

EIS CHAP -3

INFORMATION SYSTEM  
& ITS COMPONENT

CHALISA



Summarize Without  
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RTP, MTP & SM

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BY KISHAN KUMAR  
RANKHOLDER

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I Taught, They Learnt. I told them to Aspire. They Performed.  
You too have a look & try to make Your Parents and Me Proud.  
Blessings !! *Kishan Kumar*



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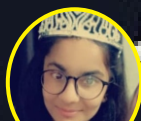
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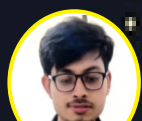
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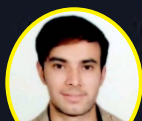
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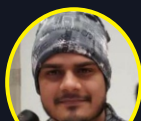
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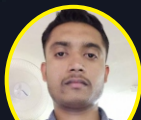
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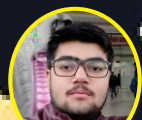
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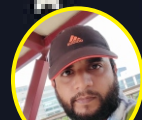
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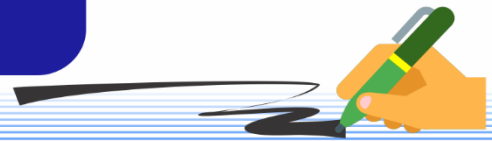
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# CHAPTER 3



## INFORMATION SYSTEM & ITS COMPONENTS

### 1. INTRODUCTION

| Data                                                                                                                                                                                                                                                           | Information                                                                                                                                                            | System                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Raw &amp; unorganized piece of information without context. Plural of Datum.</p> <p>It is not meaningful &amp; does not convey any message as such.</p> <p>It may be</p> <p>a) Qualitative (weight, Height, Colour) or</p> <p>b) Quantitative (Numbers)</p> | <p>Processed form of data which conveys some meaning.</p> <p>Data + Context = Info.</p> <p>Data is organized by organization from internal &amp; external sources.</p> | <p>Group of inter-related &amp; inter dependent components working together to achieve a common goal.</p> <p>E.g. Traffic light, Human Body, Information System</p> |

### 2. INFORMATION SYSTEM / COMPUTER BASED I.S. (CBIS)

It is the combination of Hardware, software, people, data resources & Network which

- processes Data into Information
- for specific purpose/ objective.

**Examples:**

Tally - Accounting Software in India; QuickBooks - Accounting Software across world.

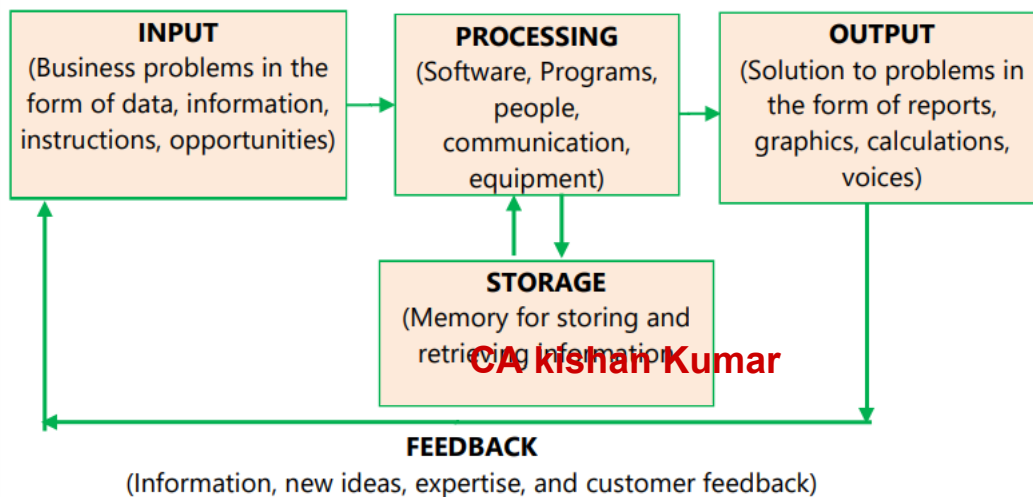
| Objectives                                                                                                                                                                                                                                                  | Characteristics                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>To convert the data into information which is useful and meaningful.</p> <p>It helps Enterprises in:</p> <p>a) Making Decision.</p> <p>b) Controls the operation.</p> <p>c) analyzing problems &amp; creating new products or services as an output.</p> | <p>a) CBIS is developed on the basis of predetermined objective.</p> <p>b) Inter-related and Inter dependant sub- system.</p> <p>c) If one sub -system fails, whole system won't work.</p> <p>d) Components Interact among themselves.</p> <p>e) Work done by individual sub-system is integrated to achieve common goal.</p> |

### 3. INFORMATION SYSTEM MODEL



I.S. Model provides a framework that emphasizes four major concepts that can be applied to all types of information systems:

|                      |                                                                                                                                                                                                                                                                             |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| a) <b>Input</b>      | Data is collected from an organization or from external environments and converted into suitable format required for processing.                                                                                                                                            |
| b) <b>Processing</b> | A process is a series of steps undertaken to achieve desired outcome or goal. It facilitates conversion of data into information.                                                                                                                                           |
| c) <b>Output</b>     | The system processes the data by applying the appropriate procedure on it and the information thus produced (output) is stored for future use or communicated to user.                                                                                                      |
| d) <b>Storage</b>    | Storage of data shall be done at the most detailed level possible. Regular backups should be stored in a geographically different locations to avoid impact on both the original data and the backup data storage due to any major disasters such as flooding or fires etc. |
| e) <b>Feedback</b>   | I.S. needs feedback that is returned to appropriate members of the enterprises to help them to evaluate at the input stage.                                                                                                                                                 |



Q. Information System Model is responsible to convert the data into information which is useful and meaningful to the user. Explain all steps involved in Information System Model.

## 4. COMPONENTS OF INFORMATION SYSTEM

| People Resources                                                                                                                                            | Computer System                                                                                                                                   |                                                                           | Data Resources                                                                                                                        | Network & Communication System                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Anyone who manage, run, program or use I.S.                                                                                                                 | Comprise of                                                                                                                                       |                                                                           | <ul style="list-style-type: none"> <li>Data</li> <li>Database</li> <li>Database Management System</li> <li>Database Models</li> </ul> | <ul style="list-style-type: none"> <li>Computer Network</li> <li>Telecommunication</li> </ul> |
| <ul style="list-style-type: none"> <li>Programmers</li> <li>System Admin.</li> <li>Data Entry Operator</li> <li>Help Desk</li> <li>CEO &amp; CIO</li> </ul> | Hardware                                                                                                                                          | Software                                                                  |                                                                                                                                       |                                                                                               |
|                                                                                                                                                             | <ul style="list-style-type: none"> <li>Input Devices</li> <li>Processing Devices</li> <li>Data Storage Devices</li> <li>Output Devices</li> </ul> | <ul style="list-style-type: none"> <li>OS S/w</li> <li>App S/w</li> </ul> |                                                                                                                                       |                                                                                               |

Q. Discuss briefly the components of Computer based Information Systems.

#### 4.1. HARDWARE

Tangible portion of Computer System that can be seen and touched.

| Input devices                                                                                                                                                                                                                                                                                                                    | Processing devices                                                                                                                                                                                                          | Data storage devices                                                                                                               | Output devices                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Device through which user interacts with system i.e., Instructions are given to information system.<br><b>Types</b><br>a) <b>Text based Input</b> – Keyboard<br>b) <b>Point based Input</b> – Mouse, light pens.<br>c) <b>Image based</b> – Scanner, Bar Code, QR Code reader, MICR reader<br>d) <b>Audio based</b> – Microphone | Device used to process data using program instructions, perform calculations, and control other hardware devices.<br><b>Examples</b><br>Central Processing Unit (CPU),<br>Mother board,<br>Network Card,<br>Sound Card etc. | Memory where data & program is stored on temporary or permanent basis.<br><b>Types</b><br>a) Primary Memory<br>b) Secondary Memory | Device through which system responds<br>Provides output to decision makers to solve problem.<br><b>Examples</b><br>Speakers,<br>Headphones,<br>Screen (Monitor),<br>Printer,<br>Video |

##### 4.1.1. PROCESSING DEVICES

- Most common processing device is **CPU** which is the main hardware that interprets and executes the software instructions.
- Built on a small flake of silicon containing the equivalent of several million transistors.
- Transistors are like switches which could be “ON” or “OFF” i.e. taking a value of 1 or 0.
- CPU is known as brain of computer & consists of following three functional units:

| Control Unit                                                                                                                                        | ALU                                                                                                                                                                                          | Processor Registers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| It<br>➤ controls flow of data & instruction to and from memory,<br>➤ interprets the instruction; and<br>➤ controls which tasks to execute and when. | Arithmetic and Logic unit performs<br>➤ arithmetic operations such as addition, subtraction, multiplication, and<br>➤ logical comparison of numbers: Equal to, Greater than, Less than, etc. | Registers are part of the computer processor which is used<br>➤ to hold a computer instruction,<br>➤ perform mathematical operation &<br>➤ execute commands.<br>These are high speed, very small memory units within CPU for storing small amount of data (mostly 32 or 64 bits).<br>Registers could be<br>a) <b>accumulators</b> (for keeping running totals of arithmetic values),<br>b) <b>address registers</b> (for storing memory addresses of instructions),<br>c) <b>storage registers</b> (for storing the data temporarily) and<br>d) <b>miscellaneous</b> (used for several functions for general purpose). |



### 4.1.2. DATA STORAGE DEVICES

Refers to the memory where data and programs are stored on temporary or permanent basis.

| a) Primary memory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | b) Secondary memory                                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Also known as Main Memory or Internal Memory. It is directly accessed by the processor using data bus.<br><b>Mainly of two types</b> – Random Access Memory (RAM) and Read Only Memory (ROM)<br><br><b>Cache Memory</b> – Helps to bridge the huge speed gap b/w Registers & primary memory.<br>It is smaller, very fast memory in-built into CPU. Acts as a buffer between RAM & CPU.<br>Cache memory stores data frequently used by main memory so that Registers/CPU can access it faster. E.g. Values that have been computed earlier. | It is external memory.<br>Not directly accessible by CPU but can be accessed by Primary Memory.<br><b>Characteristics</b><br>a) Non-volatile (permanent storage),<br>b) Large capacity,<br>c) Slower speed,<br>d) Economical<br><b>Examples</b><br>Hard disk, Pen drive, memory card etc. |

### RAM VS ROM

| Aspect                    | RAM                                                                                | ROM                                                                                                                                                                          |
|---------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Data Retention</b>     | Volatile in nature means Information is lost as soon as power is turned off.       | Non-volatile in nature (contents remain intact even in absence of power).                                                                                                    |
| <b>Persistence</b>        | The purpose is to hold program and data while they are in use.<br>Temporary Memory | These are used to store small amount of information that is rarely changed during the life of the system for quick reference by CPU. For example – BIOS.<br>Permanent Memory |
| <b>Information Access</b> | Info. can be read as well as modified.                                             | Info. can be read only and not modified.                                                                                                                                     |
| <b>Impact</b>             | High impact on system's performance.                                               | No impact on system's performance.                                                                                                                                           |
| <b>Cost</b>               | Costly per unit size.                                                              | Cheap per unit size.                                                                                                                                                         |
| <b>Speed</b>              | Quite high.                                                                        | Slower than RAM.                                                                                                                                                             |
| <b>Capacity</b>           | RAM memory is large and high capacity.                                             | ROM is generally small & of low capacity.                                                                                                                                    |

