC — Define, Measure, Analyse, Improve and Control.
- (ii) CPFR — Collaborative Planning, Forecasting, and Replenishment.
- (iii) GOLF — Government, Ordinary, Local and Foreign.
- (iv) CRAFT — Computerised Relative Allocation of Facilities Techniques .
- (v) MSE — Mean Squared Error.
- (vi) VMI — Vendor – managed Inventory.
- (vii) WBS — Work Breakdown Structure.
- (viii) UPC — Universal Product Code.
- (ix) QFD — Quality Function Deployment.
- (x) DFA — Design For Assembly.

Answer 2. (C)

- (i) **False.**
For a consumer the product is one which is optima combination of potential utilities.
- (ii) **False.**
Games theory is a mathematical method for analyzing calculated circumstances, such as in games, where a person's success is based upon the choices of others.
- (iii) **True.**
Under production by service the chemical and physical properties of materials are improved without any physical change.

(iv) **False.**

It is integral part of manufacturing process.

(v) **False.**

It depends on the purpose for which forecasts is made.

(vi) **True.**

Under this plan, added value is defined as the change in market value due to the alteration in the form, location & availability of product or service, excluding the cost of bought in materials or services. The ascertainment of the ratio of earnings & added value is done. Wage is proportionately increased due to any reduction in this ratio. For successful implementation, constant negotiation between employers & employees is required by the scheme. Rucker plan is known as share of production plan.

(vii) **False.**

Dispatching aims at the principle of completion of job by due date.

(viii) **False.**

It is Inspection card.

(ix) **True.**

It writes the value of a decision problem at a certain point in time in terms of the payoff from some initial choices and the value of the remaining decision problem that results from those initial choices. This breaks a dynamic optimization problem into simpler sub-problems, as Bellman's Principle of Optimality prescribes.

(x) **False.**

It helps in reducing shutdown cost.

Q. 3. (a) Contrast the capabilities and limitations of the following pairs of material handling equipment :

(i) EOT crane and Jib crane

(ii) Belt conveyor and Fork lift truck

(b) Distinguish between a job shop and a flow shop.

(c) C Ltd. manufactures three different items of tools. The time required to produce each tool on different operation is as follows :

Operation	Time in minutes		
	Drills	Cutters	Reamers
Turning	16	34	40
Grinding	10	8	17
Milling	4	5	8
Heat Treatment	3	3	3
Other data available :			
Sales per annum (units)	18000	20000	15000
Opening Stock (units)	5000	6000	—
Closing Stock (units)	2000	3000	4000

The workers are trained in each trade as such their services are interchangeable. They are paid at ₹ 27.50 per hour. The workers are paid for 2500 hours per annum which includes 200 hours for leave which time substitute operators are appointed and for 300 hours the machines are taken for overhaul. Using the above data, calculate :

(i) The production quantity.

(ii) No. of operators required per annum.

(iii) Annual direct labour cost on each type of tool, and

(iv) Indirect labour cost giving breakup of leave wages, overhaul time and idle time wages.

Answer 3. (a)

(i)

	EOT Crane	Jib crane
Capabilities	This is used for moving heavy work pieces in a rectangular area in large machine or assembly shops.	This is used to handle small work pieces.
Limitations	It can move load only in vertical direction.	It's movement is restricted to a semicircular area.

(ii)

	Belt conveyor	Fork lift truck
Capabilities	It provides continuous movement of material in chemical plants, power houses, etc.	It can move unit load on its fork anywhere and is capable of lifting and stacking material as well.
Limitations	It is only a fixed path material handling equipment.	It cannot move material continuously.

Answer 3. (b)

Job shop	Flow shop
(i) In a flow shop, continuous production/assembly line, each of the n jobs must be processed through m machines in exactly the same order and once in every machine.	(i) In a job shop, not all n jobs are assumed to pass through or require processing in m machines. Also some jobs may require more than one operation in the same machine. The sequencing of operations, may be different for different jobs.
(ii) Specialised machine results in low variable cost per unit and high volume absorbs the fixed cost easily; so unit cost is low.	(ii) Wide variety at reasonably low cost since general purpose machines are utilized.
(iii) Even unskilled or semi-skilled operator will be able to operate the machine thereby reducing dependencies on workers.	(iii) Through grouping of facility around standard operations, high capacity utilization could be effected.
(iv) Operation management is much simpler and meeting delivery commitments is relatively easier.	(iv) The workers are engaged in non-repetitive and challenging job. Their job gets enriched and morale high.
(v) Failure at any stage would result in breakdown of entire flow until repair is completed.	(v) Determination of optimum batch size creates a problem.
(vi) The pace of production is determined by the slowest machine.	(vi) Material flow is complicated and unsystematic.
(vii) The system is relatively inflexible.	(vii) Machines are diverse and operations are complex requiring highly skilled workers.
(viii) The system requires high investment due to specialized nature of machine.	(viii) Material Handling cost is usually higher since flow lines are irregular.

Answer 3. (c)

(i) Production quantity (units) :

Particulars	Drills	Cutters	Reamers
Sales	18000	20000	15000
Add : Closing Stock	2000	3000	4000
	20000	23000	19000
Less : Opening Stock	5000	6000	-
Production quantity	15000	17000	19000

(ii) No. of operators per annum :

Product	No. of units	Hours Required				Total
		Turning	Grinding	Milling	Heat Treatment	
Drills	15000	4000	2500	1000	750	8250
Cutters	17000	9633	2267	1417	850	14167
Reamers	19000	12667	5383	2533	950	21533
Total		26300	10150	4950	2550	43950
No. of operators required at (2500 – 300) hours = 2200 hours p.a rounded off to full operator		12	5	3	2	22

(iii) Annual direct labour cost (Rate per hour ₹ 27.50)

	Drills	Cutters	Reamers	Total
Direct labour hours	8250	14167	21533	43950
Direct labour cost. (₹)	226875	389592.50	592157.50	1208625

(iv) Indirect labour cost :

	Turning	Grinding	Milling	Heat Treatment	Total
No. of Hrs taken (no. of operators*2200)	26400	11000	6600	4400	
Total hours required as above	26300	10150	4950	2550	
Idle time hrs	100	850	1650	1850	
Leave hrs. (no. of operators*200)	2400	1000	600	400	
Overhaul hrs.	3600	1500	900	600	
Leave wages (leave hrs.*₹ 27.50)	66000	27500	16500	11000	121000
Overhaul time wages(overhaul hrs.*27.50)	99000	41250	24750	16500	181500
Idle time wages (idle time hrs*27.50)	2750	23375	45375	50875	122375
Indirect labour cost	167750	92125	86625	78375	424875

Q. 4. (a) A dairy plant management is to make a choice between Location A and Location B for locating a dairy plant for processing and distribution of milk . Location A could supply milk through road milk tankers (ROMT) where as Location B could have the facility of roads milk tankers (ROMT) as well as rail milk tankers (RLMT). Determine the following using the cost data given below :

- (i) The Breakeven point for location A and location B
- (ii) The production quantity at which either of the locations could be selected.
- (iii) State the conditions in which location A or location B would be preferred.

	Location A (Distribution by ROMT)	Location B (Distribution by ROMT & RLMT)
Selling Price (SP) of milk	₹ 10 /litre	₹ 10/litre
Variable cost (VC)	₹ 5.50/litre	₹ 3.00 per litre
Fixed cost per year (FC)	₹ 120,00,000	₹ 180,00,000

(b) Dumpers are used to transport the Steel Ingots from Melting Shop to Ingot Yard, which is situated at a distance of 0.6 km from the melting shop. The capacity of the dumper is 8 tonnes. Due to speed restrictions, within factory the dumper cannot run beyond 12 Km/per hour. In order to avoid congestion in the Melting shop, a minimum transportation of 3200 Tonnes is necessary per shift (of 8 hrs. duration). Find the number of dumpers that would be required. Ignore the loading and unloading time.

Answer 4. (a)

At breakeven point :

Total revenue (TR) = Fixed cost (FC) + Variable cost (VC)

Quantity (Q) at breakeven point = $FC/[SP-VC]$

Q_{bep} for location A = $120,00,000/(10-5.5) = 120,00,000/4.5 = 26,66,666.6$ litres

Q_{bep} for location B = $180,00,000/(10-3) = 180,00,000/7 = 25,71,428.5$ litres.

(ii) Total cost of Location A and Location B at a given production volume can be calculated by the following formulae :

Total cost at Location A = $120,00,000 + 5.5Q$

Total cost at Location B = $180,00,000 + 3.0 Q$

Production volume for which Total Cost (TC) is same in both location A and B (Point of indifference)

$$TC_A = TC_B$$

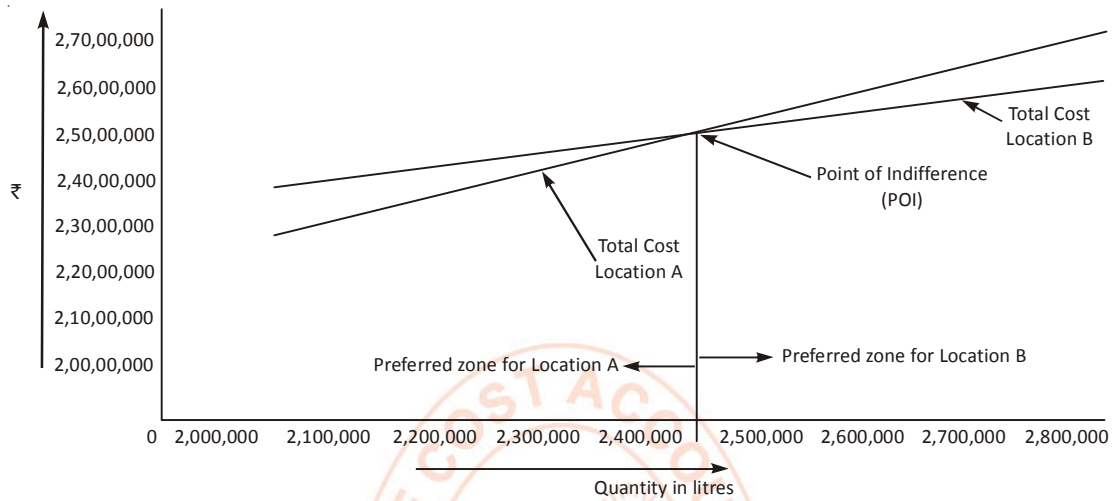
$$120,00,000 + 5.5Q = 180,00,000 + 3.0 Q$$

$$\text{Or } 5.5Q - 3Q = 60,00,000$$

$$\text{Or } 2.5Q = 60,00,000$$

$$\text{Or } Q = 60,00,000/2.5$$

$$\text{Or } Q = 24,00,000 \text{ litres}$$



Total Costs and point of indifference between location A and location B

(iii) Comparison of total cost in respect of location A and location B

	Location A	Location B
Production Volume Q (litres)	$TC = 120,00,000 + 5.5Q$ (₹)	$TC = 180,00,000 + 3.0Q$ (₹)
2,000,000.00	23000000	24000000
2,100,000.00	23550000	24300000
2,200,000.00	24100000	24600000
2,300,000.00	24650000	24900000
2,400,000.00	25200000	25200000
2,500,000.00	25750000	25500000
2,600,000.00	26300000	25800000
2,700,000.00	26850000	26100000
2,800,000.00	27400000	26400000

From the Figure and Table, It is observed that Location A would be suitable for production upto a level of 2400000 litres, where as Location B would be suitable for production level beyond 2400000 litres.

Answer 4. (b)

Distance travelled per trip = $0.6 + 0.6 = 1.2$ Km.

No. of trips can be made per hour = $12/1.2 = 10$ trips.

No. of trips per single shift = $10 \times 8 = 80$ trips.

Tonnage moved per shift = $80 \times 8 = 640$ tonnes.

No. of dumpers required = Required tonnage to move per shift/Tonnage moved per shift per dumper = $3200/640 = 5$ Nos.

- Q. 5. (a) There are five departments namely P, Q, R, S and T. The products manufactured by the factory needs the services of all the departments in different proportion. The volume of material for the products that move in between departments in terms of percentage of volume is given below. The distance between the departments also given. The layout engineer has prepared two layouts. Find which layout is better using load-distance matrix method.

Product Group	Sequence in which the departments used to department	Percentage of volume of material moves from department
I	PQRST	30
II	PRQTS	35
III	PRSQR	20
IV	PTSR	15

Distance between departments in meters in each layout is given below :

From	To	Layout I	Layout II	From	To	Layout I	Layout II
P	Q	20	25	C	Q	10	15
P	R	15	10	C	S	30	35
P	T	40	35	D	Q	25	30
Q	R	10	15	D	R	30	40
Q	T	25	25	E	S	15	10

- (b) Should the following industries 'Simplify' or 'Diversify' and why?

(I) Automobile (II) Cosmetic

Answer 5. (a)

First let us write the load matrix and distance matrix from the data given.

Load Matrix or Volume Matrix

		To				
		P	Q	R	S	T
From	P	—	30	55	—	15
	Q	—	—	50	—	35
	R	—	35	—	50	—
	S	—	20	15	—	30
	T	—	—	—	50	—

Distance matrix for layout I

		To (distance in meters)				
		P	Q	R	S	T
From	P	—	20	15	—	40
	Q	—	—	10	—	25
	R	—	10	—	30	—
	S	—	25	30	—	15
	T	—	—	—	15	—

Next step is to multiply both volume matrix and distance matrix and workout volume-distance matrix. The row elements of this matrix are added and then these totals are added to get the grand total. The layout, which gives smaller total, will be the preferable layout.

The distance matrix of the second layout is :

To (distance in meters)

		<i>P</i>	<i>Q</i>	<i>R</i>	<i>S</i>	<i>T</i>
From	P	—	25	10	—	35
	Q	—	—	15	—	25
	R	—	15	—	35	—
	S	—	30	40	—	20
	T	—	—	—	10	—

Distance - Volume Matrix (L_1 for Layout I and L_2 for layout II)

		From						
		<i>P</i>	<i>Q</i>	<i>R</i>	<i>S</i>	<i>T</i>	<i>Total for Layout I</i>	<i>Total for Layout II</i>
P	L_1	—	600	825	—	600	2025	172
	L_2	—	650	550	—	525		
Q	L_1	—	—	500	—	875	1375	1650
	L_2	—	—	750	—	900		
R	L_1	—	350	—	1500	—	1850	2290
	L_2	—	540	—	1750	—		
S	L_1	—	500	450	—	450	1400	1800
	L_2	—	600	600	—	600		
T	L_1	—	—	—	750	—	750	500
	L_2	—	—	—	500	—		
Grand total for layout I =							7400	
Grand total for layout II =								6250

As layout II is having lesser grand total i.e. weighted distance for layout II is smaller, it is preferable. When number of layouts is prepared, weighted distance for all is calculated and the smaller is selected.

