PAPER 9 - OPERATIONS MANAGEMENT & INFORMATION SYSTEM

The following table lists the learning objectives and the verbs that appear in the syllabus learning aims and examination questions:

	Learning objectives	Verbs used	Definition
LEVEL B	KNOWLEDGE What you are expected to know	List	Make a list of
		State	Express, fully or clearly, the details/facts
		Define	Give the exact meaning of
	COMPREHENSION What you are expected to understand	Describe	Communicate the key features of
		Distinguish	Highlight the differences between
		Explain	Make clear or intelligible/ state the meaning or purpose of
		Identity	Recognize, establish or select after consideration
		Illustrate	Use an example to describe or explain something
	APPLICATION How you are expected to apply your knowledge	Apply	Put to practical use
		Calculate	Ascertain or reckon mathematically
		Demonstrate	Prove with certainty or exhibit by practical means
		Prepare	Make or get ready for use
		Reconcile	Make or prove consistent/ compatible
		Solve	Find an answer to
		Tabulate	Arrange in a table
	ANALYSIS How you are expected to analyse the detail of what you have learned	Analyse	Examine in detail the structure of
		Categorise	Place into a defined class or division
		Compare and contrast	Show the similarities and/or differences between
		Construct	Build up or compile
		Prioritise	Place in order of priority or sequence for action
		Produce	Create or bring into existence

Paper 9 - Operations Management & Information System

Full Marks: 100 **Time allowed-3hrs**

This paper contains 3 questions. All questions are compulsory, subject to instruction provided against each question. All workings must form part of your answer. Assumptions, if any, must be clearly indicted.

Question No. 1 : Answer all questions. [20 marks]

1. (a)'Design for Manufacturing and Design for Assembly are related concepts in manufacturing'. Justify.
(b) Define Time Study.
(c) For a certain element of work, the basic time is established to be 20 seconds. A time study observer record rating of 125 on a 100 normal scale. What is the observed time?
(d) Define Customer-Driven Quality.
(e) Describe Rotable Spare.
(f) Define Material Planning.
(g) Describe Commerce Net.
(h) Define programmed decision making.
(i) Define Feasibility Study.
(j) Describe legacy data. **[10 × 2=20]**

Answer :

1. (a) Design for Manufacturing (DFM) and **Design for Assembly (DFA)** are related concepts in manufacturing. The term design for manufacturing is used to indicate the designing of products that are compatible with an organisation's capability. Design for assembly focuses on reducing the number of parts in a product or on assembly methods and sequence that will be employed.

(b) A technique of work-measurement used for determining as accurately as possible from a limited number of observations, the time necessary to carry out a given activity at a denned standard of performance. A stop watch is used for the purpose of recording the actual time taken by the worker under observation to perform various elements of the work or task.

(c) (Observed time) x (observed rating) = (Basic or normal time) x (standard rating)
Observed Time = [(Basic or normal time) x (standard rating)]/Observed rating
= (20 x 100) / 125 = 16 seconds

(d) Customer-Driven Quality: Quality is meeting or exceeding customer expectations. The term "customer" includes both the "internal customer" and the "external customer" in the "customer chain".

(e) These are repairable and re-usable spares, such as a jet engine or an electric motor which can be reconditioned after failure and put back in operation.

(f) Materials planning is the scientific way of determining the requirements of raw materials, components, spares and other items that go into meeting the production needs within economic investment policies. Materials planning is a subset of the overall production planning and control system which has a broad perspective.

(g) Commerce Net is a consortium of companies which is promoting the use of internet for E-commerce. Sponsored by Silicon Valley vendors and US government agencies, it was

launched in 1994 with the aim of creating infrastructure for business-to-business transactions on the internet.

Today, it has over 120 members and helps companies to streamline their procurement and development cycles by performing transactions online, overcome impediments to e-Commerce by making new interfaces, security mechanisms and indexing tools.

(h) Programmed decision making refers to those decision making process which are based on some standard set of procedure established by the management and according to scientific principle of management. In case of programmed decision making, supporting information sets and reports are standard, well defined and well structured.

(i) It is essential to carry out the feasibility study of the project before its implementation. Feasibility Study refers to a process of evaluating alternative systems through cost/benefit analysis so that the most feasible and desirable system can be selected for development.