### PROCESSOR REGISTERS VS CACHE MEMORY

| Processor Registers                                                                                   | Cache Memory                                                                                                              |
|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| These are high speed memory units within CPU for storing small amount of data (mostly 32 or 64 bits). | It is fast memory built into a computer's CPU and is used to reduce the average time to access data from the main memory. |
| The registers are the only Memory Units most processors can operate on directly.                      | Cache memory is an interface between CPU and Main storage. It is not directly accessible for operations.                  |

### PRIMARY MEMORY VS SECONDARY MEMORY

| Aspect       | Primary/ Main Memory                                                     | Secondary Memory                                           |
|--------------|--------------------------------------------------------------------------|------------------------------------------------------------|
| Basic        | Directly accessible by Processor/ CPU.                                   | Not directly accessible by CPU.                            |
| Data         | Instructions or data to be currently executed are copied to main memory. | Data to be permanently stored is kept in secondary memory. |
| Volatility   | Usually volatile.                                                        | Non-volatile.                                              |
| Formation    | Made of semi-conductors.                                                 | Made of magnetic and optical material.                     |
| Access Speed | Accessing data from P.M. is faster.                                      | Accessing data from S.M. is slower.                        |
| Size         | Smaller size.                                                            | Larger size.                                               |
| Expense      | Costlier than secondary memory.                                          | Cheaper than primary memory.                               |
| Memory       | Internal memory.                                                         | External memory.                                           |



#### 4.1.3. OUTPUT DEVICES

- Output devices are devices through which system responds.
- CBIS provide output to decision makers at all levels in an enterprise to solve business problems, the desired output may be in visual, audio or digital forms.
- Information shown on a display device is called soft copy because the information exists electronically and is displayed for a temporary period.

#### Types of Output

|                      |                                                                                                           |
|----------------------|-----------------------------------------------------------------------------------------------------------|
| a) Textual output    | comprises of characters that are used to create words, sentences, and paragraphs.                         |
| b) Graphical outputs | are digital representations of non-text information such as drawings, charts, photographs, and animation. |
| c) Tactile output    | such as raised line drawings may be useful for some individuals who are blind.                            |
| d) Audio output      | any music, speech, or any other sound.                                                                    |
| e) Video output      | consists of images played back at speeds to provide the appearance of full motion.                        |

Examples of output devices: Speakers, Headphones, Monitor, Printer, Automotive navigation system etc.

#### 4.2. SOFTWARE

- Set of instructions & programs that tells Computers what to do. Created through a process of coding/programing through language like C++, JAVA
- Two types:

|                           |                      |
|---------------------------|----------------------|
| Operating System Software | Application Software |
|---------------------------|----------------------|

Set of instructions/ programs/ software that

- manages H/w resources and
- acts an intermediary b/w hardware & App software.

**Examples:**

**Personal Computer** - Windows, OS X, Linux,

**Mobile/ Tablet** - Android, iOS, Tizen, Harmony OS etc.

**Activities by OS [HUMAN -FT]**

- a) **Performing hardware function**- acts as intermediary b/w H/w & App s/w.
- b) **User Interface**- Helps to connect user with I.S. It may be GUI based (uses icons and menus) or CUI based.
- c) **Memory management** - Maximizes available memory & storage. Provides Virtual Memory (later)
- d) **Logical Access Security** - OS helps in user identification & Authorization through Password PIN.
- e) **Networking capability** - Helps to connect various hardwares.
- f) **File Management** - Keeps a track of where each file is stored based on which it provides the file retrieval.
- g) **Task Management** - Facilitates a user to work with more than one App at a time i.e. **Multitasking**. Also, allows more than one user to use the system i.e. **Time sharing**.
- h) **Hardware Independence** - Any device irrespective of manufacturer or design can use OS to run itself. OS provides Application Programme Interface (APIs) used to create App without considering details of H/w.

Include all software that causes computer to perform useful tasks other than running the computer itself.

It addresses real-life problems of its end users which may be business or scientific or any other problem.

Application programs usually require an operating system to function.

**Examples**

App suite - MS office, G Suite

Content Access S/w - VLC, Abode PDF Reader

Enterprise S/w - ERP like SAP

| Advantages               | Disadvantages                    |
|--------------------------|----------------------------------|
| a) Addresses user needs  | a) Costly development of App S/w |
| b) Low threat from virus | b) Risk of Virus attack          |
| c) Regular updates       |                                  |

**Virtual Memory** is not a separate device but an imaginary memory supported by OS.

IF RAM required to run a program falls short, OS moves data from RAM to a space in HDD called paging file.

This frees RAM to execute the work Thus, it is allocation of HD space to help RAM.

Q. Discuss the term 'Operating System' and various operations performed by it.

Q. What is virtual memory? How does it differ from secondary memory?

### 4.3. DATA RESOURCES

Organization generates & collects huge quantity of different type of data like production related data, HR related data, market related data etc. These are stored in DATABASES.

| Database                                                                                                                 | Database Management System                                                                   | Database Models                                    |
|--------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|----------------------------------------------------|
| Refers to set of logically inter-related organised data i.e., data of some context<br>To manage unrelated data, separate | Software that helps organization in organising, controlling & using the data needed by Apps. | Determines the logical structure of a database and |



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>database is used.<br/>They store both</p> <ul style="list-style-type: none"> <li>➤ operational data (produced from day to day working) as well as</li> <li>➤ non-operational data (used for education, research etc.)</li> </ul> <p><b>Hierarchy of database</b></p> <ol style="list-style-type: none"> <li><b>Database:</b> Collection of Files.</li> <li><b>File / Table / Entity:</b> Collection of Records.</li> <li><b>Record:</b> Collection of Fields.</li> <li><b>Field:</b> Collection of Characters</li> <li><b>Characters:</b> Collection of Bits.</li> </ol> | <p>Helps to create &amp; maintain well organized database.<br/>Normally single user.<br/>Operations that it can perform –</p> <ul style="list-style-type: none"> <li>▪ Adding, Deleting or Modifying files in database &amp;</li> <li>▪ Retrieving or querying data from existing files.</li> </ul> <p><b>Examples</b></p> <ol style="list-style-type: none"> <li><b>Commercial DBMS</b> – MY SQL, Oracle</li> <li><b>Personal DBMS</b> – MS Access, Open Office Base</li> </ol> | <p>fundamentally determines in which manner data can be stored, organized and manipulated.</p> <p><b>Types</b></p> <ol style="list-style-type: none"> <li>Hierarchical Database Model</li> <li>Network Database Model</li> <li>Relational Database Model</li> <li>Object Oriented Data Base Model</li> </ol> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

#### 4.3.1. TYPES OF DATABASE MODELS

| Hierarchical Database Model                                                                                                                                                    | Network Database Model                                                                                                    | Relational Database Model                                                                                                                                                                                                                                                                                                                                            | Object Oriented Data Base Model(OODBMS)                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Records/Nodes are logically organized into a hierarchy of relationships in an inverted tree pattern.                                                                           | This structure views all records in sets; wherein each set is composed of an owner record and one or more member records. | <p>This allows collection of records in a tabular structure.</p> <p>Main terms used in this model are</p> <ol style="list-style-type: none"> <li><b>Relation</b> defined as a table with columns and rows;</li> <li><b>Named columns</b> of the table as <b>Attributes</b> (fields) and</li> <li><b>Domains</b> as set of values the attributes can take.</li> </ol> | <p>It is based on the concept that the world can be modeled in terms of objects and their interactions.</p> <p>This provides a mechanism to store complex data such as images, audio and video, etc.</p> |
| Top parent record that "own" other records is called Parent Record/ Root Record which may have one or more child records, but no child record has more than one parent record. | It implements one-to-one, one-to-many, many-to-one and the many-to-many relationship types.                               | <p>All relations adhere to some basic rules:</p> <p>First, the ordering of columns is immaterial in a table.</p> <p>Second, there cannot be identical record in a table.</p> <p>Third, each record will contain a single value for each of its attributes.</p>                                                                                                       | In this, the data is modeled and created as objects.                                                                                                                                                     |
| Each node is related to the others in a parent-child relationship. Thus, the hierarchical data structure implements one-to-one and one-to-many                                 | It can represent the data more efficiently than in the hierarchical model.                                                | <p>RDB contains multiple tables, with all the tables connected by one or more common fields.</p> <p>For each table, one of the fields is identified as a Primary Key, which is the unique identifier for each record in the table.</p> <p>If the primary key of one table is used in another table to access the former, it is called Foreign Key.</p>               | OODBMS helps programmers make objects which are an independently functioning application or program, assigned with a specific task or role to perform.                                                   |

|                |  |                                                                  |  |
|----------------|--|------------------------------------------------------------------|--|
| relationships. |  | Popular examples of RDB are Microsoft Access, MySQL, and Oracle. |  |
|----------------|--|------------------------------------------------------------------|--|

#### 4.3.2. ADVANTAGES OF DBMS

|                                          |                                                                                                                                                |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. <i>Permitting data sharing</i>        | same info is available to different users.                                                                                                     |
| 2. <i>Minimize data redundancy</i>       | as duplication of info is either eliminated or controlled or reduced. It significantly reduces cost of storing information on storage devices. |
| 3. <i>Integrity can be maintained</i>    | Database contains Accurate, consistent & upto date data. Change in Database is allowed to be made only by authorised person.                   |
| 4. <i>Program &amp; File Consistency</i> | As file formats & programs are standardized.                                                                                                   |
| 5. <i>User Friendly</i>                  | Enable user to access data & use it easily without need of computer expert.                                                                    |
| 6. <i>Improved Security</i>              | Since multiple users use same data, necessary to define user access rules on need to know and need to do basis.                                |
| 7. <i>Program/ Data Independence</i>     | Data resides in DB & not in App; so both are independent.                                                                                      |
| 8. <i>Faster application development</i> | Since data is already present in DB, so App developer has to think only about logic to retrieve data in the way a user needs.                  |

#### 4.3.3. DISADVANTAGES OF DBMS

|                                       |                                                                                                                           |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| 1. <i>Costly &amp; Time consuming</i> | in terms of both system and user-training.                                                                                |
| 2. <i>Security Risk</i>               | It may be possible for some unauthorized user to access the DB. In such cases, it could be at all or nothing proposition. |

**Q.** Database Management Systems is a software that aids in organizing, controlling and using the data needed by the application program. However, there are many advantages and disadvantages associated with it. Discuss them.

**Q.** ABC Pvt. Ltd. is a brand manufacturer of automobile parts with huge clientele all over the country. The company maintains the data of its clients in Oracle-the Database management software. Explain the advantages that the company would be benefitted by using Database Management System. [MTP Dec 21]

#### 4.3.4. CONCEPTS RELATED WITH DATA

##### A. BIG DATA

- Refers to such massive large data sets that conventional database tools do not have processing power to analyze them. E.g.- Google handle billions of searches every day.
- Some industries that use big data analytics include E-commerce (Amazon), Retail Business (Walmart), Healthcare Industry, Hospitality Industry etc..