Answer 5. (b)

(I) Automobile manufacturer should follow simplification for the following reasons :

- Since many parts and processes are involved , simplification reduces production control problems.
- Simplification would enable use of special purpose machines with permanently installed special purpose tooling ,since high precision jobs are involved.
- Semi skilled workforce can be employed in place of highly skilled , thus reducing labour costs;
- Since a variety of raw materials/ components inventory is needed , simplification would help in reducing inventory.

(II) Cosmetics manufacturer should follow diversification for the following reasons :

- Seasonal fluctuations in demand for different types of cosmetics can be met.
- Risk of loss due to certain products is minimized.
- Provides better customer service by offering a wide choice of items in this high fashion industry
- Overhead Costs are spread over a larger sales volume, thus reducing overall costs.

Q. 6. (a) Sajo Beauty Salon (SBS) estimate that their customers on any day depend on the number of women visiting the Shopping Mall in which SBS is located. The relationship is expressed as :

$$A = (W/50) - 10$$

Where A = No. of customers

W = No. of women visiting the Mall

The total variation and the explained variation are 3200 and 2626, respectively.

Find :

- (i) The co-efficient of correlation.
 - (ii) The co-efficient of determination.
 - (iii) On Women's Day, 3500 ladies visited the Mall. How many customers should have been expected at SBS?
- (b) The targeted weekly output of a manufacturing unit employing 20 workers is 400 pieces. The group is entitled to earn an incentive @ 10% on aggregate of wages based on basic piece rate plus dearness allowance (which is ₹ 120 per week) upon achievement of a minimum of 80% of the output target. This incentive rate is increased by 2.5% flat for every 10% increase in achievement of targets upto a maximum of 10% at the level of 120% of the output target in the following manner :

Output Target	Incentive Rate
80%-90%	10%
90%-100%	12.5%
100%-110%	15%
110%-120%	17.5%
120% and above	20%

During the four weeks in February, the actual output achieved by the workers are 383 pieces, 442 pieces, 350 pieces and 318 pieces respectively. The average basic rate is ₹ 5. Compute the amount of incentive earned by the group during each of the four weeks.

Answer 6. (a)

$$(i) \text{ Co-efficient of co-relation } = \sqrt{\frac{\text{Explained variation}}{\text{Total variation}}} = \sqrt{\frac{2626}{3200}} = 0.905884$$

$$(ii) \text{ Co-efficient of determination in case of simple regression is } R^2 = 0.820625$$

$$(iii) A = (W/50) - (10)$$

$$\text{where } W = 3500$$

$$A = (3500/50) - (10) = 70 - 10 = 60$$

The number of customers expected on that day is 60.

Answer 6. (b)**Computation of incentives by group in February**

Particulars	WEEKS			
	1st	2nd	3rd	4th
Actual output achieved (nos. of pieces)	383	442	350	318
Achievement (%) with respect to Standard (actual output/targeted output) × 100	95.75%	110.5%	87.5%	79.5%
Wages at piece rate (₹ 5 × quantity) [₹]	1915	2210	1750	1590
Dearness Allowance [₹]	120	120	120	120
Total [₹]	2035	2330	1870	1710
Incentive Rate (%)	12.5%	17.5%	10%	NIL
Incentive amount earned by group (₹)	254.38	407.75	187	NIL

Q. 7. (a) Explain the term 'cost of quality'.**(b) What are the objectives of using Control Charts for Variables?**

(c) A company manufactures a component on batches of 2000 each. Each component is tested before being sent to the agents for sales. Each component can be tested at the factory at a cost of ₹ 25. If any component is found to be defective, it can be rectified by spending ₹ 200. In view of the large demand for the components and the sophisticated system of manufacture, a proposal came up that the practice of pre-testing of the components be dispensed with to save costs. In that event, any defective component is received back from the customer under warranty, the cost of rectification and redespach will be ₹ 400 per component.

State at what percentage of manufacture of components will the company find it cheaper to pre-test each component.

Answer 7. (a)

The maintenance of quality involves certain expenditure and costs. These are known as Costs of Quality and they comprise of the following :

- Higher cost due to use of better quality of materials.
- Use of more expensive machines of advanced designs.
- Deployment of highly skilled workers , there by increasing total costs.
- Heavy rejections and attendant reworking.
- Costs of disposal of scrap and wastes.

There are three categories of quality :

Cost of Appraisal : The costs associated with measuring, evaluating or auditing products or services to assure conformance to quality standards and performance requirements. For example, incoming and source inspection/test of purchased material, In-process and final inspection/test, product, process or service audits calibration of measuring and test equipment, associated supplies and materials.

Cost of prevention : The costs of all activities specifically designed to prevent poor quality in products or services. Examples are the costs of : New product review, quality planning , supplier capability surveys, process capability evaluations, quality improvement team meetings, quality improvement projects, quality education and training.

Cost of Failure : The costs resulting from products or services not conforming to requirements or customer/user needs. Failure costs are divided into internal and external failure categories.

Internal Failure Costs : Failure costs occurring prior to delivery or shipment of the product, or the furnishing of a service, to the customer. Examples are the costs of : Scrap, Rework, Re-inspection, Re-testing, Material review, Downgrading.

External Failure Costs : Failure costs occurring after delivery or shipment of the product — and during or after furnishing of a service — to the customer. Examples are the costs of: Processing customer complaints, Customer returns, Warranty claims, Product recalls.

Total Quality Costs : The sum of the above costs.

The costs mentioned above get added to the product cost and hence high quality becomes more expensive, generally. Thus cheaper products may not be able to afford the luxury of Costs of Quality.

Answer 7. (b)

The objectives of using Control Chart for Variables are as follows :

- (i) To monitor a production process on a continuing basis.
- (ii) To analyze the process with a view to establishing or changing specifications/production, procedures/inspection and/or procedures.
- (iii) To provide a basis for continuous evaluation of production as to when to look for causes for external variations and to take action with a view to correct a process and when to leave a process alone.
- (iv) To provide a basis for correct decisions on acceptance or rejection of manufactured or purchased product.

Answer 7. (c)

Let the total defectives be 'd'

- (i) **If each component is tested before being sent to the agents for sales**

No. of components in a batch	= ₹ 2000
Cost of testing each component	= ₹ 20
Cost of rectification before despatch	= ₹ 200
Total Cost	= $(2000 \times 25) + 200d$

- (ii) **If components despatched without pre- testing and any defectives received back for rectification under warranty**

Total Cost	= ₹ 400d
In difference point of two alternatives	
$(2000 \times 25) + 200d$	= 400d
$400d - 200d$	= 2000×25
$200d$	= 50,000
d	= $50000/200$
	= 250

Defective Components = 250 components

Percentage of defectives to total components = $\frac{250}{2000} \times 100 = 12.5\%$

Analysis : If defectives exceed 12.5% of the total number of components, pre-testing is recommended.

Q. 8. (a) A factory has three departments X, Y, and Z to manufacture two products A and B. Department 'X' can produce parts for 7000 units of A or parts for 12000 units of B per week but cannot do both at the same time, though parts for some A and for some B can be produced. Similarly Department 'Y' can produce 9000 parts for A or 6000 parts for B or combinations in between.

Final assembly is undertaken in department 'Z' with separate assembly lines for A and B with maximum capacities by 6000 and 4000 units respectively. Both lines can be operated at the same time. What is the optimal Product Mix?

(b) A turning department wants to install enough semi automatic lathes to produce 2,50,000 good components per year. The turning operation takes 1.5 minutes per component. But it is observed that the output of lathes will have 3 percent defectives. How many lathes will be required, if each one is available for 2,000 hours of capacity per year?

Answer 8. (a)

Let the optimal quantity of the product 'A' be M numbers and optimal quantity of product 'B' be N numbers.

So constraints of 'X' will be

$$M/7000 + N/12000 \leq 1$$

Ignoring inequality,

$$M/7000 + N/12000 = 1$$

$$\text{Or, } 12M + 7N = 84000 \quad \dots (i)$$

From the constraints of 'Y' department,

$$M/9000 + N/6000 \leq 1$$

Ignoring inequality,

$$M/9000 + N/6000 = 1$$

$$\text{Or, } 6M + 9N = 54000 \quad \dots (ii)$$

From the constraints of Z department,

$$M < 6000 \quad \dots (iii)$$

$$N < 4000 \quad \dots (iv)$$

Solving equation (i) and (ii)

$$12M + 18N = 108000 \quad \dots (ii) \times 2 \quad \dots (v)$$

$$12M + 7N = 84000$$

Subtracting (i) from (v)

$$11N = 24000$$

$$N = 2181.8.$$

Substituting the value of N in Eq. (ii)

$$6M + 9 \times 2182 = 54000$$

$$\text{Or, } 6M = 54000 - 19638$$

$$\text{Or, } 6M = 34362$$

$$\text{Or, } M = 5727.$$

The values of M & N thus obtained satisfies the equations (iii) and (iv).

Therefore the optimal Product Mix is 5728 units of A & 2182 units of B.

Answer 8. (b)

$$\begin{aligned}
 \text{Required system capacity} &= \frac{\text{Actual good components required}}{\text{System efficiency}} \\
 &= \frac{2,50,000}{0.97} = 2,57,732 \text{ components per year.} \\
 &= \frac{2,57,000 \text{ components per year}}{2000 \text{ hours per year}} = 129 \text{ units/hr.}
 \end{aligned}$$

$$\begin{aligned}
 \text{Individual lathe capacity} &= \frac{60 \text{ minutes per hour}}{1.5 \text{ minutes per component}} \\
 &= 40 \text{ components per machine hours.}
 \end{aligned}$$

$$\begin{aligned}
 \text{Number of lathes required} &= \frac{129 \text{ units per hour}}{40 \text{ units per machine hour}} \\
 &= 3.2 \text{ machines}
 \end{aligned}$$

Now the firm can go for 3 or 4 lathes. If it installs three machines, it may have to carefully manage the capacity by proper scheduling or using overtime or by over loading of lathes. If it installs 4 machines, the firm will have some excess capacity. This idle capacity may be utilized by accepting orders, which need the services of lathes, or it can lease the capacity to the firms, which needs the capacity.

Q. 9. (a) A Company adopts a counterseasonal product strategy to smooth production requirements. It manufactures its spring product line during the first four months of the year and would like to employ a strategy that minimises production costs while meeting the demand during these four months. The Company presently has on its rolls, 30 employees with an average wage of ₹ 1,000 per month. Each unit of the product requires 8 man-hours. The Company works on single shift basis (8 hrs. shift/day). Hiring an employee costs ₹ 400 per employee per occasion and discharging an employee costs ₹ 500 per person per occasion. Inventory carrying costs are ₹ 5/unit/month and shortage costs are ₹ 100/unit/month. The Company forecasts the demand for the next four months as below :

Month	(Demand units)	No. of working days in the month
January	500	22
February	600	19
March	800	21
April	400	21

The Company is thinking of adopting one of the following pure strategies:

Plan 1 : Vary work force levels to meet the demand.

Plan 11 : Maintain 30 employees and use inventory and stockouts to absorb demand fluctuations.

Which strategy would you recommend? You may assume nil inventory at the start.

(b) An item exhibiting a constant hazard rate has a reliability of 90 per cent for an operating time of 500 hours.

- What is the average failure rate of the item?
- What is the MTBF?

(iii) What is the reliability of the item for an operating time of 1000 hours? for 2000 hours?

(iv) Corresponding to a reliability of 0.5, what is the operating time? (Reliability is given by $e^{-\lambda t}$ where λ is average failure rate)

(c) Discuss the points to be considered while designing a Maintenance programme for an organization?

Answer 9. (a)

The overall costs of both the strategies are computed in the following tables.

Plan I : Varying the work force levels to suit the production needs :

	January	February	March	April	Total
1. Workers required	$\frac{500}{22} = 23$	$\frac{600}{19} = 32$	$\frac{800}{21} = 38$	$\frac{400}{21} = 19$	
2. Labour cost	23000	32000	38000	19000	112000
3. Hiring costs		9×400 = 3600	6×400 = 2400		6000
4. Lay off costs	7×500 = 3500			19×500 = 9500	131000
					Total 131000

Plan II : Maintain a steady work force and use of inventory plus stock on

	January	February	March	April	Total
1. Workers used	30	30	30	30	
2. Labour cost	30000	30000	30000	30000	1,20,000
3. Units produced	660	570	630	630	
4. Inventory costs	5×160 = 800	5×130 = 650		5×190 = 950	2400
5. Shortage costs			100×40 = 4000		4000
					Total 1,26,400

On the basis of costs, Plan II would be the choice. Moreover this strategy would result in higher worker morale, smoother production, and generally, a higher quality product.

Answer 9. (b)

The item is exhibiting a constant hazard rate or age specific failure rate; which means, it is showing a negative exponential failure behaviour. In this case the reliability is given by $e^{-\lambda t}$ where λ is the average failure rate.

(i) For our problem $t = 500$ hours and $e^{-\lambda t} = 0.90$

Thus, $e^{-\lambda t} = e^{-\lambda (500)} = 0.90$

Therefore, $\lambda = \frac{(0.105)}{500} = 0.00021$, which is the average failure rate per hour.

(ii) Now, MTBF = $\frac{1}{\lambda} = \frac{1}{0.00021} = 4761.9$ hours.

(iii) Reliability for 1000 hours :

$$= e^{-\lambda t} \text{ where } t \text{ is 1000 hours.}$$

$$= e^{-(0.00021) \times (2000)} = e^{-0.21} = 0.8106$$

Reliability for 2000 hours :

$$= e^{-(0.00021) \times (2000)} = 0.6570$$

(iv) Corresponding to a reliability of 0.5, we have :

$$e^{-\lambda t} = 0.5000$$

$$\text{i.e. } e^{-(0.00021) \times (t)} = 0.5000$$

$$\text{Therefore, } -(0.00021) (t) = 0.639$$

$$\text{i.e. } t = 3300 \text{ hours}$$

Thus, the item has a reliability of 0.50 for an operating time of 3300 hours.