(j) Legacy data are stored manually, in excel files or in legacy system. Collection of legacy data is needed to be planned carefully to avoid the syndrome known as "garbage in and garbage out" which will undermine the confidence on the system after implementation. Cleaning of data should be done by removing duplicate and unnecessary information, before importing to ERP system.

Operations Management

Answer any three questions

2. (a) (i) Explain the term Quality Function Deployment (QFD). [5]

(ii) List the important steps in problem analysis. [3]

(iii) State the causes of low productivity. [3]

(iv) The following matrix gives the unit cost of transporting a product from production plants P_1, P_2 and P_3 to destinations D_1, D_2 and D_3. Plants P_1, P_2 and P_3 have a maximum production of 65, 25 and 110 units respectively and destinations D_1, D_2 and D_3 must receive at least 60,65 and 75 units respectively.

To	D_1	D_2	D_3	Supply
From				
P_1	₹500	₹500	₹800	65
P_2	₹1,000	₹1,200	₹1,400	25
P_3	₹500	₹900	₹700	110
Demand	60	65	75	200

You are required to formulate the above as linear programming problem. (Only formulation is required.) [5]

(b) (i) Identify the five common process decisions considered by production/operations managers. [5]

(ii) Production Manager of a unit wants to know from what quantity he can use automatic machine against semi-automatic machine.

Data	Automatic	Semi-automatic
Time for the job	4 mins	10 mins
Set up time	4 hrs	3 hrs
Cost per hour	₹40	₹24

Calculate the break-even point. [7]

(iii) The demand for three months for 100 Watt bulbs is given below:

Period	January	February	March
Demand	1000	1200	1600

If the weight assigned to the period of January, February and March are 0.30, 0.38 and 0.32 respectively, forecast the demand for the month of April by using Weighted Moving Average Method. [4]

(c) (i) The breakdown probability of an equipment is given below:

Month	Probability
1	0.05
2	0.15
3	0.30
4	0.30
5	0.20

There are 50 such equipments in the plant. The cost of individual preventive replacement is ₹15 per equipment and the cost of individual breakdown replacement is ₹30 per equipment. Which is the most suitable maintenance policy? Periodicities of replacement are considered every one, two, three and four months. [10]

(ii) TV repairman finds that time spends on his jobs has an exponential distribution with mean 30 minutes. If he repairs sets on the first-come first-served basis and if the arrival of sets is approximately Poisson with an average rate of 10 per 8-hour day, what is repairman's expected idle time each day? Also obtain average number of units in the system. [6]

(d) (i) A book store wishes to carry 'Ramayana' in stock. Demand is probabilistic and replenishment of stock takes 2 days (i.e. if an order is placed on March 1, it will be delivered at the end of the day on March 3). The probabilities of demand are given below

Demand(daily)	0	1	2	3	4
Probability	0.05	0.10	0.30	0.45	0.10

Each time an order is placed, the store incurs an ordering cost of ₹ 10 per order. The store also incurs a carrying cost of ₹ 0.50 per book per day. The inventory carrying cost in calculated on the basis of stock at the end of each day.
The manager of the bookstore wishes to order 5 books when the inventory at the beginning of the day plus order outstanding is less than 8 books.
Currently (beginning 1st day) the store has a stock of 8 books plus 6 books ordered two days ago and expected to arrive next day.
Use Monte-Carlo Simulation for 10 cycles.
The two digit random numbers are given below:
89 34 78 63 61 81 39 16 13 73

(ii) A project with normal duration and cost along with crash duration and cost for each activity is given below:

Activity	Normal time (Hrs.)	Normal cost (₹)	Crash time (Hrs.)	Crash cost (₹)

1-2	**5**	**200**	**4**	**300**
2-3	**5**	**30**	**5**	**30**
2-4	**9**	**320**	**7**	**480**
2-5	**12**	**620**	**10**	**710**
3-5	**6**	**150**	**5**	**200**
4-5	**0**	**0**	**0**	**0**
5-6	**8**	**220**	**6**	**310**
6-7	**6**	**300**	**5**	**370**

Overhead cost is ₹ 50 per hour.

Required:
(1) Draw network diagram and identify the critical path. **[8+8]**

Answer:

2. (a) (i) "QFD is a very systematic and organised approach of taking customer needs and demands into consideration when designing new product and services or when improving existing products and services." Another name for this approach is "customer-driven engineering" because the voice of the customer is diffused throughout the product (or service) development life cycle.