##### Benefits of Big Data Processing

|                                      |                                                        |
|--------------------------------------|--------------------------------------------------------|
| a) <i>Improved Customer Services</i> | as it helps in reading & evaluating customer feedback. |
|--------------------------------------|--------------------------------------------------------|

|                                         |                                                                                                                                                                                                                          |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| b) <b>Better Operational Efficiency</b> | Integration of Big Data technologies and data warehouse helps an Org to offload infrequently accessed data, this improving efficiency.                                                                                   |
| c) <b>Better Decision Making</b>        | by using outside intelligence. E.g. Access to social data from Facebook, Twitter etc. helps Org to finetune their business strategy.<br><br>Also helps in Early identification of risk to the products/services, if any. |

**Q.** Nowadays, many industries like hospitality, healthcare and public service agencies deal with massively large data sets that conventional database tools can't process. Big data has significant benefits due to which it has provided a new direction to these businesses. Elaborate these benefits.

## B. DATA WAREHOUSE

- Data warehouse is a large collection of business data used for storage & analysis to help an organization make decisions.
- However, directly analyzing the data that is needed for day-to-day operations is not a good idea as it creates interference in normal functioning of Organisation.
- The process of extracting data from operational databases and bringing it into the data warehouse is commonly called **ETL**, which stands for **Extraction, Transformation, and Loading**.
  - a) First stage, the data is **Extracted** from one or more of the organization's databases.
  - b) Second stage, the data so extracted is placed in a temporary area called **Staging Area** where it is **Transformed** like cleansing, sorting, filtering etc. of the data as per the information requirements.
  - c) Final stage, **Loading** of the data so transformed into a data warehouse which itself is another database for storage and analysis.

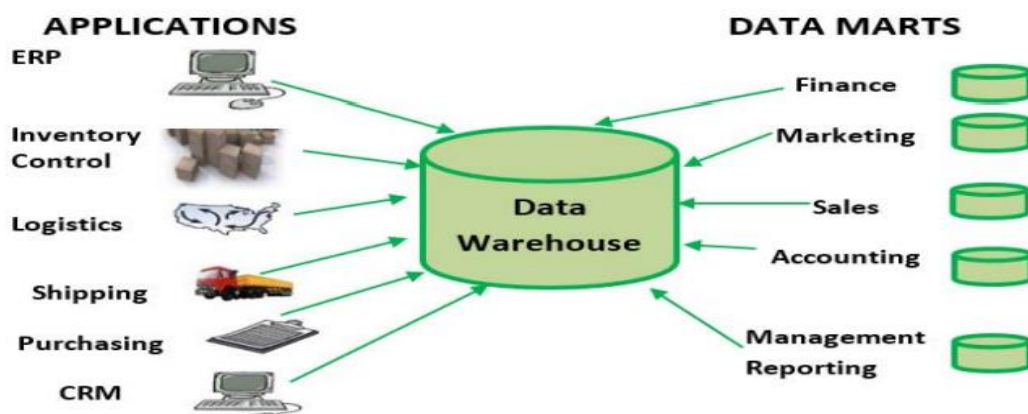
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**Features i.e. data warehouse should meet following criteria:**

- a) **Uses Non-Operational Data** i.e. a copy of data from the active databases
- b) **Data Is time Variant** i.e. when data is loaded in data warehouse, it receives time stamp which allows Org. to compare over a period of time.
- c) **Data is standardized** in terms of rules & format like Date, Units of measurements etc.

### Two School of thoughts/Approach

| Bottom-Up Approach                                                                   | Top-Down Approach                                                                         |
|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Step I: Create small data warehouses known as Data Marts to solve specific problems. | Step I: Create enterprise wide data warehouse                                             |
| Step II: Combine them to form large data warehouse.                                  | Step II: As specific needs are identified, create smaller data marts from data warehouse. |





## Benefits of Database Warehouse

- Better understanding of data.
- Determine inconsistent data as it provides centralized view of all collected data.
- Generate one version of truth viz. number of employees, sales etc.
- Create historical record of data which allows an organization to analyze trends.
- Data warehouse can be used along with Business Intelligence tools for new information & analysis.

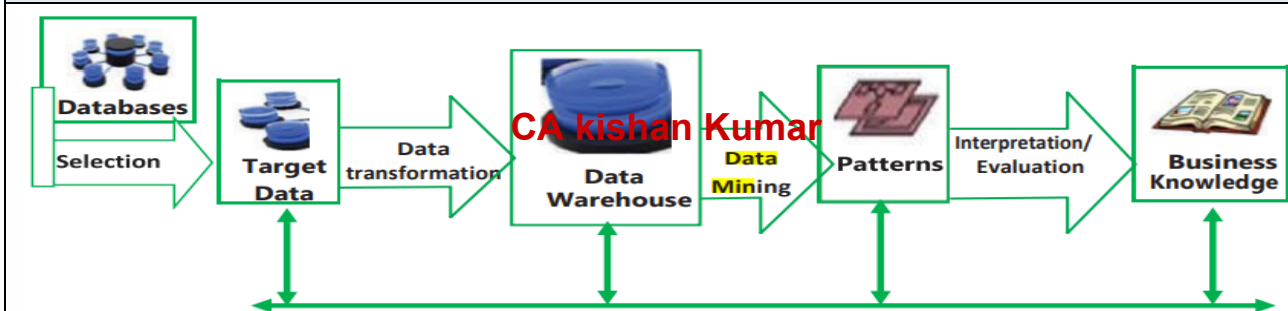
Q. Data Warehouse extracts data from one or more of the organization's databases and loads it into another database for storage and analysis purpose. As a Data Warehouse Manager, determine the design criteria, which should be met while designing Date Warehouse. [NTS & Two approach]

Q. Write a short note on Extraction- Transformation-Load (ETL).

## C. DATA MINING

- Process of analyzing large data to find previously unknown trends & pattern to make decision.
- This is accomplished through automated means against extremely large data set such as data warehouse.
- Examples of Data Mining tools - MS Excel, Oracle Data Mining, Rapid Miner

### The steps involved in the Data Mining process



|                                                  |                                                                                                                                                                                                             |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Data Integration                              | <ul style="list-style-type: none"> <li>Data is collected and integrated from all the different sources which could be flat files, relational database, data warehouse or web etc.</li> </ul>                |
| 2. Data Selection                                | <ul style="list-style-type: none"> <li>All the collected data may not be required for data mining. So, we select only those data which we think is useful for data mining.</li> </ul>                       |
| 3. Data Cleaning                                 | <ul style="list-style-type: none"> <li>The data that is collected may contain errors, missing values or inconsistent data. It needs to be cleaned to remove all such inconsistencies.</li> </ul>            |
| 4. Data Transformation                           | <ul style="list-style-type: none"> <li>The cleaned data needs to be transformed into an appropriate form for mining using different techniques like - smoothing, aggregation, normalization etc.</li> </ul> |
| 5. Data Mining                                   | <ul style="list-style-type: none"> <li>Various data mining tools are applied on the data to discover the interesting hidden patterns.</li> </ul>                                                            |
| 6. Pattern Evaluation and Knowledge Presentation | <ul style="list-style-type: none"> <li>Involves visualization, transformation, removing redundant patterns etc. from the patterns generated from data mining .</li> </ul>                                   |
| 7. Decisions / Use of Discovered Knowledge       | <ul style="list-style-type: none"> <li>This step helps user to make use of the knowledge acquired to take better informed decisions.</li> </ul>                                                             |

**Q.** Data Mining is commonly applied in banking industry to credit ratings and to intelligent anti-fraud systems to analyze transactions, card transactions, purchasing patterns and customer financial data etc. The process of Data Mining involves sequential execution of steps for its implementation. Discuss the steps involved in this process.

#### D. DIFFERENCES B/W DATABASE, DATA WAREHOUSE & DATA MINING

| Database                                                                                                                                        | Data Warehouse                                                                                                                                                          | Data Mining                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| This stores real time information.                                                                                                              | This stores both historic & transactional data.                                                                                                                         | This analyses data to find previously unknown trends.                                                                                                                                                |
| Example: In a tele-communication sector, the database stores information related to monthly billing details, call records, minimum balance etc. | Example: In the same tele-communication sector, information in a data warehouse will be used for product promotions, decisions relating to sales, cash back offers etc. | Example: In the same tele-communication sector, information will be analysed by data mining techniques to find out call duration with respect a particular age group from the entire data available. |
| Its function is to record                                                                                                                       | Its function is to report & analyse                                                                                                                                     | Its function is to extract useful data                                                                                                                                                               |

#### 4.4. NETWORKING AND COMMUNICATION SYSTEMS

| 1. <b>Computer Network</b>                                                                                                              | Collection of Computers & other hardware interconnected by communication channel/ mode/ medium which allows sharing of data, resources & information.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                         |                     |                                                                                                                                         |                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| 2. <b>Telecommunication</b>                                                                                                             | Refers to sharing/exchanging of data/info over computer network. It helps in <ul style="list-style-type: none"> <li>a) Increase in efficiency of operations;</li> <li>b) Improvement in effectiveness of management; and</li> <li>c) Innovation in market place.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |                     |                                                                                                                                         |                                                                                                       |
| 3. <b>Network &amp; Communication System</b>                                                                                            | <p>Consists of both hardware as well as software.</p> <p>Links various piece of hardware &amp; transfer data from one physical location to another.</p> <p>Computers and communications equipment can be connected in networks for sharing voice, data, images, sound and video.</p> <p><b>Types:</b></p> <table border="1"> <thead> <tr> <th>Connection Oriented N/w</th><th>Connection Less N/w</th></tr> </thead> <tbody> <tr> <td>First connection is established between sender &amp; receiver.<br/>Then data is exchanged<br/>E.g. – Telephone; Transfer of movie from laptop</td><td>No prior connection is made before data exchange.<br/>Inspired by portal Network.<br/>E.g. – Email, SMS</td></tr> </tbody> </table> | Connection Oriented N/w | Connection Less N/w | First connection is established between sender & receiver.<br>Then data is exchanged<br>E.g. – Telephone; Transfer of movie from laptop | No prior connection is made before data exchange.<br>Inspired by portal Network.<br>E.g. – Email, SMS |
| Connection Oriented N/w                                                                                                                 | Connection Less N/w                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                         |                     |                                                                                                                                         |                                                                                                       |
| First connection is established between sender & receiver.<br>Then data is exchanged<br>E.g. – Telephone; Transfer of movie from laptop | No prior connection is made before data exchange.<br>Inspired by portal Network.<br>E.g. – Email, SMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                         |                     |                                                                                                                                         |                                                                                                       |