Answer 9. (c)

While designing a maintenance programme the main objective of management should be to reduce the total cost of maintenance without sacrificing the efficiency and effectiveness of the plant. The following points are to be considered while designing a maintenance programme :

- (i) The maintenance operation should increase the life of the asset at affordable cost.
- (ii) The maintenance programme should not affect the normal working of the plant. This involves proper planning, having spare machines etc.
- (iii) Manpower required for maintenance plan should be determined and proper training should be imparted to them.
- (iv) The equipments may be classified according to their criticality.
- (v) Lubrication schedules should be prepared, spares and equipment replacement policy should be decided.
- (vi) The maintenance plan should be communicated to all concerned.
- (vii) Modern techniques like OR, PERT to be employed in carrying out maintenance.
- (viii) Maintenance standard time may be fixed.
- (ix) The programme itself may have to be modified in light of the experience gained.

Q. 10. (a) Explain, in brief the various reasons for holding inventory in context of operations management.

(b) A firm has to place orders for the supply of raw materials every three months. The raw materials are procured from a supplier at periodic intervals. The annual requirements of the raw materials amount to ₹ 12 lacs. The cost of ordering is estimated to be ₹ 5000/- per order and the cost of carrying inventory is estimated to be 25% of the value of inventory. Average lead time for procurement of the raw materials from the supplier is observed to be two months. The demand for the raw materials can be approximated to a normal distribution with a standard deviation of ₹ 1 lac per period. Design an inventory system for the raw materials for a service level of 97.5%.

(c) Discuss the managerial uses of Break-even Analysis.

Answer 10. (a)

Inventory may broadly be held for precautionary, speculative and transaction motives. These may be discussed as under :

(i) **Precautionary** : Business is characterised by uncertainties. Some industries are also seasonal in nature. In order to protect the production flow from stock outs, customers from being deprived of the product and consequently changing his loyalty in favour of some other brands etc. the industries play safe by holding stock of raw materials, WIP and finished goods. For seasonal industries, to smoothen the demand throughout the period, some amount of stock piling may be necessary.

(ii) **Transaction** : Inventories are required for day to day work. If a JIT concept is being used, no inventory will be held. However since JIT is a terminal concept, so long such a system is finally achieved, some amount of stock is to be maintained. There may be a balancing problem requiring building up of in process inventory. Economic order quantity or batch quantity may also be required to trade off between the number of orders or set up costs to that of carrying of inventories.

There may also be instances of items calling for long lead time and delivery time. Items that are to be imported or have to be brought from a long distance, may result in inventories-in-transit. In the era of globalisation, sourcing of raw materials or process goods from different countries have become quite common. This ordinarily calls for an inventory blocking.

(iii) **Speculation** : Finally, holding up of stock may also be because of a speculative reason. The prices of raw material or finished goods may go up. The company may like to take this opportunity to reap benefits by holding inventories.

However, since the resources are limited, hoarding of stock could not be encouraged as it may lead to wide spread speculation resulting in economic gambling.

Answer 10. (b)

Let the cost of the item = ₹ C/unit

No. of units in one year = ₹ 1200000/C

Inventory Carrying Cost = 0.25C

EOQ in units = $\sqrt{[2 \times (1200000/C) \times 5000] / 0.25C} = 219089/C$

So EOQ in rupee terms = EOQ in units $\times C = ₹ 219809/-$

No. of orders per annum = $1200000/219089 = 5.48$ i.e 5 to 6 orders.

Ordering policy is quarterly , i.e 4 orders per annum. Hence, it is not optimal.

Average lead time consumption = $1200000/12 = ₹ 200,000$.

Inventory System Design :

Since company has to place orders every three months, the inventory system at a 97.5% service level may be computed as under :

S.D per period = ₹ 1 lac (period signifies present ordering period i.e 3 months)

Variance = ₹ 100000² for three months.

Variance for 5 months = ₹ 100000² $\times 5/3$

Order is being placed every 3 months while lead time is 2 months. So average stock required to be maintained is for 5 months = ₹ $1200000/12 \times 5 = ₹ 500000$.

Safety stock at a service level of 97.5% is 2σ for this period i.e $2 \times 100000 \times \sqrt{5/3}$

Where $100000 \times \sqrt{5/3}$ is S.D = ₹ 258200 (approx)

So Total Stock = ₹ $(500000 + 258200) = ₹ 758200$.

Safety Stock = ₹ 258200.

This will indicate the inventory system.

Answer 10. (c)

Managerial uses of Break-even Analysis are as follows :

- (i) **Capacity planning** : The BEA helps the management in understanding the impact of increase in output on fixed and variable costs of the organization.
- (ii) **Choice of technique of production** : Useful guide in selecting the most economical production process or equipment.
- (iii) **Product mix decision** : Helps to find out the best combination of product that can maximize profit.
- (iv) **Plant shutdown decision** : During recession when demand for a product falls considerably, BEA facilitates such decision by differentiating between sunk and out of pocket costs.
- (v) **Add or drop a product** : BEA helps management in product planning by indicating the impact of such decision on costs and earning of the enterprise.
- (vi) **Make or buy decision** : BEA helps management to decide whether spare parts and components are to be manufactured in-house or purchased from market.
- (vii) Volume required to achieve target profits.

Q. 11. (a) A company manufactures a specialised equipment. Direct labour required to make the first equipment is 2000 hours. Learning curve is 80%. Direct labour cost is ₹ 4 per hour. Direct material needed for one equipment is ₹ 7,200. Fixed overheads are ₹ 32,000.

Required :

- (i) Using the Learning Curve Concept calculate the expected average unit cost of making—
(a) 4 equipments, (b) 8 equipments.
- (ii) After manufacturing 8 equipments, if a repeat order for manufacture of another 8 equipments is received, what lowest price can be quoted for the repeat order?
- (b) A learning curve has strategic implications. Discuss.
- (c) It is not worthwhile to improve the productivity when the industry is facing recession leading to reduction in profits. Comment.

Answer 11. (a)

Working Notes :

Cumulative production	Labour hours required for manufacture of each equipment	
1	2000	
2	1600	(2000 × 80%)
4	1280	(1600 × 80%)
8	1024	(1280 × 80%)
16	819.20	(1024 × 80%)

(i) Calculation of cost per equipment

Particulars	4 machines ₹	8 machines ₹
Materials	7,200	7,200
Labour (1280 × 4)	5,120 (1024 × 4)	4,096
Overheads (32,000/4)	8,000 (32,000/8)	4,000
	20,320	15,296

(ii) Labour hours required for each machine after manufacturing 8 equipments

(Labour Hours)

8 Machines	(1024 × 8)	8192
16 Machines	(819.2 × 16)	13107
Hours for 8 additional machines		4915
Each additional machine	(4915/8)	615

Quotation for repeat order after manufacturing 8 equipments

(₹)

Materials		7,200
Labour	(615 L.H. × ₹ 4)	2,460
Overheads		—
Total		9,660

Answer 11. (b)

The learning curve is particularly important in productivity improvement results during the rapid development and mature phases of the product life cycle. Its uses in strategic planning is discussed below :

- (i) A firm which has the largest market share will produce the largest number of units and will have the lowest cost, even if all the firms are on the same percentage learning curve.
- (ii) If through process technology advantages ,a firm can establish itself on a lower percent learning curve than a competitor, it will have lower unit cost, even if both firms have the same cumulative output.
- (iii) A firm with greater experience can use an aggressive price policy as a competitive weapon.
- (iv) A firm can use aggressive process technology policy by allocating resources towards mechanization in earlier stages and automation in the later stages of growth to maintain its position.

Answer 11. (c)

This statement is not correct. Productivity improvement has to be constantly done in industry. While productivity improvements during periods of economic boom can lead to greater profits, productivity improvement during economic recession, is all the more necessary for cost reduction and lesser losses. With improved productivity, the unit cost of production is reduced, thereby minimizing the losses in such a situation. Put in other words, a company would end up with longer losses, if it does not care to improve productivity during recessionary periods.

Q. 12. (a) As a cargo loader for North West Airlines, you are charged with the responsibility of setting a time standard (in minutes) for uploading refrigerated unitized loads. The following study was conducted over 300 hours with 900 uploadings performed.

Composite Worker Rating (in percent)	Activity	Number of Times Observed
80	Manually check and lift unitized load onto trailer	100
100	Tow loaded trailer with tractor to aircraft	300
120	Check electrical contracts holding pins and safety wires (called <i>wiring out</i> ; this time will be reduced by 50 percent by an additional inspection during manufacture of the containers)	400
90	Correct any malfunctioning observed during wiring out	100
110	Load unitized load into plane bay with automatic lift	400
140	Return tractor and trailer to warehouse	300
	Personal or idle time	400

Official North West personal time allowance fraction is 0.10 for an eight-hour work day *unless otherwise stated*; it is not otherwise stated here.

(b) Define work sampling. Write down the formula indicating terms used for determining the sample size.

Answer 12. (a)

$$\begin{aligned}\text{Average cycle time} &= \frac{300 \text{ hours}}{900 \text{ uploadings}} \\ &= \frac{1}{3} \text{ hour} \\ &= 20 \text{ minutes}\end{aligned}$$

Normal Minutes/Uploading

$$20 \times \frac{100}{2000} \times .80 = 8.0 \text{ minutes}$$

$$20 \times \frac{300}{2000} \times 1.00 = 3.0 \text{ minutes}$$

$$20 \times \frac{400}{2000} \times 1.20 \times 0.50 = 2.4 \text{ minutes}$$

$$20 \times \frac{100}{2000} \times .90 = .9 \text{ minutes}$$

$$20 \times \frac{400}{2000} \times 1.10 = 4.4 \text{ minutes}$$

$$20 \times \frac{300}{2000} \times 1.40 = 4.2 \text{ minutes}$$

Total normal time minutes/uploading = 22.9 minutes

$$\text{Standard time} = \frac{15.7 \text{ minutes/uploading}}{1 - .10} = 25.4 \text{ minutes/uploading}$$

$$= .42 \text{ hours/uploading.}$$

Answer 12. (b)

Work sampling is a work measurement technique in which a sufficient large number of instantaneous observations of a worker or machine are taken over a period of time to obtain a reasonably accurate picture of the time spent on different activities. It is based on statistical theory of sampling. Work sampling is thus a method of finding out percentage occurrence of a certain activity or delay by statistical sampling.

The procedure of work sampling consists of following steps :

- (i) The purpose of study to be determined first.
- (ii) The worker or machine to be identified.
- (iii) The operations to be observed to be decided.
- (iv) The number of observations to be made to be decided.
- (v) The activity performed at each visit to be recorded.
- (vi) Percentage of total time spent on each activity to be calculated.
- (vii) Standard time is established by adding allowances.

The formula deciding the sample size is as follows :

$$n = \{4p(1-p)\}/s^2 \text{ where,}$$

n = sample size

p = extent of activity being observed.

s = accuracy of sample results.

- Q. 13. (a) Given below are the observations of a work sampling study of a maintenance gang. Calculate (i) Individual utilization, (ii) Percent time lost for each cause by the gang, (iii) Overall utilization and its accuracy for 95% confidence limit.

Worker	Round Number									
Worker	1	2	3	4	5	6	7	8	9	10
Fitter No. 1	W	B	B	S	W	B	B	B	A	A
Fitter No. II	S	S	B	B	B	G	G	A	B	B
Welder	W	G	B	B	B	A	I	B	B	A
Electrician	W	W	S	B	B	B	I	B	B	W
Helper	I	B	B	I	B	B	A	B	B	I

B = Busy in worksite, working. W = Walking between Jobs. G = Getting materials or tools. S = Getting instructions. I = Idle. A = Away, not in work spot.

- (b) Under what circumstances would work or activity sampling be preferable to time study for developing labour standards?
- (c) Five architectural rendering jobs are waiting to be assigned at AST Ltd. Their work (processing) times and due dates are given in the following table. The company wants to determine the sequence of processing according to (1) FCFS, (2) SPT, (3) EDD, and (4) LPT rules. Jobs were assigned a letter in the order they arrived.

Job	Job Work (Processing) Time (Days)	Job Due Date (Days)
A	6	8
B	2	6
C	8	18
D	3	15
E	9	23

Answer 13. (a)

There are fifty observations out of which 26 observations shows busy, 6 readings shows walking between machines, 4 readings are getting instructions, 6 readings are away, 3 readings are getting materials and 5 are idle.

- (a) Fitter I is busy 5 times out 10 readings, hence individual utilisation is 50%.
Fitter II is busy 5 times out of 10 readings, hence individual utilisations is 50%.
Welder and electrician are also 5 times busy out of 10 readings; hence individual utilisation is 50%.
Helper is 6 times busy hence his utilisation is 60%.

- (b) Time lost in walking is $\frac{6}{50} = 12\%$

Time lost in getting material $\frac{3}{50} = 6\%$

$$\text{Time lost in getting instructions} = \frac{4}{50} = 8\%$$

$$\text{Time lost in getting away from work spot} = \frac{6}{50} = 12\%$$

$$\text{Idle time} = \frac{5}{50} = 10\%$$

(c) For 95% confidence limit and number of observations 50,

$$S \times p = 2 \times \sqrt{\left\{ \frac{p \times (1-p)}{n} \right\}}, \text{ Here } p = \frac{26}{50} \text{ as 26 times busy out of 50 readings. } = 0.52$$

$$q = 1 - p = 1 - 0.52 = 0.48 \text{ and } n = 50.$$

$$S \times 0.52 = 2 \times \sqrt{\frac{(0.52 \times 0.48)}{50}} = 2 \times \sqrt{0.005} = 2 \times 0.071 = 0.141$$

$$S = \frac{0.141}{0.52} = 0.027 \text{ say approximately } \pm 3\%.$$

Answer 13. (b)

Time study calls for qualified time study engineer or rate setter recording the time for an activity over time. For predetermined time setting, detailed process sequencing and corresponding time for each process has to be computed. The advantages of work sampling over time study are as follows :

- (i) Studies of several operators and machines can be done simultaneously.
- (ii) No trained time study personnel are required.
- (iii) No timing equipment required.
- (iv) Long cycle work may be studied with fewer observer hours.
- (v) The study may be interrupted at any time without any adverse consequences.
- (vi) Operator can not influence results as he is not aware as to the precise timing at which he would be observed.
- (vii) Also he tends to perform naturally as he does not get the feeling of someone breathing down his neck as in the case of time study where the operator is watched continuously.