QFD is a planning tool that defines a process for developing products or services. The aptitude to plan is rare in the human race. Managers are evaluated on short-term results, which further inhabit this aptitude for planning. It is difficult to use Deming's PDCA (Plan, Do, Check, Act) cycle to improve the product development process if the P of PDCA Cycle is weak. QFD is applying TQM philosophy to product development by focusing on P. Using QFD counteracts the inherent weakness embedded in human nature — that of avoiding planning.

(ii) There are six important steps in analysis of problem:
(a) Write the result of the problem.
(b) Write the problems under main headings.
(c) Thinking by QC.
(d) Discussion on results of problem suggestions.
(e) Suggestions.
(f) To find main reasons of the problem by Pareto principle.

(iii) For evolving specific measures for improving productivity it will help the management to analyse on continuing basis, the causes of low productivity and, at the same time to keep abreast with the latest management and productivity techniques.
In the Indian context, the causes of low productivity have their origin in two distinct sources. The first category consists of the exogenous or external factors like shortages of essential inputs-power, raw materials, transport facilities etc. — over which the management of an enterprise has little or no control. The second basket contains the endogenous of internal factors mainly in the form of system deficiencies preventing the optimum utilisation of resources.

Since the management can do practically nothing to control the external factors and their adverse effect on productivity, it will be fruitless to discuss them here. The challenge before the Indian managers lies in overcoming the internal causes of low productivity.

(iv) Let the units transferred from P_1 to D_1 = p_1d_1
Let the units transferred from P_1 to D_2 = p_1d_2
Let the units transferred from P_1 to D_3 = p_1d_3
Let the units transferred from P_2 to D_1 = p_2d_1
Let the units transferred from P_2 to D_2 = p_2d_2
Let the units transferred from P_2 to D_3 = p_2d_3
Let the units transferred from P_3 to D_1 = p_3d_1
Let the units transferred from P_3 to D_2 = p_3d_2
Let the units transferred from P_3 to D_3 = p_3d_3
Subject to:
$p_1d_1 + p_1d_2 + p_1d_3 \leq 65$
$p_2d_1 + p_2d_2 + p_2d_3 \leq 25$
$p_3d_1 + p_3d_2 + p_3d_3 \leq 110$
$p_1d_1 + p_2d_1 + p_3d_1 \leq 60$
$p_1d_2 + p_2d_2 + p_3d_2 \leq 65$
$p_1d_3 + p_2d_3 + p_3d_3 \leq 75$
$p_1d_1, p_1d_2, p_1d_3, p_2d_1, p_2d_2, p_2d_3, p_3d_1, p_3d_2, p_3d_3 \geq 0$.

(b) (i) Five common process decisions considered by production/operations managers are:

- **Process choice** determines whether resources are organised around products or processes in order to implement the flow strategy. It depends on the volumes and degree of customisation to be provided.
- **Vertical integration** is the degree to which a firm's own production system handles the entire supply chain starting from procurement of raw materials to distribution of finished goods.
- **Resource flexibility** is the ease with which equipments and workers can handle a wide variety of products, levels of output, duties and functions.
- **Customer involvement** refers to the ways in which customers become part of the production process and the extent of their participation.
- **Capital intensity** is the mix of equipment and human skills in a production process. Capital intensity will be high if the relative cost of equipment is high when compared to the cost of human labour.

(ii) Let x be the break-even quantity between automatic and semi-automatic machines. This means, for volume of output x, the total cost of manufacture is the same on both automatic and semi-automatic machines.
For quantity =x units
Total manufacturing cost on automatic machines= (4.0 + 4x/60) x 40
Total manufacturing cost on semi-automatic machines = (3.0 +10x/60) x 24
If 'x' is the break-even quantity, then
(4.0 + 4x/60) x 40 = (3.0 +10x/60) x 24
160 + (4x/60) x 40 = 72 + (10x/60) x 24
160 + 8x/3 = 72 + 4x
4x -8x/3= 160 -72
4x/3 = 88
x= 66 units.

Hence for quantity upto 65, a semi-automatic machine will be cheaper. For quantity 66, both semi-automatic and automatic machines are equally costly. For quantity more than 66, automatic machine becomes cheaper than semi-automatic machine.