**Computer Network is modeled to address following basic issues:**

|                      |                                                                                                                                                                  |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. <b>Routing</b>    | Process of deciding on how to communicate the data from source to destination in a N/w.                                                                          |
| 2. <b>Bandwidth</b>  | Amount of data which can be transferred across the network in a given time. Higher bandwidth, higher is the speed of data transfer and faster the website loads. |
| 3. <b>Resilience</b> | Ability of a network to recover from any kind of error like power failure, connection failure                                                                    |

|                      |                                                                                                                                                                                                    |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                      | etc. If one server is down, other will manage.                                                                                                                                                     |
| <b>4. Contention</b> | Situation where there is some conflict for some common resource in a network.<br>E.g. Two or more computer systems try to communicate at the same time. Policy should be made for priority access. |

| Benefits of Computer Network                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Value & Impact of Telecommunication                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>a) <b>Computational power is distributed</b> among computers in Network. This reduces load on individual system &amp; improve performance.</p> <p>b) <b>User communication</b> - it allows users to communicate using e-mail, video conferencing etc.</p> <p>c) <b>Resource sharing</b> - Data stored in Database can be shared across different systems using computer network. Similarly, H/w like Printer can be shared.</p> <p>d) <b>Reliability</b> - Enable critical operations to run across different systems 24x7 which are distributed across network. Hence reliability increases.</p> <p>e) <b>Distributed nature of information</b> - Enables distribution of Info geographically as well as consolidation of info when required. E.g. Preparing F.S. of Bank.</p> | <p>a) <b>Time compression</b> - Enables organization to transmit data &amp; information quickly &amp; accurately b/w remote sites.</p> <p>b) <b>Overcoming Geographical Dispersion</b> - Enables Org with units in remote areas to function as 1 unit.</p> <p>c) <b>Restructuring of Business Relationship</b> - Eliminates intermediaries from various business processes. This results in increased operational efficiency.</p> |

## 5. INFORMATION SYSTEM CONTROLS

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|                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>▪ <b>Objectives of I.S. Controls</b></p> <p>a) Undesired risk, events are prevented, detected created</p> <p>b) To ensure Business objectives are achieved.</p>                                                                                                                                                                                                                               |
| <p>▪ <b>How above objectives are achieved?</b></p> <p>By designing &amp; implementing effective information control framework which</p> <ul style="list-style-type: none"> <li>➤ comprises policies, procedures, practices, and organization structure</li> <li>➤ that gives reasonable assurance that business objective shall be achieved.</li> </ul>                                          |
| <p>▪ <b>Critical controls lacking in a computerized environment are as follows</b></p> <p>a) Lack of management understanding of IS risks and related controls;</p> <p>b) Lack of awareness &amp; knowledge of IS risks and controls amongst the business users and even IT staff;</p> <p>c) Absence or inadequate IS control framework;</p> <p>d) Complexity of implementation of controls.</p> |

## 6. TYPES OF I.S. CONTROLS

| Objective of Controls |                   |                    | Nature of I.S. Resources |                         |                        | I.S. Functions       |              |
|-----------------------|-------------------|--------------------|--------------------------|-------------------------|------------------------|----------------------|--------------|
| Preventive Control    | Detective Control | Corrective Control | Environmental Control    | Physical Access Control | Logical Access Control | Managerial Functions | App Controls |



### 6.1. I.S. CONTROLS BASED ON OBJECTIVES

| Preventive Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Detective Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Corrective Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>It prevents errors, omissions or security incidents from happening.</p> <p>Proactive in nature.</p> <p>Can be implemented in manual or computerized environment.</p> <p><b>Characteristics:</b></p> <ol style="list-style-type: none"> <li>Clear-cut understanding about the vulnerabilities of the asset.</li> <li>Understanding probable threats.</li> <li>Provision of necessary controls to prevent probable threats from materializing.</li> </ol> <p><b>Examples</b></p> <ul style="list-style-type: none"> <li>Locks; Security Guards</li> <li>Fireproof walls, Smoke detectors</li> <li>Qualified Personnel</li> <li>Training &amp; Documentation</li> <li>PIN &amp; Password</li> <li>Intrusion Prevention system</li> <li>Firewall &amp; Anti-virus</li> </ul> | <p>Designed to detect errors, omissions or security incidents that escape preventive controls.</p> <p>Investigative in nature.</p> <p><b>Characteristics:</b></p> <ol style="list-style-type: none"> <li>Clear understanding of lawful activities.</li> <li>Established mechanism to refer the reported security incident to appropriate person.</li> <li>Interaction with preventive control to prevent such act from occurring in future.</li> <li>Surprise checks by supervisor.</li> </ol> <p><b>Examples</b></p> <ul style="list-style-type: none"> <li>Fire alarm, CCTV camera,</li> <li>Cash Counting.</li> <li>Review of financial records</li> <li>Monitor actual expenditures against budget</li> <li>Duplicate checking of calculations</li> <li>Internal audit functions</li> <li>Bank reconciliation</li> <li>Intrusion Detection System</li> </ul> | <p>Designed to correct errors, omissions or security incidents once they have been detected.</p> <p>Reactive in nature.</p> <p>Reduces impact of risk/ security incident once it has been detected.</p> <p><b>Characteristics:</b></p> <ol style="list-style-type: none"> <li>Minimizing impact of threat</li> <li>Identifying root cause of problem</li> <li>Provide remedy</li> <li>Getting feedback</li> <li>Modifying preventive controls to prevent future occurrence.</li> </ol> <p>Corrective process should also be subject to preventive &amp; detective controls.</p> <p>Generally, its more effective to prevent error or detect them as early as possible to their source.</p> <p><b>Examples</b></p> <ul style="list-style-type: none"> <li>Quarantining the virus,</li> <li>System Reboot,</li> <li>Rerun Procedure</li> <li>Corrective journal entries</li> <li>Business Continuity Plan &amp; Backup procedure</li> </ul> |

Q. Determine the controls that are classified based on the time when they act, relative to a security incident.

Q. Define any two information system controls based on objectives of controls.

Q. Describe the term Preventive Controls and provide suitable examples. Also, discuss their broad characteristics in brief.

Q. Identify the control that is used to correct errors, omissions or incidents once they have been detected. Enlist its major characteristics as well.

Q. Discuss Corrective Controls with the help of examples. Also, discuss their broad characteristics in brief.

### 6.2. CONTROLS BASED ON NATURE OF I.S. RESOURCES

**6.2.1. Environmental Controls** - Related to IT environment in which I.S. functions. Environmental exposures & relevant controls are as follows:

| Fire Exposure                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Water Exposure                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Electrical Exposures                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Pollution Damage                                                                                                                                                                                                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Damage to equipment &amp; facility due to fire.</p> <p><b>Controls:</b></p> <ol style="list-style-type: none"> <li>Install smoke detectors</li> <li>Install manual &amp; automatic fire alarms at strategic location.</li> <li>Install fire extinguishers</li> <li><b>Norms to reduce electric firing</b> – i.e. computer room shouldn't be on basement or ground floor &amp; Fire-resistant material should be used with Less wood &amp; plastic.</li> <li><b>Regular Inspection</b> by Fire Department Officials and procedures to be followed during an emergency should be properly documented. Fire exits should be clearly marked.</li> <li><b>Documented and Tested Emergency Evacuation Plans</b> – should emphasize human safety but should not leave information processing facilities physically unsecured.</li> </ol> | <p>Damage to equipment &amp; facility due to water related incidents like pipe burst, cyclone, floods etc.</p> <p><b>Controls:</b></p> <ol style="list-style-type: none"> <li><b>Water Detectors:</b> should be placed under the raised floor, near drain holes and near any unattended equipment storage facilities.</li> <li><b>Strategically locating the computer room:</b> should not be located in the basement of ground floor of a multi-storey building.</li> <li>Install water alarms at strategic locations</li> <li>Use of water proof walls, ceilings &amp; floors</li> <li>Proper drainage system</li> </ol> | <p>Due to electrical faults like</p> <ul style="list-style-type: none"> <li>sudden upsurge in power supply,</li> <li>voltage fluctuations,</li> <li>non-availability of electricity etc.</li> </ul> <p><b>Controls:</b></p> <ol style="list-style-type: none"> <li><b>Electrical Surge Protectors</b> built into UPS</li> <li><b>Un-interruptible Power System/ Generator</b></li> <li>Voltage regulator &amp; Circuit breakers</li> <li>Emergency Power off switch</li> </ol> | <p>Major pollutant is Dust which can cause permanent damage to H/w and stored data.</p> <p><b>Controls:</b></p> <ol style="list-style-type: none"> <li>Regular cleaning</li> <li>Prohibition on eating, drinking &amp; smoking in I.S facility.</li> <li>Power leads from two sub-station</li> </ol> |

**Q.** Physical security mechanisms in an organization provides protection to people, data, equipment, systems, facilities and company assets. Determine some major ways of protecting the organization's computer installation in the event of any explosion or fire.

**Q.** You are an Information Technology Consultant to a firm who is in the process of shortlisting the resources for the controls for the environmental exposures – water damage and power spikes in that firm. Prepare a checklist for same.

**6.2.2. Physical Access Control** – Relates to physical security of tangible & intangible I.S. resources. It is applied against physical exposures which include abuse of information processing device, theft, damage, Blackmail etc.

| Locks on Doors                                                                                                                                                                                                                  | Physical Identification Medium                                                                                                                                                                                                             | Logging on Facility                                                                                                                                                                                                                                             | Other PACs                                                                                                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> <li><b>Bolting door lock</b> – No duplicate key.</li> <li><b>Cipher locks/ combination locks</b> – To enter, a person presses a four-digit number, and the door will unlock for a</li> </ol> | <ol style="list-style-type: none"> <li><b>Personal Identification Number (PIN)</b> – means to identify &amp; verify authenticity of user. User needs to login by inserting a card in some device and then enter their PIN via a</li> </ol> | <p>Official record of access/ activities.</p> <ol style="list-style-type: none"> <li><b>Manual logging</b> – Visitors sign visitor's log indicating their name, date &amp; time of visit, company represented, purpose of visit, &amp; person to see</li> </ol> | <ol style="list-style-type: none"> <li>CCTV monitored by security.</li> <li>Simple security guard.</li> <li>Controlled visitor access – Responsible employee will escort visitor</li> <li>Single entry point</li> </ol> |

|                                                                                                                     |                                                                                                                                                    |                                                                                                                                                                               |                                                                                                                                                                  |
|---------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| predetermined period.                                                                                               | PIN keypad for authentication.                                                                                                                     | b) <b>Electronic logging</b> – Combination of biometric security & electronic security system.<br><br>Maintains details/logs of access attempt, whether failed or successful. | e) <b>Dead Man's Door</b> – Pair of doors where first entry door must close & lock, for second door to open, with only one person permitted in the holding area. |
| c) <b>Electronic door locks</b> – Magnetic or chip-based plastics card key is used to gain access in these systems. | b) <b>Plastic card</b> – used for identification purposes.<br><br>c) <b>Identification badge</b> – can be issued to personnel as well as visitors. |                                                                                                                                                                               | f) <b>Alarm system &amp; Perimeter fencing</b>                                                                                                                   |

**Q.** As a member of an EDP (Electronic Data Processing) Team of an IT Department of the Company A, determine the controls that are related to the physical security of the tangible Information Systems Resources stored on tangible media?