Answer 13. (c)

1. The FCFS sequence shown in the next table is simply A-B-C-D-E. The "flow time" in the system for this sequence measures the time each job spends waiting plus time being processed. Job B, for example, waits 6 days while Job A is being processed, then takes 2 more days of operation time itself; so it will be completed in 8 days — which is 2 days later than its due date.

Job Sequence	Job Work (Processing) Time	Flow Time	Job Due Date	Job Lateness
A	6	6	8	0
B	2	8	6	2
C	8	16	18	0
D	3	19	15	4
E	9	28	23	5
	28	77		11

The first-come, first-served rule results in the following measures of effectiveness :

$$(i) \text{ Average completion time} = \frac{\text{Sum of total flow time}}{\text{Number of jobs}}$$

$$= \frac{77 \text{ days}}{5} = 15.4 \text{ days}$$

$$(ii) \text{ Utilization} = \frac{\text{Total job work (processing) time}}{\text{Sum of total flow time}}$$

$$= \frac{28}{77} = 36.4\%$$

$$(iii) \text{ Average number of jobs in the system} = \frac{\text{Sum of total flow time}}{\text{Total job work (processing) time}}$$

$$= \frac{77 \text{ days}}{28 \text{ days}} = 2.75 \text{ jobs}$$

$$(iv) \text{ Average job lateness} = \frac{\text{Total late days}}{\text{Number of jobs}} = \frac{11}{5} = 2.2 \text{ days}$$

2. The SPT rule shown in the next table results in the sequence B-D-A-C-E. Orders are sequenced according to processing time, with the highest priority given to the shortest job.

Job Sequence	Job Work (Processing) Time	Flow Time	Job Due Date	Job Lateness
B	2	2	6	0
D	3	5	15	0
A	6	11	8	3
C	8	19	18	1
E	9	28	23	5
	28	65		9

Measurements of effectiveness for SPT are :

$$(i) \text{ Average completion time} = \frac{65}{5} = 13 \text{ days}$$

$$(ii) \text{ Utilization} = \frac{28}{65} = 43.1\%$$

$$(iii) \text{ Average number of jobs in the system} = \frac{65}{28} = 2.32 \text{ jobs}$$

$$(iv) \text{ Average job lateness} = \frac{9}{5} = 1.8 \text{ days}$$

3. The EDD rule shown in the next table gives the sequence B-A-D-C-E. Note that jobs are ordered by earliest due date first.

Job Sequence	Job Work (Processing) Time	Flow Time	Job Due Date	Job Lateness
B	2	2	6	0
A	6	8	8	0
D	3	11	15	0
C	8	19	18	1
E	9	28	23	5
	28	68		6

Measurements of effectiveness for EDD are :

(i) Average completion time = $\frac{68}{5} = 13.6$ days

(ii) Utilization = $\frac{28}{68} = 41.2\%$

(iii) Average number of jobs in the system = $\frac{68}{28} = 2.43$ jobs

(iv) Average job lateness = $\frac{6}{5} = 1.2$ days

4. The LPT rule shown in the next table results in the order E-C-A-D-B.

Job Sequence	Job Work (Processing) Time	Flow Time	Job Due Date	Job Lateness
E	9	9	23	0
C	8	17	18	0
A	6	23	8	15
D	3	26	15	11
B	2	28	6	22
	28	103		48

Measurement of effectiveness for LPT are :

(i) Average completion time = $\frac{103}{5} = 20.6$ days

(ii) Utilization = $\frac{28}{103} = 27.2\%$

(iii) Average number of jobs in the system = $\frac{103}{28} = 3.68$ jobs

(iv) Average job lateness = $\frac{48}{5} = 9.6$ days

The results of these four rules are summarized in the following table :

Job Sequence	Job Work (Processing) Time	Flow Time	Job Due Date	Job Lateness
FCFS	15.4	36.4	2.75	2.2
SPT	13.0	43.1	2.32	1.8
EDD	13.6	41.2	2.43	1.2
LPT	20.6	27.2	3.68	9.6

LPT is least effective measure for sequencing for AST Ltd. SPT is superior in 3 measures, and EDD is superior in the forth (average lateness).

Q. 14. (a) A project consists for four (4) major jobs, for which four (4) contractors have submitted tenders. The tender amounts, in thousands of rupees, are given below :

Contractors	Jobs			
	A	B	C	D
1	120	100	80	90
2	80	90	110	70
3	110	140	120	100
4	90	90	80	90

Find the assignment, which minimizes the total cost of the project. Each contracts has to be assigned one job.

(b) Write short notes on :

- (I) Line of Balance
- (II) Sound incentive plan
- (III) Supply Chain Management

(c) What do you understand by the term 'utilities' in a factory? Briefly describe the different 'Utilities' required in a factory.

Answer 14. (a)

The given problem is a standard minimization problem. Subtracting the minimum element of each row from all its elements in turn, the given problem reduces to

Contractors	Jobs			
	A	B	C	D
1	40	20	0	10
2	10	20	40	0
3	10	40	20	0
4	10	10	0	10

Now subtract the minimum element of each column from all its elements in turn. Draw the minimum number of lines horizontal or vertical so as to cover all zeros.

Contractors	Jobs			
	A	B	C	D
1	30	10	0	10
2	0	10	40	0
3	0	30	20	0
4	0	0	0	10

Since the minimum number of lines to cover all zeros is equal to 4 (= order of the matrix), this matrix will give optimal solution. The optimal assignment is made in the matrix below :

Contractors	Jobs			
	A	B	C	D
1	30	10	0	10
2	0	10	40	∞
3	∞	30	20	0
4	∞	0	∞	10

The optimal assignment is

Contractors	Job	Cost (in thousands of rupees)
1	C	80
2	A	80
3	D	100
4	B	90

Hence, total minimum cost of project will be ₹ 3,50,000.

Answer 14. (b)

- (I) Line of Balance is a production planning system, which schedules key events necessary for completing an assembly with respect to delivery dates for completed system. Graphic displays are used to monitor progress achieved on a project and to indicate where an objective is not being met. Thus the LOB technique is based on the principle of 'Management by Exception' wherein, management attention is directed to existing or potential problems. The LOB technique is a useful complement to PERT and Gantt Charts.
- (II) Incentive is a management tool that is used to motivate the employees to work towards attainment of organizational goals. Well developed and properly operated incentive can yield significant productivity gains. Incentive plans may be financial or non-financial, individual or group. Characteristics of a sound incentive plan are as follows :
- Simple* : Simple enough for employees to understand easily and compute his own incentive pay.
 - Accurate* : Scheme should be based on accurate and scientific standards.
 - Secure* : A minimum basic wage should be guaranteed to all employees irrespective of the reward.
 - Effective* : The incentive plan should convince the workers that they are being accurately rewarded for good performance.
 - Economy* : The incentive plan should result in reduction in unit cost of production. Administration cost of implementing the plan should be justifiable.
 - Equity* : The scheme should be beneficial to both management and employees.
 - Control systems* : The plan should be coordinated properly with control procedures like QC, Inventory control, production control etc.
 - Flexible* : The plan should provide for revision of standards when changes in underlying conditions take place and modifications agreed with trade unions should be clearly specified.
 - Basis whether individual or group should be clearly stated.
 - Grievance machinery* : This will help in prompt redressal of complaints arising out of the plan. Adjustments should be made for failure beyond the control of workers.

(III) **Supply Chain Management** : The term 'supply chain' comes from a picture of how organizations are linked together. If we start with purchase department and work down on the supply side, we find a number of suppliers, each of whom in turn has its own supplier. This can indeed be a complex network or a series of chains.

The objectives of supply chain management are reduction of uncertainty and risk in the supply chain which will enable reduction in inventory levels, cycle time of processing and ultimately improve end-customer service levels. The focus is on system optimization. Some of the useful tools are forecasting, aggregate planning, inventory management, scheduling etc.

The forecast becomes an input to the aggregate plan, which sets the guidelines and constraints for development of an inventory system from which the detailed workforce and equipment schedules can be determined. The decisions made in one node of the supply-chain affect the other areas, e.g if an automobile industry factory plans to assemble 1000 vehicles in a given period, it is imperative that the supplier of tyres makes available 4000 tyres at the plant in time for use on the assembly line.

The overall plan needs to be optimized so that adequate number of men, materials and time available to meet the requirements.

Answer 14. (c)

Utilities comprise of the auxiliary and support facilities required to operate the main production facilities. These are very crucial, especially, in a process plant. Sometimes, in continuous chemical processing plants, utilities like de-mineralized water and steam become process inputs. In steel making, oxygen is an input. Compressed air plays a key role in instrumentation and conveying of materials.

Some common 'Utilities' are :

- (i) **Water** : This is a very important utility and refers to water storage, water treatment, steam generation, other industrial uses including potable water, cooling water, water for fire fighting/irrigation of landscapes, etc., This is a scarce resource and recycling is important. Role of water is very crucial in some chemical, metallurgical and power plants and in such cases water alone determines the survival of the plant.
- (ii) **Compressed Air** : A bunch of compressors is installed for producing compressed air used in instruments and for pneumatic conveying equipment.
- (iii) **Steam** : Process Steam is generated through suitable boilers depending on pressure, temperature and quantity of steam required. Process steam is normally used for heating process vessels, etc.
- (iv) **Captive Power** : is an important utility and its role is likely to increase in future, with the advent of power sector reforms in the country and with no improvements in sight in the existing power scenario. Conventional choices are thermal power, diesel gensets and gas turbines. Non-conventional sources growing in popularity in the recent times are solar energy systems, windmills, etc.
- (v) **Effluent Treatment** : With stringent environmental regulations and increasing public awareness, air, water and solid waste pollutants have to be monitored, controlled and kept within the statutory limits.
- (vi) **Others** : There are a number of other utilities required in a manufacturing organization like Heating, Ventilation, A.C. and Refrigeration Plants, Humidification Systems, Oxygen Plants, Chemical Recovery Systems Fire Protection, Communication Systems, etc.

- Q. 15. (a) A company has 3 plants and 3 warehouses. The cost of sending a unit from different plants to the warehouses, production at different plants and demand at different warehouses are shown in the following cost matrix table :

Plants	Warehouses			Production
	P	Q	R	
A	8	16	16	152
B	32	48	32	164
C	16	32	48	154
Demand	144	204	82	

Determine a transportation schedule, so that the cost is minimized. Assume that the cost in the cost matrix is given in thousand of rupees.

- (b) Competent Automobile is an authorised service centre of Maruti Cars. A new manager employed wants to analyse the efficiency of work and service personnel. To facilitate his analysis, he has classified the service procedure into the following seven activities :

Activity	Duration (Hrs.)	Precedence Activity
A	8	—
B	4	—
C	6	A
D	9	B
E	11	A
F	3	C
G	1	D, E, F

Help him by—

- Drawing the network diagram.
- Finding the critical path.
- Calculating the expected time for service of a car.
- Amount of slack time for the technician in each activity.
- Computing the Earliest Starting and Finishing Time.
- Computing the Latest Finishing and Starting Time.

- (c) What is Technology Life Cycle?

Answer 15. (a)

The given problem is an unbalanced transportation problem since the demand (= 430 units) is 40 units less than the production (= 470). It is converted into a balanced problem by a dummy warehouse as given below :

Plants	Warehouses				Production
	P	Q	R	Dummy	
A	8	16	16	0	152
B	32	48	32	0	164
C	16	32	48	0	154
Demand	144	204	82	40	

The objective of the company is to minimize the transportation cost. Let us apply Vogel's approximation method for finding the initial feasible solution :

Plants	Warehouses				Production	Row Penalty
	P	Q	R	Dummy		
A	8	152	16	0	152/0	88
B	32	42	82	40	164/124/42/0	32 0 0 16
C	144	10	48	0	154/10/10	16 16 16 16
Column Penalty	144/0	204/52/42/0	82/0	40/0		
	8	16	16	0		
	8	16	16	-		
	16	16	16	-		
	-	16	16	-		

The solution obtained by VAM is given below :

Plants	Warehouse				Production
	P	Q	R	Dummy	
A	8	152	16	0	152
B	32	42	82	40	164
C	144	10	48	0	154
Demand	144	204	82	40	

The initial solution is tested for optimality. There are 6 (= m+n-1) independent allocations. Let us introduce $u_i, v_j, i = (1, 2, 3), j = (1, 2, 3, 4)$ such that $\Delta_{ij} = c_{ij} - (u_i + v_j)$ for allocated cells.

We assume $u_2 = 0$ and remaining u_i 's, v_j 's and Δ_{ij} 's are calculated as below :

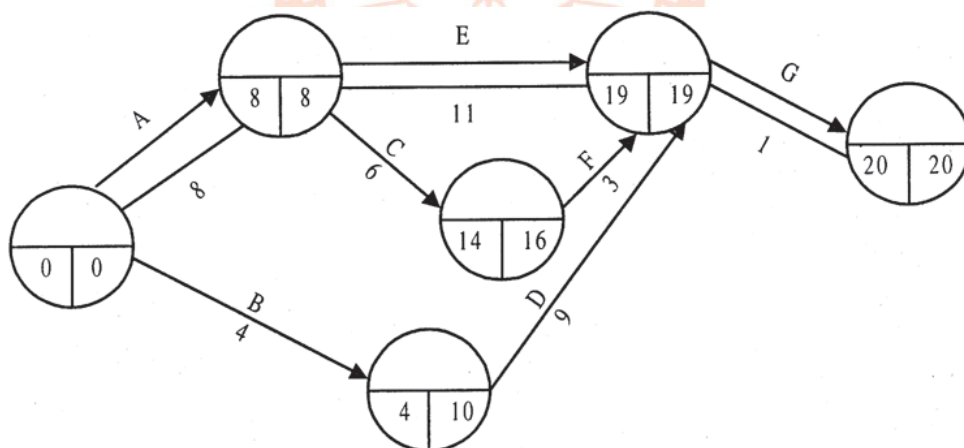
Plants	Warehouse				u_i
	P	Q	R	Dummy	
A	8	152	16	32	-32
	8	16	16	0	
B	0	42	82	40	0
	32	48	32	0	
C	144	10	32	16	-16
	16	32	48	0	
V_j	32	48	32	0	

On calculating Δ_{ij} 's for non-allocated cells, we found that their values are positive, hence the initial solution obtained above is optimal. The optimal allocations are given below :

Plant	Warehouse	Units	Cost per unit	Total cost
A	Q	152	16	2432
B	Q	42	48	2016
B	R	82	32	2624
B	Dummy	40	0	0
C	P	144	16	2304
C	Q	10	32	320
Total				= ₹ 9696

Since one of the Δ_{ij} 's = 0, the solution is not unique. Alternate solution exists.