(iii) D_1 =1000 nos. W_1 = 0.30
D_2 = 1200 nos. W_2 = 0.38
D_3 = 1600 nos. W_3 = 0.32

Therefore Weighted Moving Average = $W_1 \times D_1 + W_2 \times D_2 + W_3 \times D_3$
= 0.30 x 1000 + 0.38 x 1200 + 0.32 x 1600
= 300 + 456 + 512
= 1268.
The demand for the month of April is 1268 nos. of 100 Watt bulbs.

(c) (i) Individual Breakdown Replacement Policy
The average number of individual breakdown replacements per month are:

$$\frac{\text{Number of equipments in the palnt}}{\text{Average life of an equipment}}$$

Average (Mean) life of an equipment, i.e., the mean operating time before failure
= (1 x 0.05) + (2 x 0.15) + (3 x 0.30) + (4 x 0.30) + (5 x 0.20) = 3.45 months

The average number of individual breakdown replacements per month

$$\frac{\text{No. of equipments}}{\text{mean life of an equipment}} = \frac{50}{3.45} = 14.49$$

Therefore, per month cost of individual breakdown maintenance = 14.49 x ₹30
= ₹434.70

Individual Preventive Replacement Policy

Case I: Replacement period = 1 month
The total cost per unit replacement comprises two components – (a) the possibility that the equipment may fail before its replacement age, needing a breakdown replacement and (b) the possibility that the equipment may not fail till its replacement age.

Cost component (a) = (0.05) x (₹ 30)	= ₹ 1.50
Cost component (b) = (0.95) x (₹ 15)	= ₹ 14.25
Total cost of replacement per equipment	= ₹ 15.75

Now, Cost per month = $\frac{\text{Total cost of replacement for all the equipments in the palnt}}{\text{Expected life of an equipment}}$

The expected life of an equipment, under preventive replacement period of one month is one month only, as the first breakdown coincides with the preventive replacement.

Thus Cost per month = $\frac{(₹15.75)x(50)}{1}$ = ₹ 787.50

Case II: Preventive Replacement Period = 2 months

Cost component (a) = (0.05 + 0.15) x (₹ 30) = ₹ 6.00
Cost component (b) = (0.80) x (₹ 15) = ₹ 12.00
Total cost of replacement per equipment = ₹ 18.00

Expected life of an equipment = (1 x 0.05) + (2 x 0.95) = 1.95 months

Cost per month = $\frac{(₹18.00)x(50)}{1.95}$ = ₹ 461.54

Case III: Preventive Replacement Period = 3 months

Cost component (a) = (0.05 + 0.15 + 0.30) x (₹ 30) = ₹ 15.00
Cost component (b) = (0.50) x (₹ 15) = ₹ 7.50
Total cost of replacement per equipment = ₹ 22.50

Expected life of an equipment = (1 x 0.05) + (2 x 0.15) + (3 x 0.80) = 2.75 months

Therefore, Cost per month = $\frac{(₹22.50)x(50)}{2.75}$ = ₹ 409.09

Case IV: Preventive Replacement Period = 4 months

Cost component (a) = (0.05 + 0.15 + 0.30 + 0.30) x (₹ 30) = ₹ 24.00
Cost component (b) = (0.20) x (₹ 15) = ₹ 3.00
Total cost of replacement per equipment = ₹ 27.00

Expected life of an equipment =(1 x 0.05)+(2 x 0.15)+(3 x 0.30)+(4 x 0.50)= 3.25 months

Total cost per month = $\frac{(₹27.00)\,x\,(50)}{3.25}$ = ₹415.38

The costs (per month) of the different policies are presented in the table below:

Cost Comparisons of Different Maintenance Policies

Policy	Cost per months, ₹
Individual Breakdown Maintenance	434.70
Individual Preventive Maintenance	
I every 1 months	787.50
II every 2 months	461.54
III every 3 months	409.09
IV every 4 months	415.38

Therefore, individual preventive replacement every three months is the best option.

(ii) Here mean or expected number of arrival (λ) = $\frac{10}{8}$ per hour.

Mean or expected number of items served (μ) = $\frac{1}{30} \times 60 = 2$ per hour.

Repairman's idle time each day, $P_O = 1 - \frac{\lambda}{\mu} = 1 - \frac{10}{8} \times \frac{1}{2} = \frac{3}{8}$.

In a day of 8 hours, idle time = $\frac{3}{8} \times 8 = 3$ hours.

Average number of units in the system:

$L_S = \frac{\lambda}{\mu - \lambda} = \frac{10}{8} \times \frac{1}{2 - \frac{10}{8}} = \frac{10}{8} \times \frac{8}{6} = \frac{5}{3}$ units.