#### LOGICAL ACCESS CONTROL

- LAC is applied to protect I.S. from logical access violators like Hacker, current & past employees, IS personnel, End User etc.)
- Ensures that logical access to system, data, program, OS is restricted to authorized users only.
- Key factors considered in designing logical access controls include
  - confidentiality and privacy requirements,
  - authorization, authentication and incident handling,
  - virus prevention and detection, **CA kishan Kumar**
  - firewalls, centralized security administration, user training and tools for monitoring compliance

**Q.** Due to absence of Logical Access Controls in XYZ Limited; the company's security mechanism got attacked by a Logical Access Violator Mr. X leading to potential loss resulting in total shutdown of the computer functions of the company. Discuss the categories under which the Logical Access Violator Mr. X may fall into.

**Q.** An Internet connection exposes an organization to the harmful elements of the outside world. Discuss the various factors under User Access Management through which the protection can be achieved.

**Q.** An internet connection exposes an organization to the harmful elements of the outside world. As a network administrator, which Network Access controls will you implement in the organization to protect from such harmful elements?

**Q.** Operating System security involves policy, procedure and controls that determine, 'who can access the operating system,' 'which resources they can access', and 'what action they can take'. As an Information Systems auditor, determine the key areas which shall be put in place by any organization.

**Q.** Mr. A is a System Administrator of the company who must ensure the protection of Operating System used in information system of the company. How can this purpose be achieved?



Logical Access Controls

| User Access Management                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | User Responsibility                                                                                                                                                                                                                               | Network Access Control                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | OS Access Control                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | App & Monitoring System Access Control                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Involves administration within a system for giving individual users the access to the tools they require at the right time.</p> <p>a) <b>User Reg-</b> Info w.r.t. user is documented. De-registration is equally imp.</p> <p>b) <b>Privilege Management-</b> User access and privileges should be aligned with his duties i.e. 'Need to know basis' or 'Need to do basis'.</p> <p>c) <b>User password mgt</b> - Involves activities like creation, storage, revocation &amp; reissue of password.</p> <p>d) <b>Review of user access rights</b> over a period of time as duties &amp; responsibilities change.</p> | <p>a) <b>Password use-</b> should be strong (min length, special character) &amp; should be changed periodically</p> <p>b) <b>Unattended user equipment</b> - user should be educated not to leave their device unattended &amp; unprotected.</p> | <p>Internet connection exposes Organization to harmful elements.</p> <p>a) <b>Policy on use of N/w</b> - Selection of appropriate services and approval to access them should be part of this policy.</p> <p>b) <b>Enforced path</b> - User is routed through a definite path for connecting to Org. network that may be through firewall.</p> <p>c) <b>Firewall</b> - System that enforces access control between two networks</p> <p>d) <b>Encryption</b> - Discussed later.</p> <p>e) <b>Segregation of networks</b> - Sensitive N/w, like VPN between B.O &amp; H.O. is segregated from other internet users.</p> <p>f) <b>Call back devices</b> - Aims to keep intruder off the intranet. It ensures access to N/w is allowed only from authorized telephone no. or terminal. User is required to enter a password &amp; then the system breaks the connection. If caller is authorized, the call back device dials the caller's no. to establish a new connection.</p> | <p>a) <b>Automated terminal identification</b> - Ensures that only authorized terminal is connected to I.S.</p> <p>b) <b>Terminal log-in procedure</b> - User provides ID and password to login system. First line of defence.</p> <p>c) <b>Access token</b> - After successful login by user, OS generates access token which contains user info. This info is used to provide access to user during the session.</p> <p>d) <b>Access control list</b> - OS has A.C.L which contains info on user's access rights.</p> <p>e) <b>Terminal timeout</b> - Logout the user if system is inactive for specified period.</p> <p>f) <b>Limitation of connection time</b> - Define available time slot for connection to OS.</p> <p>g) <b>Duress alarm</b> - means to alert authorities if user is forced to execute a command</p> <p>h) <b>Password Mgt.</b> - could enforce selection of good passwords.</p> | <p>a) <b>Information access restriction</b> - Access to info is restricted by App. User can access only those data which is authorized.</p> <p>b) <b>Sensitive System isolation</b> - Based on critical constitution of system in Org, it may be necessary to run specific system in isolation. E.g. Cash counting.</p> <p>c) <b>Event logging</b> - all events should be logged (user id, time of access, terminal location etc), archived &amp; reviewed.</p> <p>d) <b>Monitor System use</b> - Based on risk assessment and criticality of system, it should be monitored. Extent of detail and frequency of review depends on sensitivity of system.</p> <p>e) <b>Clock Synchronization</b> - Event logs maintained across the network must be synchronized for generating correct reports.</p> |

**Controls when mobile:** Ease of access on the move provides efficiency and results in additional responsibility

on the management to maintain information security. Theft of data carried on the disk drives of portable computers is a high-risk factor.

Both physical and logical access to these systems is critical. Information is to be encrypted and access identifications like fingerprint, eye-iris, and smart cards are necessary security features.

### 6.3. CLASSIFICATION OF CONTROLS BASED ON I.S. FUNCTIONS

Auditors have found two ways to be useful when conducting information systems audits, as given below:

| Management Control Framework                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Application Control Framework                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Objective:</b> Managerial Control ensures that I.S. is developed, implemented, operated &amp; maintained in planned and controlled manner.</p> <p><b>Types</b></p> <ol style="list-style-type: none"> <li>Top Management Controls</li> <li>System Development Management Controls</li> <li>Programming Management Controls</li> <li>Data Resource Management Controls</li> <li>Quality Assurance Management Controls</li> <li>Security Management Controls</li> <li>Operations Management Controls</li> </ol> | <p><b>Objective:</b> App controls ensures data remains complete, accurate &amp; valid through input, update &amp; storage.</p> <p>It involves ensuring that individual application systems safeguard assets, maintain data integrity and achieve objectives effectively and efficiently.</p> <p><b>Types</b></p> <ol style="list-style-type: none"> <li>Boundary Controls</li> <li>Input Controls</li> <li>Processing Controls</li> <li>Output Controls</li> <li>Database Controls</li> <li>Communication Controls</li> </ol> |

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**Q.** Managerial Controls provide a stable infrastructure in which Information Systems can be built, operated, and maintained on day-to-day basis. List down various controls that can be adapted by management for its smooth functioning. [MTP Dec 21]

### MANAGERIAL CONTROLS

#### 6.3.1.1. TOP MANAGEMENT CONTROLS

- Controls of Top Management should ensure that I.S. functions properly & meets strategic business objectives.
- Scope of controls includes Framing high level of IT policies, procedures & standards
- Controls flow from the top of an Organization to down but responsibility still lies with the senior management.
- 4 Major functions of Senior Management:

| Planning                                                                                                                                                      | Organising                                                                                                                                                                             | Leading                                                                                                                                    | Controlling                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| <p>Top Mgt. prepares plan for achieving I.S. goals. Two types of plans (Strategic &amp; Operational plan).</p> <p>Steering committee shall assume overall</p> | <p>Includes creating IT organizational structure with documented roles and responsibilities and agreed job descriptions.</p> <p>Includes arranging and allocating Resources needed</p> | <p>Includes motivating &amp; Communicating with Personnel.</p> <p>Ensures that personal objectives are aligned with Org. objectives so</p> | <p>Includes comparing actual performance with planned performance.</p> <p>In case of any deviation, corrective action is taken.</p> |

|                                   |                                                      |                                               |  |
|-----------------------------------|------------------------------------------------------|-----------------------------------------------|--|
| responsibility for I.S. function. | to achieve goals determined in Planning phase E & E. | that there is harmony of objects w/o conflict |  |
|-----------------------------------|------------------------------------------------------|-----------------------------------------------|--|

**Q.** Mr. X is an auditor of the company and plays a vital role in evaluating the performance of various controls under managerial controls. The top management is the one who takes responsibility for Information Systems function. Explain the functions that a senior manager must perform in organizing and controlling functions.

**Q.** Information systems have set high hopes to companies for their growth as it reduces processing speed and helps in cutting cost. Being an auditor of ABC manufacturing company, discuss the key areas that should pay attention to while evaluating Managerial controls by top management.

#### 6.3.1.2. SYSTEM DEVELOPMENT MANAGEMENT CONTROLS

- Related to controlling the process involved in system development life cycle.
- Ensures proper documentation & authorizations are available for each phase of system development.
- **6 steps**

|                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>i) Problem definition and Feasibility assessment</b> | <p>I.S. is developed to help resolve problems or to take advantage of opportunities. All the stakeholders must agree on the problem &amp; feasibility assessment is done to obtain a commitment to change &amp; to evaluate cost-effectiveness of solutions.</p> <p>All solutions must be properly and formally authorized to ensure their economic justification and feasibility.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>ii) Analysis of existing system</b>                  | <p>Designers need to analyze the existing system that involves two major tasks:</p> <ol style="list-style-type: none"> <li>Studying existing organizational history, structure, and culture to gain an understanding of social systems, &amp; the willingness of stakeholders to change.</li> <li>Studying the existing product and information flows as the proposed system will be based primarily on current product and information flows.</li> </ol> <p>The designers need to understand strengths &amp; weaknesses of existing product to determine the new system requirements and the extent of change required.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>iii) Information Processing System design</b>        | <p>This phase involves following activities:</p> <ol style="list-style-type: none"> <li><b>Elicitation of detailed requirements:</b> Either ask the stakeholders for their requirement if they are aware about it or discover it through analysis and experimentation in case they are uncertain about their need.</li> <li><b>Design of data/ information flow:</b> Designers shall determine the flow of data/information, its frequency &amp; timing and the extent to which data and information flows will be formalized. Tools such as DFD can be used for this.</li> <li><b>Design of Database and user interface:</b> Involves determining its scope and structure, whereas the design of user interface determines the ways in which users interact with a system.</li> <li><b>Physical design:</b> Involves breaking up the logical design into units which in turn can be decomposed further into implementation units such as programs and modules.</li> <li><b>Design of the hardware/software platform:</b> In case the hardware and software platforms are not available in the organization, the new platforms are required to be designed to support the proposed system.</li> </ol> |
| <b>iv) Hardware/ Software acquisition &amp;</b>         | <p>To purchase the new application system or hardware, a request for a proposal must be prepared, vendor proposals are sought, and final decision is made based on evaluation.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |



|                                             |                                                                                                                                                                                                                                             |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>procedures development</i>               |                                                                                                                                                                                                                                             |
| <i>v) Acceptance Testing and Conversion</i> | <p>Acceptance Testing is carried out to identify errors or deficiencies in the system prior to its final release into production use.</p> <p>Conversion phase comprises the activities undertaken to place the new system in operation.</p> |
| <i>vi) Operation and Maintenance</i>        | <p>The new system is run as a production system and periodically modified to better meet its objectives.</p> <p>The maintenance activities associated with these systems need to be approved and monitored carefully.</p>                   |