Answer 15. (b)



- (i) Critical Path : A–E–G
- (ii) Expected time for service of a car : 20 hrs.
- (iii) Slack time for the technician in each of the 3 paths are :
- ACFG : 2 hrs.
- AEG : 0 hrs.
- BDG : 6 hrs.
- (iv) & (v)

Activity	Duration	ES	EF	LF	LS
A	8	0	8	8	0
B	4	0	4	10	6
C	6	8	14	16	10
D	9	4	13	19	10
E	11	8	19	19	8
F	3	14	17	19	16
G	1	19	20	20	19

(ES, EF, LF, LS)

ES - Early Start, EF - Early Finish, LS - Late Start, LF - Late Finish

Answer 15. (c)

Technology Life Cycle comprises of 4 stages, viz., Innovation, Syndication, Diffusion and Substitution.

- (i) **Innovation** : This stage, in turn, comprises of three stages, namely Intelligence, Design and Choice. Intelligence stage involves creation of a product or technology through pure research, applied research, market research, brain storming etc., and selection through preliminary screening and feasibility analysis.
- Design stage** : involves development of the process or technology through which the concept could be given shape and Design and Testing are then done before final launching /adoption. Choice of the desired product/technology paves the way for finally launching the same in the market.
- (ii) **Syndication** : During this stage, the technology/product is demonstrated and slowly commercialized.
- (iii) **Diffusion** : In this stage, the new technology slowly penetrates and replaces the old one. (E.g. Pentium chips have replaced 486 and the colour TV have phased out the Black & White T.V)
- (iv) **Substitution** : Substitution comes in when the cycle is complete and original technology is completely replaced by the advanced one (e.g the valve set radio no more exists.)

Section II : Information Systems

Q. 16. (a) Choose the most appropriate answer from the four alternatives in the set :

(i) For information recording the magnetic tape is divided into vertical columns called :

- (A) Channels
- (B) Tracks
- (C) Grid
- (D) Frames

(ii) Oracle is a software package for :

- (A) MRP
- (B) DBMS
- (C) MIS
- (D) TQM

(iii) Tree topology is :

- (A) Combination of BUS topologies.
- (B) Combination of RING topologies.
- (C) Combination of STAR topologies.
- (D) None of the above.

(iv) .org is an example of

- (A) IP address
- (B) Domain name
- (C) URL
- (D) None of the above.

(v) 'Packet switching' on the Internet refers to :

- (A) Type of circuitry
- (B) Switching components
- (C) Method of data movement.
- (D) Packet of hard copy of documents.

(vi) Military or Defence Service is :

- (A) Open System
- (B) Closed System
- (C) Cannot define
- (D) Not a system.

(vii) First Calculating Machine

- (A) Punch Card machine
- (B) Analytical engine
- (C) Adding machine
- (D) Abacus.

(viii) Personal Digital Assistant is

- (A) Notebook computer
- (B) Micro computer
- (C) Hand held computer
- (D) PC

(ix) Internet surfing is example of

- (A) Full duplex mode of transmission.
- (B) Half duplex mode of transmission.
- (C) Simplex mode of transmission.
- (D) Complex mode of transmission.

(x) One KB stands for :

- (A) 100 bytes
- (B) 10000 bytes
- (C) 999 bytes
- (D) 1024 bytes

Q. 16. (b) Complete the following sentences by putting an appropriate word in the blank position :

- (i) Data access in disk may be defined either in _____ or _____ way.
- (ii) _____ of a file arranges records within a file in some defined sequence.
- (iii) Bootstrapping means loading _____ in Computer after switching on the power.
- (iv) The total volume of work performed by the computer system over a given period of time is termed as _____ .
- (v) A symbol that marks to current position of the mouse on the screen or the point of entry of data is termed as _____ .
- (vi) Peoplesoft is a popular _____ package.
- (vii) Eliminating errors of a program is called _____ .
- (viii) _____ refers to an imitation of actual computer instruction.
- (ix) _____ contains information about the location of a document.
- (x) _____ is the art of secret or hidden message.

Q. 16. (c) Expand the following abbreviations :

- (i) VRML
- (ii) RISC
- (iii) HTTP
- (iv) OOPS
- (v) MFLOPS
- (vi) INGRES
- (vii) B2C
- (viii) A/D
- (ix) SQL
- (x) WYSIWYG

Q. 16. (d) Match Column I with relevant terms in Column II.

Column I	Column II
(i) Black box test	(A) Hierarchical data structure.
(ii) Trojan Horse	(B) Repetitive operation based on Parameters.
(iii) Handshaking	(C) Without internal logic.
(iv) Hang up	(D) Access method on net.
(v) Inverted tree	(E) Buffer storage to reduce processing delays.
(vi) Iteration	(F) Virus hidden inside data or program.
(vii) Bit map	(G) Connected sequence of characters or bits.
(viii) Spooling	(H) Transferring a file from a host computer to user's computer.
(ix) String	(I) Problem in hardware, software or media.
(x) Download	(J) Communication between two pieces of hardware

Answer 16. (a)

- (i) (D) **Frames.**
The magnetic tape storage is divided into vertical columns, called frames and horizontal column called tracks or channels.
- (ii) (B) **DBMS.**
The Oracle Database (commonly referred to as Oracle RDBMS or simply as Oracle) is an object-relational database management system (ORDBMS) produced and marketed by Oracle Corporation.
- (iii) (A) **Combination of BUS topologies.**
Several bus LANs are joined to a main bus through repeaters and bridges to form a structure of a tree.
- (iv) (B) **Domain name.**
A domain name is an identification string that defines a realm of administrative autonomy, authority, or control on the Internet. Last component for the category. ORG stands for organisation (nonprofit making)
- (v) (C) **Method of data movement.**
Packet switching is a digital networking communications method that groups all transmitted data—regardless of content, type, or structure – into suitably sized blocks, called packets.
- (vi) (B) **Closed System.**
Because of their rules, procedures are rigid for sake of strict code of discipline.
- (vii) (D) **Abacus.**
Invented by a Chinese mathematician in 450 BC
- (viii) (C) **Hand held computer.**
A personal digital assistant (PDA), also known as a palmtop computer, or personal data assistant, is a mobile device that functions as a personal information manager. PDAs are largely considered obsolete with the widespread adoption of smartphones.
- (ix) (B) **Half duplex mode of transmission.**
Mode of transmission is both directional but sending or receiving at a time.

(x) (D) **1024 bytes.**

The kilobyte (symbol: kB) is a multiple of the unit byte for digital information. Although the prefix kilo-means 1000, the term kilobyte and symbol kB or KB have historically been used to refer to either 1024 (2^{10}) bytes or 1000 (10^3) bytes, dependent upon context, in the fields of computer science and information technology.

Answer 16. (b)

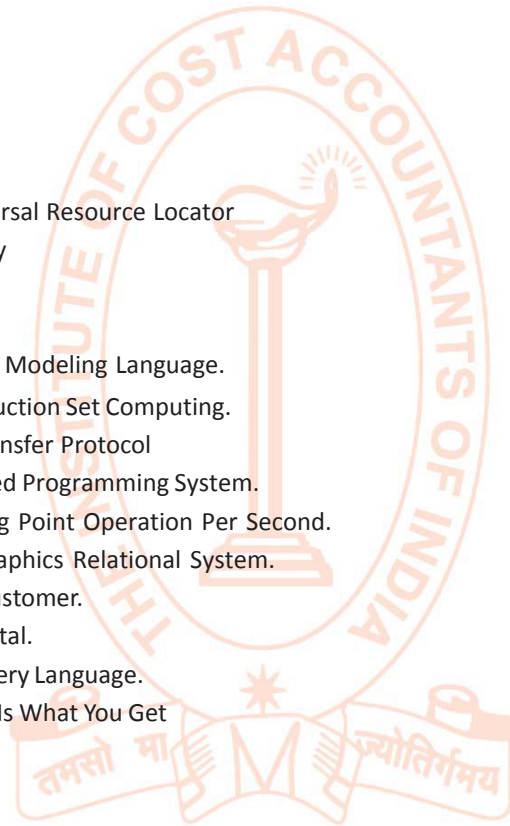
- (i) direct, sequential
- (ii) Sorting
- (iii) Operating System
- (iv) throughput
- (v) cursor
- (vi) ERP
- (vii) debugging
- (viii) Pseudo code
- (ix) URL or Universal Resource Locator
- (x) Cryptography

Answer 16. (c)

- (i) Virtual Reality Modeling Language.
- (ii) Reduced Instruction Set Computing.
- (iii) Hyper Text Transfer Protocol
- (iv) Object Oriented Programming System.
- (v) Million floating Point Operation Per Second.
- (vi) Interactive Graphics Relational System.
- (vii) Business to Customer.
- (viii) Analog to Digital.
- (ix) Structured Query Language.
- (x) What You See Is What You Get

Answer 16. (d)

- (i) — C
- (ii) — F
- (iii) — J
- (iv) — I
- (v) — A
- (vi) — B
- (vii) — D
- (viii) — E
- (ix) — G
- (x) — H



Q. 17. Discuss briefly the following term with reference to Information Technology :

- (a) Stored Program Concept
- (b) Reference files
- (c) System decomposition
- (d) Toggle
- (e) Virtual Memory

Answer 17.

- (a) **Stored program concept :** Computers can perform variety of mathematical calculations without error. They can sort data, merge lists, search files, make logical decisions and comparisons. However, computer is devoid of any original thinking. It is provided with a set of instructions. These instructions are stored in primary memory and executed under the command of the control unit of CPU. This is known as stored program concept.
- (b) **Reference files :** These files contain keys of records in other files. In order to retrieve a record from a file, the reference file is first searched to find out in which file a record can be located.
- (c) A computer system is difficult to comprehend when considered as a whole. Therefore, it is better that the system is decomposed or factored into sub systems. The boundaries and interfaces are defined, so that sum of the sub systems constitutes the entire system. This process of decomposition is continued with sub systems divided into smaller sub systems until the smallest sub systems are of manageable size. The sub systems resulting from this process generally form hierarchical structure.
- (d) **Toggle :** It is a switch or control code that turns an event on or off by repeated action or use. It also means to turn something on or off by repeating the same action.
- (e) Virtual memory is a provision of secondary storage which acts as primary memory. When the size of main memory is less than required size for a program to run, the operating system enables it with the help of hard disk (main storage media). The system followed is breaking the programs and accommodating the part according to the size of main memory available and rest is stored in hard disk. When a part of program stored in hard disk is required for running the program, a part of the program stored in the main memory is transferred to hard disk and the required part is brought to main memory. This process is called swapping.

Q. 18. (a) Differentiate between open and closed systems.

- (b) Define the term system stress and system change.
- (c) Explain why information system die.

Answer 18. (a)

Open system	Closed System
Open System actively interact with other systems and establish exchange relationship. They exchange information, material or energy with the environment including random and undefined inputs. Open systems tend to have form and structure to allow them to adapt to changes in their external environment for survival and growth. Organizations are considered to be relatively open systems.	A Closed System is self-contained and does not interact or make exchange across its boundaries with its environment. Closed systems do not get the feedback they need from the external environment and tend to deteriorate. A Closed System is one that has only controlled and well defined input and output. Participant in a closed system become closed to external feed back without fully being aware of it. Some of the examples of closed systems are manufacturing systems, computer programs etc.

Answer 18. (b)

Systems, whether they be living or artificial systems, organizational systems, information systems, or systems of controls, change because they undergo stress. A stress is a force transmitted by a system's supra-system that causes a system to change, so that the supra-system can better achieve its goals. In trying to accommodate the stress, the system may impose stress on its subsystems, and so on.

There are two basic forms of stress which can be imposed on a system, separately or concurrently :

1. A change in the goal set of the system. New goals may be created or old goals may be eliminated.
2. A change in the achievement levels desired for existing goals. The level of desired achievement may be increased or decreased. For example, the goal set for a computer system may change if a requirement is imposed by management (the supra-system) for system data to be shared among multiple users rather than be available only to a single user. When a supra-system exerts stress on a system, the system will change to accommodate the stress, or it will become pathological; that is, it will decay and terminate. Systems accommodate stress through a change in form; there can be structural changes or process changes. For example, a computer system under stress for more shareability of data may be changed by the installation of terminals in remote locations – a structural change. Demands for greater efficiency may be met by changing the way in which it stores data – a process change. It is very unlikely that system changes to accommodate stress will be global change to its structure and processes. Instead, those responsible for the change will attempt to localize it by confining the adjustment processes to only one or some of its subsystems.

Answer 18. (c)

Information Systems die due to changes in information requirement and information becoming outdated due to :

- (i) changes in business environment.
- (ii) changes in users' expectation.
- (iii) changes in technology.
- (iv) deterioration in software quality due to passage of time.

Q. 19. (a) Discuss the desired characteristics of a good coding system.

(b) What is system manual? What information is included in it?

Answer 19. (a)**Characteristics of a Good Coding Scheme :**

- (i) **Individuality** – The code must identify each object in a set uniquely and with absolute precision. To use one code number for several objects in a set would obviously cause a great deal of confusion. The code should be universally used over the entire organisation.
- (ii) **Space** - As far as possible code number must be much briefer than description.
- (iii) **Convenience** - The format of code number should facilitate their use by people. This implies that code number should be short and simple and consist of digits and or upper case alphabets. It is better to avoid use of special symbols.
- (iv) **Expandability** – As far as possible, growth in the number of objects in a set should be provided for. Therefore, whilst introducing the scheme, longer number of digits/number than necessary at present may be adopted as the code length. Related items must use similar number.
- (v) **Suggestiveness** - The logic of the coding scheme should be readily understandable. Also, the letter or number should be suggestive of the item characteristics. But this should not be carried too far in lengthening the code since it would defeat the purpose of brevity.

- (vi) **Permanence** – Changing circumstances should not invalidate the scheme or invalidation in future should be kept to minimal.