(d) (i)

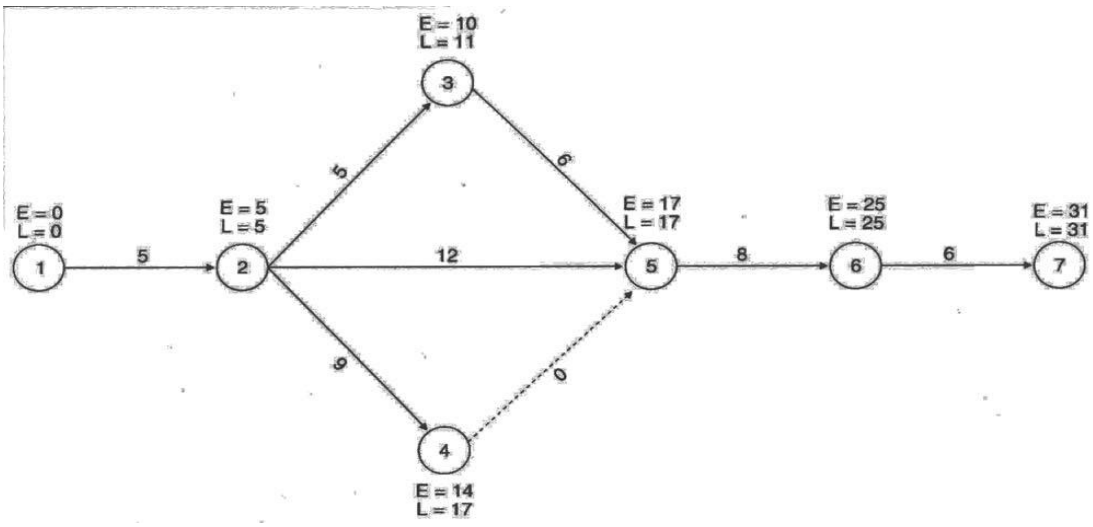
Demand	Probability	Cum. Prob.	Random No.
0	0.05	0.05	00-04
1	0.10	0.15	05-14
2	0.30	0.45	15-44
3	0.45	0.90	45-89
4	0.10	1.00	90-99

Stock in hand = 8 and stock on order = 6 (excepted next day)

R. No.	Demand	Op. Stock in hand	Receipt	Cl. Stock	Op. Stock on order	Order Qty.	Cl. Stock on order
89	3	8	-	5	6	-	6
34	2	5	6	9	-	-	-
78	3	9	-	6	-	5	-
63	3	6	-	3	5	-	5
61	3	3	-	0	5	5	10
81	3	0	5	2	5	5	10
39	2	2	-	0	10	-	10
16	2	0	5	3	5	-	5
13	1	3	5	7	0	5	5
73	3	7	-	4	5	-	5
			Total	39			

No. of orders = 4 orders, ordering cost = ₹10 × 4 = ₹40.
Closing Stock for 10 days = 39, carrying cost = 39 × ₹0.50 = ₹19.50
Total cost for 10 days = ₹59.50

(ii)



Paths →	1-2-5-6-7 (Let's denote this by A)	1-2-3-5-6-7 (Let's denote this by B)	1-2-4-5-6-7 (Let's denote this by C)
Duration	31 hours	30 hours	28 hours
The critical path is A. Its duration is 31 hours			

Information System

Answer any two questions.

3. (a) (i) Discuss the purpose for providing persistent storage for program objects and data structures. [5]

(ii) Describe the four types of implementation strategies. [6]

(iii) State the strengths/advantages of Prototyping Model. [5]

(b) (i) State the requirements of E-Procurement. [3]

(ii) List the major characteristics of Transaction Processing Systems. [5]

(iii) Describe Transaction Processing System. [4]

(iv) List the major constraints in operating MIS. [4]

(c) (i) Discuss whether web server can act as Permanent Establishment. [4]

(ii) List the steps involved to develop a sound public key infrastructure for an efficient allocation and verification of digital signatures certificates. [4]

(iii) 'The digital signature is created in two distinct steps.' Justify. [3]

(iv) State the notable features of the Information Technology Amendment Act, 2008. [5]

Answer:

3. (a) (i) Databases can be used to provide **persistent storage** for program objects and data structures. This is one of the main reasons for the emergence of the **object-oriented database systems**. Programming languages typically have complex data structures,

such as record types in PASCAL or class definitions in C++. The values of program variables are discarded once a program terminates, unless the programmer explicitly stores them in permanent files, which often involves converting these complex structures into a format suitable for file storage. When the need arises to read this data once more, the programmer must convert from the file format to the program variable structure. Object-oriented database systems are compatible with programming languages such as C++ and JAVA, and the DBMS software automatically performs any necessary conversions. Hence, a complex object in C++ can be stored permanently in an object-oriented DBMS, such as Object Store or O2 (now called Ardent). Such an object is said to be persistent, since it survives the termination of program execution and can later be directly retrieved by another C++ program.

The persistent storage of program objects and data structures is an important function of database systems. Traditional database systems often suffered from the so-called **impedance mismatch problem**, since the data structures provided by the DBMS were incompatible with the programming language's data structures. Object-oriented database systems typically offer data structure compatibility with one or more object-oriented programming languages.

(ii) Four types of implementation strategies are as follows:

(a) Direct Implementation/Abrupt change-over: Conversion by direct change over means that on a specified date the old system is dropped and the new system is put into use . The users have no possibility of using the old system other than the new one. Adaptation is a necessity. The disadvantage is that as the old system is dropped and new system is put to use, there is no adequate way to compare new results with old ones.

(b) Phased implementation: If each phase is successful then the next phase is started, eventually leading to the final phase when the new system fully replaces the old one. The advantage is that. It allows users to get involved with the system gradually. The disadvantage is that It takes too long to get the new system in place.

(c) Pilot implementation: With this strategy, the new system replaces the old one in one operation but only on a small scale, it might be tried out in one branch of the company or in one location. When one operation is sucessfully completed, other conversions are done for other operations. Each module is thoroughly tested before being used. Users become familiar with each module as it becomes operational.

(d) Parallel running implementation : The old system remains fully operational while the new systems come online, the old and the new system are both used alongside each other .If all goes well, the old system is stopped and new system carries on. The advantage is that there is a possibility of checking new data against old data in order to catch any errors in the processing of the new system. The disadvantage is that Cost of running two systems at the same time is high. The workload of employees during conversion is almost doubled.

(iii) Strengths/Advantages of Prototyping Model are:

(i) It provides quick implementation of an incomplete, but functional, application.
(ii) Prototyping requires intensive involvement by the system users.
(iii) A very short time period is normally required to develop and start experimenting with a prototype.

(iv) Since system users experiment with each version of the prototype through an interactive process, errors are hopefully detected and eliminated early in the developmental process.
(v) It reduces the cost of user training.
(vi) It improves the fact finding process.
(vii) It helps to identify confusing or difficult functions and missing functionality.
(viii) Prototyping model encourages innovation and flexible designs.

(b) (i) E-Procurement - A typical e-procurement requirement of an organization is depicted below:

- Electronic tendering comprising of tender publication, submission, short listing, evaluation and award. Facility for evaluation of IT/Service contracts containing Complex evaluation matrix.
- Compliance of agreed quantity Vis-a-Vis called quantity, consolidation of called quantity for obtaining agreed quantity discounts.
- Facility for publication and updating of electronic catalogues by vendors.
- Analytics for spend analysis which is used for strategic decisions, supplier relation management and minimization of maverick buying.
- Facilities for reverse auctions through business to business marketplace.

For meeting the above requirement, ERP vendors carried out integration of web based front end with generation of demand (planning module), preparation of purchase order (procurement module),receiving of goods (warehouse module), payment (account payable module), dealt by back end ERP system.

(ii) The Major Characteristics of TPS

- Large amounts of data are processed.
- The sources of data are mostly internal, and the output is intended mainly for an internal audience.
- The TPS processes information on a regular basis: daily, weekly, monthly, etc.
- Large storage (database) capacity is required.
- High processing speed is needed due to the high volume.
- TPS basically monitors and collects past data.
- Input and output data are structured (i.e., standardized).
- Low computation complexity is usually evident in TPS.
- A high level of accuracy, data integrity, and security is needed.
- High reliability is required.
- Inquiry processing is a must.