**Q.** Recognize the activities that deal with the System Development Controls in an IT Setup.

#### 6.3.1.3. PROGRAMMING MANAGEMENT CONTROLS

- Major phase in system development life cycle.
- Objective: To produce or acquire & to implement high-quality programs that is ACA.
- Six phases of program development lifecycle & related controls are as below:

| <i>Phases</i>                        | <i>Controls</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>i) Planning</i>                   | Involves estimating the resources required for software development, acquisition, and implementation.                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <i>ii) Design</i>                    | <p>Systematic approach to program design like structured design approach or object-oriented design is adopted that will meet the requirements articulated.</p> <p>Design should be Modular.</p>                                                                                                                                                                                                                                                                                                                              |
| <i>iii) Coding</i>                   | Structured/ systematic approach is adopted for coding Program with module implementation and integration strategy and proper documentation strategy.                                                                                                                                                                                                                                                                                                                                                                         |
| <i>iv) Testing</i>                   | <p>Program is tested before implementation. Three types:</p> <p>a) <i>Unit test</i> → Testing of individual program module.</p> <p>b) <i>Integration test</i> → Testing of group of program module.</p> <p>c) <i>Whole of Programme testing</i> → Focuses on whole Program</p>                                                                                                                                                                                                                                               |
| <i>v) Operation &amp; Management</i> | <p>Involves monitoring and making changes in system when required on timely basis.</p> <p>Three types:</p> <p>a) <i>Repair/ corrective</i> → Remove errors from s/w or fix the bugs.</p> <p>b) <i>Perfective</i> → Program is finetuned to reduce resource consumption. E.g. Better UI</p> <p>c) <i>Adaptive</i> → Change in s/w due to change in user requirement.</p>                                                                                                                                                      |
| <i>vi) Control</i>                   | <p>Runs parallel in all phases. Two Major Purposes:</p> <p>a) Task progress in various software life-cycle phases should be monitored against plan and corrective action should be taken in case of any deviations.</p> <p>b) Control on overall s/w development / acquisition process to ensure it is accurate, authentic &amp; complete.</p> <p>Techniques like Work Breakdown Structures (WBS), Gantt Charts and PERT(Program Evaluation &amp; Review Technique) Charts can be used to monitor progress against plan.</p> |

**Q.** A company XYZ is developing a software using the program development life cycle methodology and applying control, phases in parallel to the development phases to monitor the progress against plan. Being an IT developer, design the various phases and their controls for program development life cycle.

**Q.** Mr. X is appointed as an auditor of a software development and service provider company. Explain the various concerns that auditor should address under different activities of Programming Management Controls.

#### 6.3.1.4. DATA RESOURCE MANAGEMENT CONTROLS

Since, data is a critical resource, centralized planning & controls are implemented for proper management. Data integrity is defined as maintenance, assurance, accuracy, consistency of data and the control activities that are involved in maintaining it are as under:

|                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>i) Definition Controls</b>         | These controls are placed to ensure that the database always corresponds and comply with its definition standards.                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>ii) Existence/ Backup Controls</b> | <p>These controls ensure the existence of the database by establishing backup and recovery procedures.</p> <p>Backup refers to making copies of the data so that these additional copies may be used to restore the original data and ensure availability of system after a data loss due to unauthorized access, equipment failure or physical disaster.</p> <p>Various backup strategies like dual recording of data; periodic dumping of data; logging input transactions and changes to the data may be used.</p> |
| <b>iii) Access Controls</b>           | <p>These controls are designed to prevent unauthorized individual from viewing, retrieving, computing, or destroying the entity's data.</p> <p>User Access Controls are established through passwords, biometric controls; and Data Encryption controls.</p>                                                                                                                                                                                                                                                          |
| <b>iv) Update Controls</b>            | These controls restrict update of the database to authorized users in two ways either by permitting only addition of data to the database or allowing users to change or delete existing data.                                                                                                                                                                                                                                                                                                                        |
| <b>v) Concurrency Controls</b>        | These controls provide solutions, agreed-upon schedules, and strategies to overcome the data integrity problems that may arise when two update processes access the same data item at the same time.                                                                                                                                                                                                                                                                                                                  |
| <b>vi) Quality Controls</b>           | These controls ensure the ACA of data maintained in the database.                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

The above is accomplished by

- Appointing senior trust worthy persons
- Segregating duties to the extent possible
- Maintaining & monitoring logs of data administrator & data administrator's activities.

#### 6.3.1.5. QUALITY ASSURANCE MANAGEMENT CONTROL

Quality Assurance management is concerned with ensuring that

- I.S produced achieve certain quality goals.
- Development, implementation & maintenance is done as per Quality standard.

**Who will ensure Quality Assurance?**

QA Personnel who ensures

- a) Quality goals are established & clearly understood by all stakeholders.
- b) Compliance occurs with standard.
- c) Best practices in the industry are also incorporated during the production of information systems.

#### 6.3.1.6. SECURITY MANAGEMENT CONTROL

Related to Control based on nature of I.S. resources i.e., it covers

- a) Environmental Control (E.g. Fire, water)
- b) Physical Access Control
- c) Logical Access Control

However, despite all controls, disasters i.e., events which critically hit the business continuity in irreversible manner may occur.

##### Controls for disasters

- i) **Disaster Recovery Plan** - Deals with how the organization recovers from a disaster and comes back to its normalcy. A comprehensive DRP comprise four parts –
  - an Emergency Plan (actions to be undertaken immediately when a disaster occurs),
  - a Backup Plan (specifies the type of backup to be kept, frequency of taking backup, the procedures for making backup etc.),
  - a Recovery Plan (to restore full IS capabilities) and
  - a Test Plan (to identify deficiencies in the test plan).

**Business Continuity Plan (BCP)** as compared to a DRP, mainly deals with carrying on the critical business operations in the event of a disaster so as to ensure minimum impact on the business.

- ii) **Insurance** - Adequate insurance must be able to replace Information Systems assets and to cover the extra costs associated with restoring normal operations.

#### 6.3.1.7. OPERATIONS MANAGEMENT CONTROL

It is responsible for daily functioning of H/w & S/w in efficient manner.

Involves Control w.r.t

|                                                 |                                                                                                                                                                 |
|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. <b>Computer Operations</b>                   | Ensures proper functioning of H/W & S/W on day-to-day basis.                                                                                                    |
| 2. <b>Network Operations</b>                    | Ensures proper functioning of network devices, communication channels etc.                                                                                      |
| 3. <b>Data Preparation &amp; Entry</b>          | Keyboard environment & facilities should be designed to promote speed & efficiency.                                                                             |
| 4. <b>File Library</b>                          | Management of Org. data stored in machine- readable storage media like CD/ DVD, pen-drive & Hard disk.                                                          |
| 5. <b>Help Desk/ Technical support</b>          | Assist end-user in deploying & using H/W & S/W & resolving issues.                                                                                              |
| 6. <b>Documentation &amp; Programme Library</b> | Ensures documentation of <ul style="list-style-type: none"> <li>• Security Policy</li> <li>• BCP/DRP</li> <li>• System development related documents</li> </ul> |



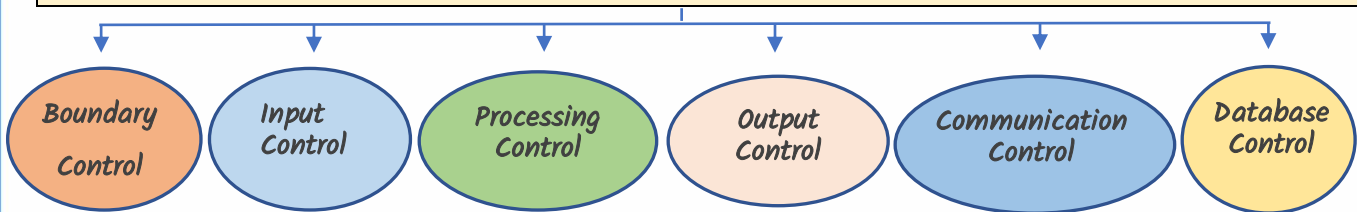
## 7. Management of outsourced operations

Responsible for carrying out day to day monitoring of outsourced contracts.

**Q.** In Information Systems, identify the type of Managerial controls that are responsible for the daily running of software and hardware facilities. Prepare a detailed note on these controls.

### APPLICATION CONTROL FRAMEWORK

**Objective** → to ensure that data remains accurate, complete and authentic during its input, update & storage.



- An **Audit Trail** records all the material events that occur within the system to analyze and search for error or irregularities.
- **A.T. Controls** ensures that a chronological record of all events occurs in a system is maintained.
- This record is needed to answer queries, fulfill statutory requirements, detect the consequences of error, and allow system monitoring and tuning.
- Provides preventive & detective control to help achieve security objectives.
- Example: App logs contain details w.r.t who initiated a transaction, who authorized it, date, time etc.

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#### Accounting AT

maintains a record of events within the system.

#### Operations AT

maintains a record of attempted or actual resource consumption associated with each event in a system.

### 6.3.2.1. BOUNDARY CONTROLS

Refers to access control mechanisms that links the authentic users to the authorized resources. Involves Identification & Authentication of users by S/w & Authorization i.e., privilege management.

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>i) Cryptographic Controls</b> | <p>Designed to protect the privacy of data and prevent unauthorized modification of data.</p> <p>Involves conversion of clear text into a cipher text for storage and transmission over networks by sender. Receiver decrypts this cipher code using auth key.</p> <p>Strength of cryptography depends on time &amp; cost to decipher the cipher text by crypto analyst.</p> <p>Three techniques of cryptography are</p> <ol style="list-style-type: none"> <li><b>Transposition</b> - Permute the order of characters within a set of data,</li> <li><b>Substitution</b> - Replace text with a key-text</li> <li><b>Product Cipher</b> - combination of transposition and substitution.</li> </ol> |
| <b>ii) Access Controls</b>       | <p>These controls restrict the use of computer system resources to authorized users and limit the actions authorized users can take with these resources.</p> <p>The access control mechanism involves three steps:</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                         |
|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                   | <p>a) <b>User Identification</b> - done by user itself by providing his/ her unique user id allotted to him/her or account number.</p> <p>b) <b>Authentication mechanism</b> is used for proving the identity with the help of a password or biometric identification including thumb impression, eye retina etc.</p> <p>c) <b>Authorization</b> - refers to the set of actions allowed to a user once authentication is done successfully. For example - Read, Write, Print, etc. permissions allowed to an individual user.</p>                                                                                                                                                                                                                                                                       |                                                                                                                                                                         |
| iii) <b>Personal Identification Numbers (PIN)</b> | <p>It is a form of remembered information used to authenticate users like verification of customers in electronic fund transfer systems.</p> <p>PIN is like a password assigned to a user by an institution, a random number stored in its database independent to a user identification details.</p> <p>Several phases of the life cycle of PINs include the steps that are</p> <ol style="list-style-type: none"> <li>Generation of the PIN;</li> <li>Issuance and delivery of PIN to users;</li> <li>Validation of the PIN upon entry at the terminal device;</li> <li>Transmission of the PIN across communication lines;</li> <li>Processing of the PIN;</li> <li>Storage of the PIN;</li> <li>Change of the PIN;</li> <li>Replacement of the PIN; and</li> <li>Termination of the PIN.</li> </ol> |                                                                                                                                                                         |
| iv) <b>Digital Signatures</b>                     | <p>Digital Signature (CA Kishan Kumar) is used as an analog signature for e-documents. Digital Signatures are not constant like analog signatures - they vary across messages and cannot be forged.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                         |
| v) <b>Plastic Cards</b>                           | <p>While PIN and Digital Signatures are used for authentication purposes, plastic cards are used primarily for identification purpose.</p> <p>This includes the phases namely - application for a card, preparation of the card, issue of the card, use of the card and card return or card termination.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                         |
| vi) <b>Audit Trail Controls</b>                   | <b>Accounting Audit Trail</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Operations Audit Trail</b>                                                                                                                                           |
|                                                   | <p>Includes details like</p> <ul style="list-style-type: none"> <li>➤ authentication information supplied</li> <li>➤ resources requested/ provided or denied</li> <li>➤ terminal Identifier and Start/ Finish Time</li> <li>➤ Action privileges allowed/ denied</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <p>Includes details like</p> <ul style="list-style-type: none"> <li>➤ resource usage from log-on to log-out time and</li> <li>➤ log of resource consumption.</li> </ul> |