Answer 19. (b)

A system manual or job specification manual is an output of the system design that describes the task to be performed by the system with complete layouts and flow charts. It contains :

- (i) **General description of the existing system** : It describes the general structure of the existing system from top management to the bottom management.
- (ii) **Flow of the existing system** : It describes the input, processing and output of the data to be flow at various levels of organisation's structure.
- (iii) **Outputs of the existing system** : The documents produced by existing system are listed and briefly described, including distribution of copies.
- (iv) **General description of the new system** : Its purpose and functions and also major differences from the existing system are stated together with a brief justification for the changes.
- (v) **Flow of the new system** : This shows the flow of the system from and to the computer operation and within the computer department.
- (vi) **Output Layouts** : It describes the user interface or layouts for the user that is used for better communication in near future.
- (vii) **Output distribution** : The output distribution is summarized to show what each department will receive as a part of the proposed system.
- (viii) **Input layouts** : The inputs to the new system are described as well as a complete layouts of the input documents, input disks or tapes are described.
- (ix) **Input responsibility** : The source of each input document is indicated as also the user department responsible for each item on the input documents.
- (x) **Macro Logic** : The overall logic of the internal flows will be briefly described by the systems analyst, wherever useful.
- (xi) **Files to be maintained** : The specifications will contain a listing of the tape, disk or other permanent record files to be maintained, and the items of information to be included in each file.
- (xii) **List of programs** : A list of programs to be written shall be a part of the systems specifications.
- (xiii) **Timing estimates** : A summary of approximate computer timing is provided by the system analyst.
- (xiv) **Controls** : This shall include type of controls, and the method in which it will be operated.
- (xv) **Audit trail** : A separate section of the systems specifications shows the audit trail for all financial information. It indicates the methods with which errors and defalcation will be prevented or eliminated.

Q. 20. (a) Differentiate between :

- (i) **Primary Storage and Secondary Storage.**
- (ii) **Compiler and Interpreter**
- (iii) **CD ROM Disks and WORM Disks.**

(b) XYZ Ltd. is considering three options to acquire software for computerizing one of its important functional area . The options are :

- (I) Buying the software package available in the market;**
- (II) Engaging software industries to design the software;**
- (III) Developing the software in-house with the help of their own IT people.**

Discuss the pros & cons of each option.

Answer 20. (a)**(i)**

Primary Storage	Secondary Storage
1. Primary Storage is the internal or main memory and is basic to all computer systems. This memory stores the programs under operation and the data which is being processed. It has a definite size and cannot be expanded off and on.	Secondary Storage is called 'auxiliary storage' and is supplementary to the primary storage associated in CPU. Such memory is also called backup storage. It is used to hold programs not currently in use and data files. It has large capacity in relation to the primary storage.
2. The most popular form of Primary Storage is RAM.	The most popular secondary storage media are Magnetic Tape, Magnetic Drums etc.
3. The processing speed is very fast as compared to secondary storage.	It contributes to slower processing speed as compared to primary storage.

(ii)

Interpreter	Compiler
1. Translates line by line	Translates the whole program.
2. Translation takes place during execution.	Translation of whole program in one go.
3. Execution time is high.	Execution is fast.
4. Requires less memory.	Requires more memory.
5. Successful run for sometimes does not guarantee full correctness of the program.	Compilation is very time consuming process.
6. Cost of interpreter is less.	Cost of compiler is high.

(iii)

CD ROM Disks	WORM Disks
1. The data on Compact Disks (CD) is permanent and cannot be altered.	WORM Disk stands for 'Write Once, Read Many' which means data once written can only be read and cannot be changed or updated.
2. Its typical storage capacity is about 650 MB. Digital Video Disk (DVD) which looks like a CD is fast replacing CD's now. It can be used from both sides with each side capable of storing 4.7 GB of data.	The typical storage capacity of WORM Disk is about 200 MB.

Answer 20. (b)

The pros and cons of each of the options are enumerated below :

Type of software	Advantages	Disadvantages
(I) Buying ready made	(i) Can be seen and tested.	(i) May not meet requirements fully.
	(ii) Will have fewer bugs	(ii) Enhancement /modifications may be expensive and time consuming.
	(iii) May be less costly	(iii) Requires development, testing and implementation time.
	(iv) Documentation/support facilities.	
(II) Developed by outside firm	(i) Better control over schedule and cost.	(i) Difficult to negotiate on effort and time required.
	(ii) Does not affect day-to-day operations due to development work.	(ii) Difficult to implement without adequate technical knowledge of the software.
	(iii) Ready skills when hardware or software platforms.	(iii) Difficult to maintain after implementation.
	(iv) Advantage of core competencies.	(iv) Unfamiliarity of the outside party about the business environment may hamper quality.
		(v) Maintenance support cost.
(III) Developed in-house	(i) Familiarity with business will lead to better quality.	(i) Difficult to adhere to time schedule.
	(ii) Will meet requirements fully.	(ii) Additional manpower cost.
	(iii) Development of in-house skills.	(iii) Particular skills may not be available.
	(iv) Source of income by selling software or consultancy services.	(iv) Turnover of skilled personnel
	(v) Improvisation according to systems followed by other software.	(v) Advantages of core competencies may not be there

Q. 21. (a) Discuss the three approaches of MIS development.

(b) Differentiate among Strategic, Tactical and Operational categories of Information required for different levels of Managerial decision-making.

Answer 21. (a)

For developing MIS, three approaches are used, viz., Top down approach, Bottom up approach and Integrative approach. Each of these is described below :

- (i) **Top down approach** : The development of MIS under top down approach starts with the defining of the objectives of the organisation, the kind of business it is in, and the constraints under which it operates. The activities or functions for which information would be required are also identified. The crucial strategic and tactical decisions are also defined and the decisions necessary to operate the activities are specified. From the activities or functions and the decisions to be made, the major information requirements are ascertained.

This approach develops a model of information flow in the organization, which acts as a guide for designing the information system. By using the model of information flow, various information sub-systems may be defined. Each sub-system comprises of various modules. The selection of a module for developing system is made on the basis of the priority assigned to it.

The various sub-systems and their modules are coordinated to achieve the objective of integration. The information system so developed is viewed as a total system, which is fully integrated, rather than as a collection of loosely coordinated sub-systems.

It is also evident from the nomenclature that top management takes the initiative in formulating major objectives, policies and plans in a comprehensive manner and communicates them down the line to middle and supervisory management levels for translating them into performance results. Managers other than those at top levels have little role in planning, they have to only concentrate on implementation and day-to-day control.

- (ii) **Bottom-up approach** : The development of information system under this approach starts from the identification of life stream systems. Life stream systems are those systems, which are essential for the day-to-day business activities. The examples of life stream systems include payroll, sales order, inventory control and purchasing etc. The development of information system for each life stream system starts after identifying its basic transactions, information file requirements and information processing programs.

After ascertaining the data/information requirements, files requirement and processing programs for each life stream system, the information system for each is developed. The next step is towards the integration of data kept in different data files of each information system. The data is integrated only after thoroughly examining various applications, files and records. The integrated data enhances the shareability and evolvability of the database. It also ensures that all programs are using uniform data. Integrated data also provides added capability for inquiry processing and ad-hoc requests for reports.

The next step under bottom up approach may be the addition of decision model and various planning models for supporting the planning activities involved in management control. Further, these models are integrated to evolve model base. The models in the model base facilitate and support higher management activities. They are useful for analysing different factors, to understand difficult situations and to formulate alternative strategies and options to deal them.

- (iii) **Integrative approach** : This approach can overcome the limitations of the above two approaches when used objectively. Integrative approach permits managers at all levels to influence the design. Top management identifies the structure and design of MIS suitable to the concern. This design is further presented to lower level managers for their views and modifications. The managers at the lower level are permitted to suggest changes, additions, or deletions and return the design with their suggestions to the top level for approval. The revised design is drawn and evaluated by the top level and sent down again in a modified form for further consideration if required. This evaluation modification and approval process continues until a final design is achieved, that is suitable for all levels.

Answer 21. (b)

Strategic-level information systems help senior management to tackle and address strategic issues and long-term trends, both within the firm and external environment. Their principal concern is matching changes in the external environment with existing organisational capability - What will be the cost-trends, where will our firm fit in, what products should be made etc? In other words, these systems are designed to provide top-management with information that assists them in making long-range planning decisions for the organization.	Tactical-level information systems serve middle level managers and help in taking decisions for a period of 2-3 years. The managers are typically concerned with planning, controlling and use summaries of transactions to aid their decision-making. In other words, these systems provide middle-level managers with the information they need to monitor and control operations and to allocate resources more effectively. In tactical systems, transactions data are summarized, aggregated, or analysed. Their purpose is not to support the execution of operational tasks but to help the manager control these operations.	Operational-level information systems are typically transaction processing systems and help in the operational level managers to keep track of elementary activities and transactions of the organisations such as sales, receipts, cash deposits, flow of materials etc. Their purpose is to answer routine questions and to track flow of transactions. Thus, the primary concern of these systems is to collect, validate, and record transactional data describing the acquisition or disbursement of corporate resources.
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Thus, each type of information system serves the requirements of a particular level in the organisation, providing the needed basis for decision making.

Q. 22. (a) Successful executives take decisions relying more on intuition than on any quantitative analytical decision technique. Do you agree to this view? Justify your answer by stating the characteristics of information used by executives.

(b) Explain the role played by Financial Information System in making financial decisions.

(c) What is Expert Systems? Write short note on it.

Answer 22. (a)

It is true that to a large extent, executives rely much more on their own intuition, gut feelings and past experience rather than on sophisticated analytical skills. The type of decisions that the executives must make is broad. Often, executives make these decisions based on a vision they have regarding what it will take to make their companies successful. The intuitive character of executive decision-making is reflected strongly in the types of information found most useful to executives.

Here are some characteristics of the types of information used in executive decision-making are discussed below :

- (i) **Lack of structure** : Many of the decisions made by executives are relatively unstructured. For instance, what general direction should the company take? Or what type of advertising campaign will best promote the new product line? These types of decisions are not so clear-cut as deciding how to debut a computer program or how to deal with an overdue account balance. Also, it is not always obvious which data are required or how to weigh available data when reaching at a decision.
- (ii) **High degree of uncertainty** : Executives work in a decision space that is often characterized by lack of precedent. For example, when the Arab oil embargo hit in the mid-1970s, no such previous event could be referenced for advice. Executives also work in a decision space where results are not scientifically predictable from actions. If prices are lowered, for instance, product demand will not automatically increase.
- (iii) **Future orientation** : Strategic-planning decisions are made in order to shape future events. As conditions change, organisations must also change. It is the executive's responsibility to make sure that the organisation keeps pointed toward the future. Some key questions about the future include: "How will future technologies affect what the company is currently doing? Where will the economy move next, and how might that affect consumer buying patterns? As one can see, the answers to all of these questions about the future external environment are vital.
- (iv) **Informal source** : Executives rely heavily on informal source for key information. For example, lunch with a colleague in another firm might reveal some important competitor strategies. Some other important information sources of information are meetings, tours around the company's facilities to chat with employees, brainstorming with a trusted colleague or two, and social events. Informal sources such as television might also feature news of momentous concerns to the executives.
- (v) **Low level of detail** : Most important executive decisions are made by observing broad trends. This requires the executive to be more aware of the large overviews than the tiny items. Even so, many executives insist that the answers to some questions can only be found by mucking through details.

Answer 22. (b)

Financial Information System plays an important role in making following financial decisions :

- (i) **Estimation of requirements of funds**: This is the very important and starting point of making financial decisions. A very careful estimation of funds and the time at which these funds are

required is made in this stage. This can be done by forecasting all physical activities of the firm and translating them into monetary units.

- (ii) **Capital structure decisions** : Decisions are to be taken to select an optimum mix of different sources of capital structure. There are many options available for procuring funds. Decision maker has to decide the ratio between debt and equity, long-term and short-term funds etc. He has to ensure that overall capital structure is such that the company is able to procure funds at optimum cost.
- (iii) **Capital budgeting decisions** : Funds procured from various sources are required to be invested in different assets. With the help of capital budgeting, decision maker can determine feasibility of investment in long-term assets. This will help in attainment of financial objectives.
- (iv) **Profit planning** : This part of profit planning is essential for the growth of the organization. The decision maker has to make decision regarding profits and dividends. He has to ensure adequate surplus in future for growth and distribution of dividends.
- (v) **Tax management** : Tax planning is aimed at reducing of outflow of cash resources by way of taxes so that the same may be effectively utilized for the benefit of business. The purpose of tax planning is to take full advantage of exemptions, deductions, concessions, rebates, allowances and other relief.
- (vi) **Working capital management** : Working capital management is concerned with the investment of long term funds into current assets. Decisions are to be taken for effective financing of current assets required for day-to-day running of the organization.
- (vii) **Current assets management** : Policy decisions are taken regarding various items of current assets. Credit policy determines the amount of sundry debtors at any point of time. Inventory policy is to be determined jointly between finance and production department.

Answer 22. (c)

Expert Systems : They are designed to replace the need for a human expert. They are particularly important where expertise is scarce and therefore expensive. This is not 'number-crunching' software, but software that expresses knowledge in terms of facts and rules. This knowledge will be in a specific area, and therefore expert systems are not general, as are most decision support systems, which can be applied to most scenarios, an expert system for oil drilling is not of much use in solving company taxation problems. While there may have been a progression from transaction-processing systems, through management information systems, to decision-support and executive information systems, expert systems have arisen largely from academic research into artificial intelligence. The expert system should be able to learn, i.e. change or add new rules. They are developed using very different programming languages such as PROLOG, which are referred to as fifth generation languages, or expert systems shells, which can make the process quicker and easier. It has been suggested that expert systems would be of greater use in the tactical and strategic level. This has been the case in banking, where expert systems scrutinize applications for loans, and lower level staff accepts the system's decision. This has replaced the somewhat subjective decision-making of more senior managers.

Q. 23. (a) PQR Ltd is planning to introduce a new range of products. The top management is advised to get developed a marketing information system which can enhance the decisional capacities in various marketing activities. You being in-charge of this project suggest what information sub-systems are required to be developed.

(b) How would you use system approach for solving problems?

Answer 23. (a)

Marketing Information System — is aimed at supporting the decision making, reporting and transaction processing requirements of marketing and sales management. It consists of following inter-related

information sub-systems to enhance the decision-making capacities in various marketing activities :

1. **Sales** - The objective of the sales manager is to coordinate the sales effort so that the long-term profitability of the company is maximized. Decisions are required in the area of adequate stocks, effective distribution channels, effective motivation of sales personnel, promotion of more profitable products or product lines and good customer relations. Information required for analysis and support of sales is as stated below :

(a) Sales Support – Sales support information system provides information to sales personnel about the following :

- (i) Product descriptions and performance specifications
- (ii) Product prices;
- (iii) Quantity discounts,
- (iv) Sales incentives for salespersons
- (v) Sales promotions;
- (vi) Strengths and weaknesses of competitor's product;
- (vii) Products' inventory levels;
- (viii) The histories of customers' relations with the company;
- (ix) Sales policies and procedures established by the company;
- (x) Buying habits of customers.