(iii) Transaction Processing System

Transaction processing refers to the processing of information relating to monetary transactions in the business activities like purchase, sale, payment, receipts etc. It is a computer based processing for different functional areas to generate all required reports for day-to-day use in the organization. The transaction processing system may be disintegrated or integrated. In case disintegrated transaction processing, data are collected from respective functional areas and processed and reports are generated for their use. In case of integrated transaction processing system, an application system which has capability of integrating all functional areas (say, ERP system), transaction processing are interlinked with all data from different system and the reports reflect the impact of integrated information.

Transaction processing may also be in batch mode or may follow on-line or distributed data processing system. Example of transaction processing in an organization:

- Payroll
- Accounts Receivable
- Bank Reconciliation
- Purchase Order Processing
- Sales Order Processing
- Inventory Control
- Job Costing etc.

(iv) Major constraints which come in the way of operating an information system are:

- Non-availability of experts, who can provide a desired direction for installing and operating the system aligning with the objectives of the organization. This problem may be overcome by grooming internal staff. The grooming of staff should be done by proper selection and training.
- Approach adopted by experts for designing and implementing MIS is a non-standardized one. Standardization may be arrived for the organizations in the same industry.
- Non-availability of cooperation from staff is a critical problem. The problem may be solved by educating the staff about the utility of MIS. The task should be carried out by organizing lectures, and explaining the utility of the system. Some persons from staff should also be involved in the development and implementation of the system.
- There is high turnover of experts in MIS. This problem can be handled by creating the better working conditions and paying at least at par with similar organizations.
- There is a difficulty in quantifying the benefits of MIS, the constraints can be resolved by educating the top managers and telling them about the advantages of MIS.

(c) (i) Earlier it was a controversial issue that whether in cyber space the web server act as permanent Establishment. However, this controversy was solved in 2001 when the working party of OECD had agreed upon considering the server as Permanent Establishment for taxing e-transactions. According to OECD the server on which website is stored and through which it is accessible is a piece of, equipment having a physical location which constitute a fixed place of business of the entity that operates that server. However, for the server or other computer equipment to constitute a Permanent Establishment following conditions must be fulfilled:

1. It must be owned or leased by that entity.
2. It must be in a fixed location.
3. Business must be wholly or partly carried on in the jurisdiction where that server or other equipment is located and the activities carried on through the server must be core and not merely preparatory or auxiliary.

Therefore, now it is settled law that existence of a web server in a country is enough to act as Permanent Establishment.

(ii) Public Key Infrastructure (PKI) is about the management and regulation of key pairs by allocating duties between contracting parties (Controller/CA/Subscribers), laying down the licensing and business norms for CAs and establishing business processes/ applications to construct contractual relationships in a digitized world. The idea is to

develop a sound public key infrastructure for an efficient allocation and verification of digital signatures certificates.

Step 1- Subscriber applies to Certifying Authority (CA) for Digital Signature Certificate.

Step 2 - CA verifies identity of Subscriber and issues Digital Signature Certificate.

Step 3 - CA forwards Digital Signature Certificate to Repository maintained by the Controller.

Step 4 - Subscriber digitally signs electronic message with Private Key to ensure Sender Authenticity, Message Integrity and Non-Repudiation and sends to Relying Party.

Step 5 - Relying Party receives message, verifies Digital Signature with Subscriber's Public Key, and goes to Repository to check status and validity of Subscriber's Certificate.

Step 6 - Repository does the status check on Subscriber's Certificate and informs back to the Relying Party.

(iii) The digital signature is created in two distinct steps. First the electronic record is converted into a message digest by using a mathematical function known as "hash function" which digitally freezes the electronic record thus ensuring the integrity of the content of the intended communication contained in the electronic record. Any tampering of the contents of the electronic record will immediately invalidate the digital signature. Secondly, the identification of the person affixing the digital signature is authenticated through the use of the private key which attaches itself to the message digest and which can be verified by anybody who has the public key corresponding to such private key. This will enable anybody to verify whether the electronic record is retained intact or has been tampered with since it was so fixed with the digital signature. It will also enable a person who has a public key to identify the originator of the message.

(iv) The notable features of the Information Technology Amendment Act, 2008 are as follows:

- Focusing on data privacy
- Focusing on Information Security
- Defining cyber café
- Making digital signature technology neutral
- Defining reasonable security practices to be followed by corporate
- Redefining the role of intermediaries
- Recognizing the role of Indian Computer Emergency Response Team
- Inclusion of some additional cyber crimes like child pornography and cyber terrorism
- Authorizing an Inspector to investigate cyber offences (as against the DSP earlier)