Q. What do you understand by Boundary Controls? Explain major Boundary Control techniques in brief.

#### 6.3.2.2. INPUT CONTROLS

Applied to ensure that data input in system is authorised, accurate, correct & complete.

| Data Code Controls                                         | Batch Controls                                           | Validation of Data Input Controls                                       |
|------------------------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------|
| These controls are aimed at reducing the error during data | Process of grouping together transactions that have some | Intended to detect errors in transaction data before data is processed. |

| feeding.                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                          | relationship with each other.                                        |                                                                                             |                                                  |                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Transcription Error                                                                                                                                                                                                                                                                    | Transposition Error                                                                                                                                                                                                                      | Financial Totals                                                     | Hash Totals                                                                                 | Doc. Counts                                      | Field Check                                                                                                                                                                                                                                                                                            | Record Check                                                                                                                                                                                                                                                                                                                                         | File Check                                                                                                                                                                                                                                                           |
| Error in entry made by human or OCR.<br><b>Types:</b> <ul style="list-style-type: none"> <li>▪ <b>Addition Error</b> - Extra digit Added.</li> <li>▪ <b>Truncation Error</b> - Digit is removed.</li> <li>▪ <b>Substitution Error</b> - Replacement of a digit with another</li> </ul> | Change in position of two digits while entry is made.<br><b>Types:</b> <ul style="list-style-type: none"> <li>▪ <b>Single-</b> Two adjacent digits are reversed.</li> <li>▪ <b>Multiple-</b> Non-adjacent digits are changed.</li> </ul> | Grand total is calculated for each field containing monetary amount. | Grand total is calculated for any code on a Doc in the batch.<br>E.g. Source Doc Serial No. | Grand total of No. of docs/ record in the batch. | Examines characters of data in the field.<br>Includes <ul style="list-style-type: none"> <li>▪ <b>Limit check</b> against pre-defined limit</li> <li>▪ <b>Picture check</b> against invalid characters</li> <li>▪ <b>Valid check codes</b> against predetermined transactions codes, tables</li> </ul> | Includes <ul style="list-style-type: none"> <li>▪ <b>Reasonableness check</b> i.e., whether value in field is reasonable or not.</li> <li>▪ <b>Valid sign-</b> to determine which sign is valid for a numeric field. E.g. weight can't be in cm</li> <li>▪ <b>Sequence check-</b> To follow a required order matching with a logical seq.</li> </ul> | Includes <ul style="list-style-type: none"> <li>▪ <b>Version usage</b> - Always use latest version</li> <li>▪ <b>Data file security</b> - for access to authorized users only.</li> <li>▪ <b>File updation &amp; maintenance</b> done by auth. Users only</li> </ul> |

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| <b>Audit Trail Controls</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accounting Audit Trail                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Operations Audit Trail                                                                                                                                                                                                                                                                                                                                   |
| Includes details like <ul style="list-style-type: none"> <li>➤ origin, contents, and timing of transaction entered into application system</li> <li>➤ details regarding the identity of the person (organization) who was the source of the data and who entered the data into the system</li> <li>➤ time and date when the data was captured</li> <li>➤ the identifier of the physical device used to enter the data into the system</li> <li>➤ the standing data to be updated by the transaction</li> <li>➤ the number of the physical or logical batch to which the transaction belongs.</li> </ul> | Includes details like <ul style="list-style-type: none"> <li>➤ time to enter data in the terminal</li> <li>➤ number of read errors made by an optical scanning device</li> <li>➤ number of keying errors identified during verification</li> <li>➤ time taken to invoke an instruction using different input devices like light pen or mouse.</li> </ul> |

**Q.** Explain various types of Data Coding Errors.

**Q.** You are an IS Auditor undertaking a job of auditing the Information Systems of an ABC Bank. While performing Audit checks, you intend to ensure the placement of Input validation controls placed in the Information System by detecting errors in the transaction data before the data is processed. Determine the



three levels of Input Validation Controls.

#### 6.3.2.3. PROCESSING CONTROLS

Responsible for computing, classifying & summarizing Data.

| Processor Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Real Memory Controls                                                                              | Virtual Memory Controls                                                                                                                            | Application Software Controls                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>To reduce errors &amp; irregularities in processing.</p> <p>a) <b>Error detection &amp; correction</b> – Processor may mal-function due to design defect, damage etc. Failure can be transient (temporary), intermittent (periodic) or permanent . In case of transient or intermittent errors, restart the device, but in case of permanent errors, halt the processor &amp; report.</p> <p>b) <b>Timing Control</b> – CPU should run a program for specified time only. Once time is completed, another program should run else there will be infinite loop &amp; it will consume CPU.</p> <p>c) <b>Component Replication</b> – In some cases, processor failure can result in heavy losses. Hence Redundant Processor should be kept.</p> | <p>Seeks to detect &amp; correct error of real memory/ RAM &amp; Prevent unauthorized access.</p> | <p>Used when RAM is insufficient to execute a program.</p> <p>This control is required to map virtual memory address with real memory address.</p> | <p>These perform validation checks to identify errors during processing of data.</p> <p>Required to ensure both the completeness and the accuracy of data being processed.</p> <p>Generally enforced through DBMS.</p> |

#### Audit Trail Controls

| Accounting Audit Trail                                                                                                                                                                                                                                                                                                                                                                                                                     | Operations Audit Trail                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Includes data items like</p> <ul style="list-style-type: none"> <li>➤ to trace and replicate the processing performed on an input data item,</li> <li>➤ intermediate results and output data values,</li> <li>➤ to check for existence of any data flow diagrams or flowcharts that describe data flow in transaction,</li> <li>➤ whether such diagrams or flowcharts correctly identify the flow of data and who made them.</li> </ul> | <p>Includes details like</p> <ul style="list-style-type: none"> <li>➤ comprehensive log on hardware consumption – CPU time used, secondary storage space used, and communication facilities used and</li> <li>➤ comprehensive log on software consumption.</li> </ul> |

**Q.** The processing subsystem of any application software is responsible for computing, sorting, classifying, and summarizing the data. The processor controls of the application software are responsible to reduce the expected losses from errors and irregularities associated with Central processors. Discuss these controls. [RTP Dec 21]

#### 6.3.2.4. OUTPUT CONTROLS

| Inference Controls                                                                                                                                        | Batch Output Production and Distribution Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Batch Report Design Controls                                                            | Online output production and Distribution Controls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| used to prevent compromise of statistical databases from which users can obtain only aggregate statistics rather than the values of individual data items | <p>Batch output in the form of tables, graphs or images is produced at some operations facility &amp; distributed to users. Includes several controls like</p> <ol style="list-style-type: none"> <li><b>Report program execution Controls</b> to ensure that only authorized users are permitted to execute batch report programs and these events are logged and monitored;</li> <li><b>Spooling file Controls</b> so that the user(s) can continue working while a queue of documents waiting to be printed on a particular printer;</li> <li><b>Printing Controls</b> to ensure that output is made on the correct printer, and unauthorized disclosure of printed information does not take place;</li> <li><b>Report collection Controls</b> to ensure that report is collected immediately and secured to avoid unauthorized disclosure and data leakage;</li> <li><b>User/ Client service Review Controls</b> to ensure user should obtain higher quality output and detection of errors or irregularities in output;</li> <li><b>Report distribution Controls</b> ensuring that the time gap between generation and distribution of reports is reduced, and a log is maintained for reports that were generated and to whom these were distributed;</li> <li><b>User output Controls</b> to be in place to ensure that users review output on a timely basis;</li> <li><b>Storage Controls</b> to ensure proper perseverance of output in an ideal environment, secured storage of output;</li> <li><b>Retention and Destruction Controls</b> in terms of deciding the time duration for which the output shall be retained and then destroyed when not required.</li> </ol> | should comply with the control procedures laid down for them during the output process. | <p>Deals with the controls to be considered at various phases like establishing the output at the source, distributing, communicating, receiving, viewing, retaining and destructing the output.</p> <ol style="list-style-type: none"> <li><b>Source controls</b> ensure that output which can be generated or accessed online is authorized, complete and timely;</li> <li><b>Distribution Controls</b> to prevent unauthorized copying of online output when it was distributed to a terminal;</li> <li><b>Communication Controls</b> to reduce exposures from attacks during transmission;</li> <li><b>Receipt Controls</b> to evaluate whether the output should be accepted or rejected;</li> <li><b>Review Controls</b> to ensure timely action of intended recipients on the output;</li> <li><b>Disposition Controls</b> to educate employees the actions that can be taken on the online output they receive; and</li> <li><b>Retention Controls</b> to evaluate for how long the output is to be retained and</li> <li><b>Deletion Controls</b> to delete the output once expired.</li> </ol> |
| <b>Audit Trail Controls</b>                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Accounting Audit Trail</b>                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Operations Audit Trail</b>                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Includes data items like                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Includes details like                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

|                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>➤ What output was assimilated for presentation to the users;</li> <li>➤ What output was then presented to the users;</li> <li>➤ who received the output;</li> <li>➤ when the output was received; and</li> <li>➤ what actions were subsequently taken with output.</li> </ul> | <ul style="list-style-type: none"> <li>➤ record of resources consumed by components in the output system;</li> <li>➤ response times and display rates for output.</li> </ul> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