(b) Sales analysis – The sales analysis is a major activity in most companies involved in sales. Its purpose is to provide information for analysis of

- (i) Product sales trends;
- (ii) Product profitability on the product-by-product basis;
- (iii) The performance of each sales region and sales branch;
- (iv) The performance of respective sales persons.

Information for sales analysis is derived primarily from the sales order entry system; the majority of information from actual sales transactions and is contained on sales invoice. It includes information on product type, product quality, price, customer identity and type, sales region and salesperson etc.

2. **Market Research and Intelligence** –The objective of marketing research is to investigate problems confronting the other managers in the marketing function. These problems may involve sales, product development, advertising and promotion, customer service, or general marketing management needs. To satisfy these decision-making and reporting requirements, the market research department must either periodically or upon demand gather information from a wide variety of sources. The investigations undertaken by market research helps in satisfaction of following informational needs of managers :

- (i) Information about the economy and economic trends and the probable impact of these trends on demand for the product.
- (ii) Information about the past sales; and sales trends for the entire industry;
- (iii) Information about potential new markets for product;
- (iv) Information about competitors, its product, strength, weaknesses, new product plans, strategies and so on.

The decision-maker can use the information provided by marketing research in a number of ways for decision making process.

3. Advertising and Promotions - The promotion and advertising development devotes its attention to planning and executing advertising campaign and to carry out various product promotions. This includes :

- (i) Promotion through limited budget;
- (ii) Allocating resources in most effective manner;
- (iii) Analysing an array of information, sales people, locations, products, styles, sizes etc.;
- (iv) Storing information that can be combined with past experiences of managers;
- (v) Establishing a body of knowledge on the response of market for each of the several types of promotional activities such as coupons, contests, trade show;
- (vi) Continuously refreshing and modifying the information base in accordance with rapid changing environment.

4. Product Development and Planning – Product development involves analysing a possible opportunity for a new product and evaluating preferred specifications and probable market success. Often the market research activity initially perceives the opportunity and passes along information about it to the new product development group. Alternatively,

- Sales persons may be aware of their need for a new product;
- Customer call reports may help elicit information about new product needed which may encourage sales persons to think about new product possibilities;
- Sales analysis system indicates the most desirable characteristics for the new product;
- Market researchers gather information about the size and structure of the market place for the product.

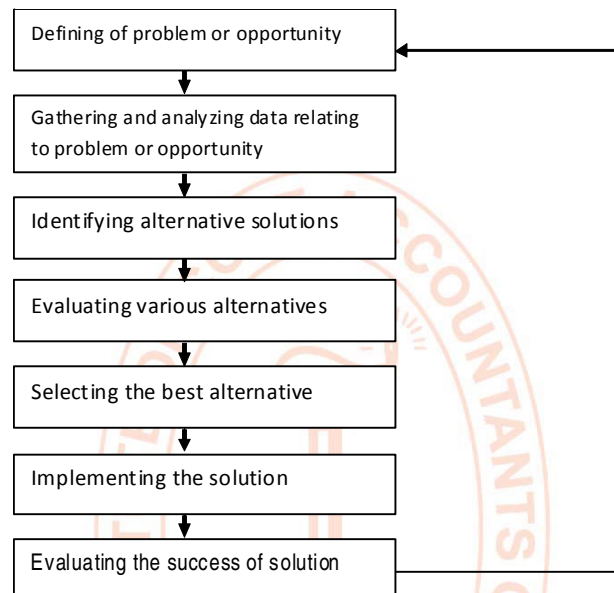
The product development department uses all these information to develop specifications for a new product. Product planning system provides marketing management with packaging, promotion, pricing and style recommendations throughout the life of product.

5. Product Pricing System – Product pricing is a complex managerial activity that is affected by product cost, customer demand, market psychology, competitors, prices and various actions taken by competitors. Prices may be determined on a full cost or marginal cost basis which is usually seen as the starting point in setting prices. Pricing information system almost always utilizes information about product cost. Past sales profitability information is useful to help in determining how much prices should be adjusted for changes in cost to ensure that margins are maintained.

6. Customer Service – The objective of marketing department is to satisfy customers with product and customer service. To achieve these objectives, management provides customers with technical assistance and product maintenance. Decisions are required in the area of training of service personnel, capabilities of equipment and location facilities to serve customers and assist in the dissemination of technical information to the customers. These decisions must be congruent with the marketing management strategy regarding customer satisfaction and service.

Answer 23. (b)

The system approach to management is in fact a way of thinking about management problems. To seek a solution for the problems by applying systems approach, we would make use of the following steps as shown in the figure given below :



- (i) **Defining of the problem** : The problem involved here is of inordinate delay between the receipt of orders and their delivery. This problem affects the vendor in various ways, e.g., a bad reputation, loss of customers, reduction in profits etc.
- (ii) **Gathering and analyzing data** : The problem of delay may be because of following reasons :
 - (a) Excessive orders in the hand of vendors
 - (b) Shortage of power
- (iii) **Identification of alternative solutions** : To overcome the stated problem by system approach, suppose the following two solutions exist :
 - (a) Refusals of orders, in case the total size of the orders exceeds the plant capacity of one shift.
 - (b) To run the plant in double shift to meet the commitment in time. Any shortfall in power supply may be met by installing a generator.
- (iv) **Evaluation of alternative solutions** : Out of the two solutions as stated above, the second solution say accounts for an overall increase in the profitability of the concern after off-setting additional cost for the generator produced power. It also helps in retaining customers and growth of the concern.
- (v) **Selection of the best alternative** : Under this step, the management closely examines the alternatives and chooses the best alternative.
- (vi) **Implementation of the solution** : The implementation of the solution requires the necessary policy changes. Besides this, the resources required to run the plant in double shift and installation of the generator are also to be arranged. Finally, appropriate procedures are developed to exercise smooth production and timely supply to customers. The concerned officers are accordingly instructed.

Q. 24. (a) What are the stages through which the program has to pass during its development?

(b) Describe any three program design tools.

Answer 24. (a)

The system developer must instruct the computer how to do everything without error and in the required sequence. Hence, the development of program has to go through a life cycle having following stages :

- (i) **Program Analysis** : In this stage, for a particular application, the programmer ascertains the inputs available, the output required and to achieve that, what kind of processing is needed. Depending upon the complexity, the programmer then determines whether the proposed application can be or should be programmed at all. It is not unlikely that the proposal is shelved for modification on technical grounds.
- (ii) **Program Design** : Depending upon the main function to be performed, the programmer develops the general organisation of the program. The input, output, file layouts, flowcharts, and program specification etc are provided to the programmer by the analyst.
- (iii) **Program Coding** : The logic of the program expressed in the flowchart is converted into program instructions. While coding, the syntax of the language used is to be kept in mind.

The coded instructions are then entered into the magnetic media through available sources such as key to diskette. The program is then compiled through compiler of the language. Several syntax errors may crop up at this stage. These errors are required to be removed after getting the printed listing etc.

- (iv) **Debug the program** : The meaning of debugging is to remove the errors so that the program may compile without errors. Many a times, structured walk through is to be adopted to remove the errors. After debugging, the program is executed against test data. Several tests are performed and later the codes are reviewed to see whether these adhere to standards or not.
- (v) **Program Documentation** : The writing of narrative procedures and instructions for people who will use software is carried out throughout the program life cycle. Managers and users should carefully review documentation to ensure that the software and system behave as the documentation indicates. If they do not, documentation should be revised. Following technical design specifications are generally included :
 - 1. A brief narrative description of what the program should do.
 - 2. A description of the output, inputs and processing to be performed by the program.
 - 3. A deadline for finishing the program.
 - 4. The identity of the programming languages to use along with coding standards to follow.
 - 5. A description of the system environment into which the program should fit.
 - 6. A description of the testing required to certify the program for use.
 - 7. A description of documentation that must be generated for users, maintenance programmers and operational personnel.

The programmer writes the coding in the light of above documentation.

- (vi) **Program Maintenance** : The requirements of business applications keep on changing and thus call for modification of various programs. The maintenance of the programs is generally done by people called maintenance programmers. The task of understanding the program written by some one and modifying the same is difficult. Therefore, the maintenance people should be involved from the beginning itself.

Answer 24. (b)

Three program design tools are briefly discussed below :

1. **Program flow chart** : Program flow chart is among the most common program design tools that managers and users encounter when reviewing the design work of the system development project. These flow charts depict the logical steps through which a computer program must proceed when solving a problem. At one time, program flow charts were considered the premier program design tool. Although they are still widely used, sometimes it is difficult for programmers to translate a program flow chart directly into a structured code.

A program flow chart depicts the logical processing steps followed by a program quite well. However, unlike some of the other program design tools, they often do not provide a broad view of how the program is organised. However, they are useful for problems involving mathematical or scientific formulae.

2. **Pseudo code** : When reviewing the work done by a program designer, users may also need to review narrative descriptions of a program logic. Pseudo code, like program flow charts, also represents program logic. However, instead of using graphical symbols and flow lines, pseudo code presents program logic in English - like statements. Pseudo code is generally preferred by programmers over flowcharts because it represents program code more closely. Many users also find pseudo code more understandable than program flow charts.

Pseudo code is used in a variety of ways. For example many fourth - generation languages use pseudocode - like statements. Besides using pseudo code to design program code in a 3GL, it can be embedded into a completed 3GL program as non-executable 'comment' statements that serve as a documentation to indicate what the program is doing. Pseudo code is particularly useful when designing transaction processing and information- retrieval programs.

3. **4GL Tools** : The tools described above were developed as manually applied methods for designing programs or systems. The main drawback of manually applied tools is that they take a lot of time to prepare. Also, when a program flow chart is prepared or a structure chart is drawn, the programmer is not sure if it is internally consistent. Fourth-generation languages provide a way out to remove these obstacles by automating many of these manual tasks by using 4GL tools. These tools ensure that the work done with them is consistent with the other work performed by the system team. The automation of manual task and internal consistency checks are two reasons due to which productivity gains result from using 4GL tools.

Q. 25. (a) Which areas of DBMS should be addressed while maintaining a database?

(b) What are the integrity controls that DBMS package may offer?

Answer 25. (a)

Following five areas of DBMS managements are be considered when trying to maintain a well-tuned database :

(i) Installation of database

- Correct installation of the DBMS product.
- Ensuring that adequate file space is available.
- Proper allocation of disc space for database.
- Allocation of data files in standard sizes for I/O balancing.

(ii) Memory Usage – One should know about following memory management issues :

- How the DBMS uses main memory?
- What buffers are being used?

- What needs the programs in main memory have? Knowledge of above issues can help in efficient usage of memory.

(iii) Input / Output (I/O) contention

- Achieving maximum I/O performance is one of the most important aspects of tuning. Understanding how data are accessed by end-users is critical to I/O contention.
- Simultaneous or separate use of input and / or output devices.
- Clock speed of CPU requires more time management of I/O.
- Spooling/Buffering etc. can be used.
- Knowledge of how many and how frequently data are accessed, concurrently used database objects need to be striped across disks to reduce I/O contention.

(iv) CPU Usage

- Multi programming and multi processing improve performance in query processing
- Monitoring CPU load.
- Mixture of online/back ground processing need to be adjusted.
- Mark jobs that can be processed in run off period to unload the machine during peak working hours.

Answer 25. (b)

Data Integrity Controls (i.e. controls on the possible value a field can assume) can be built into the physical structure of the fields. In order to have the correct database, DBMS needs to have certain controls on the data fields. Some of the security controls that DBMS imposes on data fields are as follows :

- (i) **Data Type** : In the data field, the data type defines the type of data to be entered in the field. It may be numeric, character etc.
- (ii) **Length of data field** : The length of data field defines the maximum number of characters or digits (depending upon the data type) to be entered in the data field. It may be 256, 65536 etc.
- (iii) **Default value** : It is the value a field will assume unless a user enters an explicit value for an instance of that field. Assigning a default value to a field can reduce data entry time and entry of a value to that field can be skipped. Default value helps in reducing the probability of data entry errors for most common values.
- (iv) **Range Control** : This limits the set of permissible values a field can assume. The range may be numeric lower to upper bound or a set of specific values. Range control must be used with caution since the limits of range may change with time. A combination of range control and coding led to Y2K problem, in which a field for the year was represented by only the numbers 00 to 99.
- (v) **Null Value Control** : Null value is an empty value. Each primary key field must have an integrity control that prohibits a null value. Any other required field may also have a null value control placed on it depending upon the policy of the organization. For example, a university may prohibit adding a course to its database unless that course has a title as well as value to the primary key, course-ID. Many fields legitimately may have null values so this control is to be used only when truly required.
- (vi) **Referential Integrity** : This control on a field is a form of range control in which the value of that field must exist as the value in some field in another row of same or different table. That is the range of legitimate values comes from the dynamic contents of a field in a data base table, not from some pre-specified set of values. Referential integrity guarantees that only some existing cross-referencing value is used, not that it is the correct one.

Q. 26. (a) Give one or two reasons for each of the following :

- (i) Use of multiplexer in data communication.
- (ii) Need of Repeaters in the network.
- (iii) Need of Protocol Converters.
- (iv) Need of hub in a network.

(b) What is 'Ring Network' as a network topology? What are its advantages and disadvantages?

(c) State the various functions of communications software.

Answer 26. (a)

- (i) **Multiplexer** enables several devices to share one communication line. It scans each device to collect and transmit data on a single line to the CPU.
- (ii) **Need of Repeaters in the network** – Repeaters are devices that solve the snag of signal degradation which results as data is transmitted along the cables. It boosts the signal before passing it through to the next location.
- (iii) **Need of Protocol Converters:** Protocols are the standard set of rules which govern the flow of data on a communication network. To enable diverse system components to communicate with one another and to operate as functional unit, protocol conversion is needed. It can be accomplished via hardware, software, or a combination of hardware and software.
- (iv) **Need of hub in a network:** A hub is a hardware device that provides a common wiring point in a LAN. Each node is connected to the hub by means of simple twisted pair wires. The hub then provides a connection over a higher speed link to other LANs, the company's WAN or the Internet.

Answer 26. (b)

In Ring network, the network cable passes from one node to another until all nodes are connected in the form of a loop or ring. There is a direct point-to-point link between two neighbouring nodes. These links are unidirectional which ensures that transmission by a node traverses the whole ring and comes back to the node, which made the transmission.

Advantages :

- (1) Ring network offers high performance for a small number of workstations.
- (2) It can span longer distances compared to other types of networks.
- (3) These networks are easily extendable.

Disadvantages :

- (1) Ring network is relatively expensive and difficult to install.
- (2) Failure of one computer on the network can affect the whole network.
- (3) It is difficult to trouble shoot a ring network.
- (4) Adding or removing computers can disrupt the network.

Answer 26. (c)

Communications software manages the flow of data across a network. It performs the following functions :

- (A) Access control :** Linking and disconnecting the different devices, automatically dialing and answering telephones; restricting access to authorized users; and establishing parameters such as speed, mode and direction of transmission.
- (B) Network management :** Polling devices to see whether they are ready to send or receive data; queuing input and output; determining system priorities; routing messages, and logging network activity, use and errors etc.

- (C) **Data and file transmission:** Controlling the transfer of data, files and messages *among* the various devices.
- (D) **Error detection and control:** Ensuring that the data sent was indeed the data received.
- (E) **Data security:** Protecting data during transmission from unauthorized access.

Q. 27. (a) How would you evaluate an ERP package?

(b) What are the benefits of implementing ERP package?

Answer 27. (a)

Evaluation of ERP packages is done based on the following criteria :

- (i) **Flexibility :** It should enable organizations to respond quickly by leveraging changes to their advantage, letting them concentrate on strategically expanding to address new products and markets.
- (ii) **Comprehensive :** It should be applicable across all sizes, functions and industries. It should have in depth features in accounting and controlling, production and materials management, quality management and plant maintenance, sales and distribution, human resources management and project management. It should also have information and early warning systems for each function and enterprise – wide business intelligence system for informed decision making at all levels.

It should be open and modular. It should embrace an architecture that supports components or modules, which can be used individually, expandable in stages to meet the specific requirements of the business including industry specific functionality. It should be technology independent and mesh smoothly with in house / third party applications, solutions and services including the web.
- (iii) **Integrated :** It should overcome the limitations of traditional hierarchical and function oriented structures. Functions like sales and materials planning, production planning, ware house management, financial accounting, and human resources management should be integrated into a work flow of business events and processes across departments and functional areas, enabling knowledge workers to receive the right information and documents at the right time at their desktops across organizational and geographical boundaries.
- (iv) **Beyond the Company :** It should support and enable inter-enterprise business processes with customers, suppliers, banks, government and business partners and create complete logistical chains covering the entire route from supply to delivery, across multiple geographic, currencies and country specific business rules.
- (v) **Best Business Practices :** The software should enable integration of all business operation in an overall system for planning, controlling and monitoring. It should offer a choice of multiple ready-made business processes including best business practices that reflect the experience and requirements of leading companies across industries. It should intrinsically have a rich wealth of business and organizational knowledge base.
- (vi) **New Technologies :** It should incorporate cutting edge and future proof technologies such as object orientation into product development and ensure inter- operability with the Internet and other emerging technologies.
- (vii) **Other factors to be considered are :**
 - Global presence of the package
 - Local presence
 - Market targeted by the package
 - Price of the package
 - Obsolescence of package

- Ease of implementation of package
- Cost of implementation
- Post –implementation support availability.

Answer 27. (b)

The following are some of the benefits that are achieved by implementing the ERP packages :

- Gives Accounts Payable personnel increased control of invoicing and payment processing and thereby boosting their productivity and eliminating their reliance on computer personnel for these operations.
- Reduces paper documents by providing on-line formats for quickly entering and retrieving information.
- Improves timeliness of information by permitting posting daily instead of monthly.
- Provides greater accuracy of information with detailed content, better presentation, satisfactory for the auditors.
- Improved cost control.
- Faster response and follow-up on customers.
- More efficient cash collection, say, material reduction in delay in payments by customers.
- Better monitoring and quicker resolution of queries.
- Enables quick response to change in business operations and market conditions.
- Helps to achieve competitive advantage by improving its business processes.
- Improves supply-demand linkage with remote locations and branches in different countries.
- Provides a unified customer database usable by all applications.
- Improves international operations by supporting a variety of tax structures, invoicing schemes, multiple currencies, multiple period accounting and languages.
- Improves information access and management throughout the enterprise.
- Provides solution for problems like Y2K and Single Monetary Unit (SMU) or Euro Currency.

Q. 28. (a) What is Electronic Data Interchange (EDI)? How it works?**(b) What is Teleconferencing? Explain different modes of teleconferencing.****Answer 28. (a)**

EDI is the transmission of business information in standard format between computers of independent organizations. There is no need to change the database structure by the companies for implementation of EDI. However, EDI software is required to be developed for translating the format used by one organization to the format being used by another organizations. So EDI is computer-to-computer communication using a standard data format to exchange business information electronically between independent organizations.

Working Principle of EDI – EDI is the electronic exchange of business documents such as invoices, purchase orders, shipping notices etc. EDI is a three step process :

1. First of all, sender data is converted into standard format as defined by EDI translation software.
2. Data in standard format is transferred to the receiver using communication lines.
3. Finally, standard format data is converted according to the format of receiver data base files.

EDI consists of three components :

- (i) **Communication** - To make EDI work, one needs communication software, translation software and access to standards. Communication software moves data from one point to another, flags the start and end of the document. Translation software helps the user to build a map and shows him how the data fields from his application corresponds to the elements of EDI standards. It also converts data back and forth between the application format and the EDI format.
- (ii) **Mapping** - To build a map, the user first selects the EDI standard for the kind of data he wants to transmit. Usually the trading partner tells about the kind of standards to be used. Next, he edits out parts of the standards, which do not apply, to his application. Next, he imports a file that defines the fields in his application, and finally he makes the map to show where the data required by the EDI standards is located in his application. Once the map is built, the translator will refer to it during EDI processing every time a transaction of that type is sent or received.
- (iii) **Profile** - The last step is to write a partner profile that tells the system where to send each transaction and how to handle errors or exceptions. Whereas the user needs a unique map for every kind of documents he exchanges with a partner, he should only have to define partner information once.

Answer 28. (b)

Teleconferencing refers to the electronic meeting between people who are geographically scattered. Telecommunication technology allows the people to interact with each other without traveling to the same location which saves a lot of money and valuable time. There are three modes of teleconferencing :

1. **Audio conferencing** : It is the use of audio communication equipments which allows the user to communicate with geographically dispersed persons. Audio conferencing does not require a computer but requires a two way audio communication facility. Guidelines to make Audio conferencing more efficient :
 - (i) All the participants must have an opportunity to speak.
 - (ii) Number of participants must be kept to manageable size.
 - (iii) Copy of conferencing agenda must be sent to all the participants in advance through FAX.
 - (iv) Participants must identify themselves.
 - (v) Conferencing discussion must be recorded.
 - (vi) Hard copy of the discussion must be prepared and should be sent to all the participants for approval.
2. **Video conferencing** : In this conferencing, participants can see and hear each other. It uses the television and does not require a computer. Participants gather in specially equipped rooms having audio and video facility. There are three types of Video Conferencing :
 - (i) *One way Video and Audio* : In this case, audio and video is traveled only in one direction e.g. Television.
 - (ii) *One way Video and Two way Audio* : In this case, audio is transferred in both the directions but video is transferred only in one direction e.g. discussion of news reader with field correspondent.
 - (iii) *Two way video and Audio* : In this case, audio and video is transferred in both the directions between sender and receiver e.g. discussion of persons between different studios of a news channel.
3. **Computer Conferencing** : It is the use of networked computer that allows participants with some common characteristics to exchange information concerning a particular topic. It is more disciplined form of E-Mail. It can be used within single geographic site which is not practical in case of Audio and Video conferencing.

Q. 29. (a) Define the following computer Fraud and Abuse technique :

- (i) Piggy backing
- (ii) Logic time bomb
- (iii) Data diddling.
- (iv) Scavenging

(b) What do understand by the term information security? What is its importance?

(c) Your client has recently switched over from manual accounting to computerized accounting. When you receive computerized accounts for the first quarter, you find the following types of error :

- (i) Incomplete or unauthorized data input
- (ii) Errors in the files or database during updating
- (iii) Improper distribution or disclosure of output.

You, as an information system auditor, suggest the suitable test of controls for audit of computer processing so that the above-mentioned errors can be prevented.

Answer 29. (a)

(i) Piggy Backing: It refers to tapping into a telecommunications line and latching on to a legitimate user before he logs into the system; legitimate user unknowingly carries perpetrator into the system.

(ii) Logic time Bomb: It refers to the program that lies idle until some specified circumstance or a particular time triggers it. Once triggered, the bomb sabotages the system by destroying programs, data or both.

(iii) Data diddling: Changing data before, during or after it is entered into the system in order to delete alter or add key system data is known as data diddling.

(iv) Scavenging: Gaining access to confidential information by searching corporate records is termed as scavenging. Scavenging methods range from searching for printouts or carbon copies of confidential information to scanning the contents of computer memory.

Answer 29. (b)

Security relates to the protection of valuable assets against loss, disclosure, or damage. Securing valuable assets from threats, sabotage, or natural disaster with physical safeguards such as locks, perimeter fences, and insurance is commonly understood and implemented by most organizations. However, security must be expanded to include logical and other technical safeguards such as user identifiers, passwords, firewalls, etc. which is not understood nearly as well by organizations as physical safeguards. In organizations where a security breach has been experienced, the effectiveness of security policies and procedures has to be reassessed. This concept of security applies to all information. In this context, the valuable assets are the data or information recorded, processed, stored, shared, transmitted, or retrieved from an electronic medium. The data or information is protected against harm from threats that will lead to its loss, inaccessibility, alteration, or wrongful disclosure. The protection is achieved through a layered series of technological and non-technological safeguards such as physical security measures, user identifiers, passwords, smart cards, biometrics, firewalls, etc. The objective of information security is "the protection of the interests of those relying on information, and the information systems and communications that deliver the information, from harm resulting from failures of availability, confidentiality, and integrity".

For any organization, the security objective is met when

- information systems are available and usable when required (availability),
- data and information are disclosed only to those who have a right to know it (confidentiality),
- data and information are protected against unauthorized modification (integrity).

Importance of Information Security : In a global information society, where information travels through cyberspace on a routine basis, the significance of information is widely accepted. Organizations depend on timely, accurate, complete, valid, consistent, relevant and reliable information. Accordingly, executive management has a responsibility to ensure that the organization provides all users with a secure information systems environment. Today, there are many direct and indirect risks relating to the information systems. These risks have led to gap between the need to protect systems and the degree of protection applied.

This gap is caused by :

- Widespread use of technology;
- Interconnectivity of systems;
- Elimination of distance, time and space as constraints;
- Unevenness of technological changes;
- Devolution of management and control;
- Attractiveness of conducting unconventional electronic attacks over more conventional physical attacks against organizations; and
- External factors such as legislative, legal, and regulatory requirements or technological developments;

Security failures may result in both financial losses and / or intangible losses such as unauthorized disclosure of competitive or sensitive information. Threats to information system may arise from intentional or unintentional acts and may come from internal or external sources. The threats may emanate from, among others, technical conditions (program bugs, disk crashes), natural disasters (fires, floods), environmental conditions (electrical surges), human factors (lack of training, errors, and omissions), unauthorized access (hacking), or viruses. In addition to these, other threats, such as business dependencies (reliance on third party communications carriers, outsourced operations, etc.) that can potentially result in a loss of management control and oversight are increasing in significance. Adequate measures for information security help to ensure the smooth functioning of information systems and protect the organization from loss or embarrassment caused by security failures.

Answer 29. (c)

During computer processing, the system might fail to detect erroneous input, improperly correct input errors, process erroneous input into files or databases during updating. Auditors must periodically re-evaluate processing controls to ensure their reliability.

The following test of controls may be used :

- Evaluate adequacy of processing control standards and procedures.
- Evaluate adequacy and completeness of data editing controls.
- Verify adherence to processing control procedures by observing computer operations and the data control function.
- Verify that selected application system output is properly distributed.
- Reconcile a sample of batch totals and follow up on discrepancies.
- Trace disposition of a sample of errors flagged by data edit routines to ensure proper handling.
- Verify processing accuracy for a sample of sensitive transactions.

- Verify processing accuracy for a selected computer generated transactions.
- Search for erroneous or unauthorized code via analysis of program logic.
- Check accuracy and completeness of processing controls using test data.
- Monitor online processing using concurrent audit techniques.
- Recreate selected reports to test for accuracy and completeness.

The auditor must periodically re-evaluate processing controls to ensure their continued reliability. If processing controls are unsatisfactory, user and source data controls may be strong enough to compensate.

Q. 30. (a) Explain the duties of certifying authority in respect of digital signature.

(b) What do you understand by the following terms with respect to Information Technology :

- (i) Cyber Café.**
- (ii) Communication Device.**
- (iii) Intermediary**

Answer 30. (a)

Duties of Certifying Authority in respect of Digital Signature :

- (i) Every certifying authority shall follow certain procedures in respect of digital signatures as given below :
 - make use of hardware, software and procedures that are secure from intrusion and misuse,
 - provide a reasonable level of reliability in its services which are reasonably suited to the performance of intended functions,
 - adhere to security procedures to ensure that the secrecy and privacy of the digital signatures are assured and
 - observe such other standards as may be specified by regulations.
- (ii) Every certifying authority shall also ensure that every person employed by him complies with the provisions of the Act, or rules, regulations or orders made there under.
- (iii) A certifying authority must display its license at a conspicuous place of the premises in which it carries on its business and a certifying authority whose license is suspended or revoked shall immediately surrender the license to the controller.
- (iv) Every certifying authority shall disclose its digital signature certificate, which contains the public key corresponding to the private key used by that certifying authority and other relevant facts.

Answer 30. (b)

- (i) "Cyber Café" means any facility from where access to the internet is offered by any person in the ordinary course of business to the members of the public.
- (ii) "Communication Device" means Cell Phones, Personal Digital Assistance(Sic), or combination of both or any other device used to communicate, send or transmit any text, video, audio, or image.
- (iii) "Intermediary" with respect to any particular electronic records, means any person who on behalf of another person receives, stores or transmits that record or provides any service with respect to that record and includes telecom serviceproviders, network service providers, internet service providers, web hosting serviceproviders, search engines, online payment sites, online-auction sites, online marketplaces and cyber cafes.