#### 6.3.2.5. DATABASE CONTROLS

|                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Applied to maintain <ul style="list-style-type: none"> <li>➤ integrity of database,</li> <li>➤ to prevent integrity violations when multiple programs have concurrent access to data, and</li> <li>➤ ways in which data privacy can be preserved within the system.</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                             |
| i) <b>Access Controls</b>                                                                                                                                                                                                                                                      | Seeks to prevent unauthorized access to and use of the data.<br>A security policy has to be specified followed by choosing an access control mechanism that will enforce the policy chosen.                                                                                                                                                                                                                                 |                                                                                                                                                             |
| ii) <b>Integrity Controls</b>                                                                                                                                                                                                                                                  | These are required to ensure ACA of the database.                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                             |
| iii) <b>Application Software Controls</b>                                                                                                                                                                                                                                      | When App S/w acts as an interface to interact between the user and the database, DBMS depends on App S/w to update the database correctly.<br>This is achieved through<br>a) <b>Update Controls</b> that ensure that changes to the database reflect changes to the real-world entities; and<br>b) <b>Report Controls</b> that identify errors or irregularities that may have occurred when the database has been updated. |                                                                                                                                                             |
| iv) <b>Concurrency Controls</b>                                                                                                                                                                                                                                                | Required to address the situation that arises either due to simultaneous access to the same database or due to deadlock.                                                                                                                                                                                                                                                                                                    |                                                                                                                                                             |
| v) <b>Cryptographic Controls</b>                                                                                                                                                                                                                                               | Already discussed under Boundary Controls.                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                             |
| vi) <b>File Handling Controls</b>                                                                                                                                                                                                                                              | Used to prevent accidental destruction of data contained on a storage medium.<br>These are exercised by H/w, S/w, & the users who load/ unload storage media.                                                                                                                                                                                                                                                               |                                                                                                                                                             |
| vii) <b>Audit Trail Controls</b>                                                                                                                                                                                                                                               | <b>Accounting Audit Trail</b>                                                                                                                                                                                                                                                                                                                                                                                               | <b>Operations Audit Trail</b>                                                                                                                               |
|                                                                                                                                                                                                                                                                                | Includes details like <ul style="list-style-type: none"> <li>➤ whether an App properly accepts, processes, and stores information, and</li> <li>➤ unique time stamp to all transactions,</li> <li>➤ before-images and after-images of the data item on which a transaction is applied to the audit trail.</li> </ul>                                                                                                        | Includes details like <ul style="list-style-type: none"> <li>➤ resource consumption events that affects the database definition or the database.</li> </ul> |

Q. Briefly explain major update and report controls regarding Database Controls in brief.

Q. Many organizations now recognize that data is a critical resource that must be managed properly and therefore, accordingly, centralized planning and control are implemented. Identify the various control



activities involved in maintaining the integrity of the database.

#### 6.3.2.6. COMMUNICATION CONTROLS

Applied to ensure that the data transmitted over network is accurate, complete & authentic.

|                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                             |
|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| i) <b>Physical Component Controls</b>        | Physical components shall have characteristics that make them reliable and incorporate features and controls that mitigate the possible effects of exposures.<br>Major physical components that affect the reliability of communication system are Transmission media, Communication lines, Modem, Port protection devices, Multiplexers, and Concentrators etc.                                                                                             |                                                                                                                                                                                             |
| ii) <b>Line Error Controls</b>               | While transmission of data through transmission line, there can be data loss due to noise distortion called line error.<br>These errors must be detected & corrected.                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                             |
| iii) <b>Flow Controls</b>                    | Applied, when there is difference in speed at which two nodes in a network can send, receive or process data resulting in loss of data.<br>Flow controls will be used therefore to prevent the mainframe flooding the microcomputer and as a result, data being lost.                                                                                                                                                                                        |                                                                                                                                                                                             |
| iv) <b>Link Controls</b>                     | In Wide Area Network (WAN), it refers to combination of Line error controls and flow controls.                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                             |
| v) <b>Topological Controls</b>               | A communication network topology specifies the location of nodes within a network, the ways in which these nodes will be linked, and the data transmission capabilities of the links between the nodes.                                                                                                                                                                                                                                                      |                                                                                                                                                                                             |
| vi) <b>Channel Access Controls</b>           | Two different nodes in a network can compete to use a communication channel.<br>Where possibility of contention of channel exists, some type of channel access control like<br><div style="margin-left: 20px;"> a) <b>Polling method</b> (defining an order in which a node can gain access to a channel capacity) or<br/> b) <b>Contention method</b> (nodes in network must compete with each other to gain access to a channel)<br/> must be used. </div> |                                                                                                                                                                                             |
| vii) <b>Controls over Subversive threats</b> | Firstly, physical barriers are needed to be established to access the data.<br>Secondly, in case the intruder has somehow gained access to the data, the data needs to be rendered useless when access occurs.                                                                                                                                                                                                                                               |                                                                                                                                                                                             |
| viii) <b>Internetworking Controls</b>        | Different internetworking devices like bridge, router, gateways are used to establish connectivity between homogeneous or heterogeneous networks.<br>Therefore, several control functions in terms of access control mechanisms, security and reliability of the networks are required to be established.                                                                                                                                                    |                                                                                                                                                                                             |
| ix) <b>Audit Trail Controls</b>              | <b>Accounting Audit Trail</b>                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Operations Audit Trail</b>                                                                                                                                                               |
|                                              | Includes collection of the data like<br><div style="margin-left: 20px;"> ➤ unique identifier of the source, destination and each node that transmits the message;<br/> ➤ unique identifier of the person or </div>                                                                                                                                                                                                                                           | Includes details like<br><div style="margin-left: 20px;"> ➤ number of messages that have been transmitted at each link and each node;<br/> ➤ number of errors occurring on each link </div> |

|  |                                                                                                                                                 |                                                                                                                                                                                    |
|--|-------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | process authorizing dispatch of the message;<br>➤ time and date at which the message was dispatched and received;<br>➤ message sequence number. | or at each node;<br>➤ number of retransmissions that have occurred across each link;<br>➤ log of errors to identify locations and patterns of errors;<br>➤ log of system restarts. |
|--|-------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Q. Write a brief about Line Error Control.

## 7. INFORMATION SYSTEM'S AUDITING - BY IS AUDITOR

Process of attesting/ assuring / confirming objective of -

- External Auditor that focuses on Safeguarding of Assets & Integrity of Data; and
- Internal Auditor that focuses on Effectiveness & Efficiency.

### Objectives of I.S. Audit

| Asset Safeguarding                                                                                              | Data Integrity                                                                                                                                   | System Effectiveness                                                                               | System Efficiency                                                                                        |
|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| I.S. Asset i.e., H/w S/w, data, info etc. must be protected by using internal control from unauthorised access. | It is fundamental attribute (quality) of auditing.<br>It should be maintained at all time & data should not be accessible to unauthorized users. | Involves evaluating Whether I.S. meets requirements of business & users in decision making or not. | To optimize use of various I.S. resources<br><br>To complete task with minimum consumption of resources. |

Q. Explain briefly the objectives of Information System's Auditing.

## 7.1. REASONS / NEED FOR I.S. AUDIT

Factors which influence Organisation/Mgt. w.r.t. Implementation of Controls & Audit of Computers are:

|                                           |                                                                                                                                                                                |
|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Value of computer H/w, S/w & Personnel | ▪ These I.S. resources are valuable & important & must be safeguarded                                                                                                          |
| 2. Maintenance of Privacy                 | ▪ An organization collects a lot of data which are private regarding individuals. Any leakage of private personnel data is against interest of company & must be protected.    |
| 3. Controlled evolution of computer use   | ▪ Use of technology & reliability of computer system can't be guaranteed. Hence it must be audited.                                                                            |
| 4. Cost of Data Loss                      | ▪ Data is very critical resource of an organization . Data loss can cause severe damage to Organization & hence it must be protected.                                          |
| 5. Cost of Incorrect Decision             | ▪ Management takes decisions based on information produced by I.S. In case of incorrect info, management can take incorrect decision which affects the Organization adversely. |
| 6. Cost of Computer Abuse                 | ▪ Unauthorized access to computer system may cause huge damage. It may also result in introduction of virus, malware, hacking, theft of data etc.                              |
| 7. Cost of Computer error                 | ▪ Error may occur while performing a task which may incur huge cost for                                                                                                        |

Orgn.

Q. Recognize various factors influencing an organization towards control and audit of computers.

## 7.2. I.S. CONTINUOUS AUDIT

Real time production of information → Real time recording → Real time Auditing → Continuous Assurance about Quality of data.

Thus, Continuous Audit reduces time gap between occurrence of Client's event & Auditor's assurance service thereon.

Two basis for collecting audit evidence are:

- Embedded module (Audit S/w) in system to collect, process & print Audit Evidence.
- Special Audit records used to store Audit evidence collected.

### Types of Continuous Audit Tools

| Snapshots                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Integrated Test Facility                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | System Control Audit Review File                                                                                                                                                                                                                             | Continuous & Intermittent Simulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Audit Hook                                                                                                                                                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Helps in tracing a transaction as it flows in App system.</p> <p>Built into the system at points where material processing takes place.</p> <p>Takes image of flow of Transactions as it moves through the App.</p> <p>These images are utilized to assess Authenticity, completeness &amp; accuracy of process being carried out by system.</p> <p>Important points to consider-</p> <ol style="list-style-type: none"> <li>Locate the snapshot point based on materiality.</li> <li>Determine when will snapshot be captured.</li> <li>Reporting system is designed &amp; implemented to present data in meaningful manner.</li> </ol> | <p>ITF involves creation of dummy entity/ Test data in App system.</p> <p>This test data is incorporated in normal data used as input in App system as a means to verify processing</p> <ul style="list-style-type: none"> <li>Authenticity</li> <li>Completeness &amp;</li> <li>Accuracy.</li> </ul> <p>Auditor must decide</p> <ol style="list-style-type: none"> <li>Method to be used to enter test data in System.</li> <li>Method for removing effect of ITF transaction.</li> </ol> | <p>SCARF involves embedding audit S/w module</p> <p>App system to provide continuous monitoring of system's transactions.</p> <p>Info collected is written on SCARF master file.</p> <p>Similar to snapshot technique with data collection capabilities.</p> | <p>Variation of SCARF.</p> <p>Used as Trap exception whenever App system uses DBMS.</p> <p><u>Procedure</u></p> <ul style="list-style-type: none"> <li>DBMS passes all transactions to CIS which determines whether it wants to examine it further.</li> <li>CIS simulates the App system process.</li> <li>Result of selected transactions processed by CIS is compared with result produced by App s/w to determine whether both are same or not.</li> <li>In case of any diff, exceptions are identified by CIS &amp; written to exception file.</li> </ul> <p><u>Advantage:</u></p> <p>No modification in App system but provides online audit capability</p> | <p>Audit routines that flags/ highlights suspicious transactions as soon as they occur on a real time basis.</p> <p>Thus, auditors can be informed of questionable transactions as soon as they occur.</p> <p>This approach of real-time notification displays a message on auditor's terminal.</p> |



### Advantages of Continuous Audit Techniques

|                                                                |                                                                                                                                                                                                                                               |
|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. <b>Timely, Comprehensive &amp; Detailed Auditing</b>        | Evidence would be available timelier & in a comprehensive manner. Entire processing can be evaluated & analyzed rather than examining inputs and outputs only.                                                                                |
| 2. <b>Surprise test capability</b>                             | As evidences are collected from the system itself by using continuous audit techniques, auditors can gather evidence without knowledge of systems staff and application system users. This brings in the surprise test advantages.            |
| 3. <b>Information to system staff on meeting of objectives</b> | Continuous audit technique provides information to systems staff regarding the test vehicle to be used in evaluating whether an application system meets the objectives of asset safeguarding, data integrity, effectiveness, and efficiency. |
| 4. <b>Training for new users</b>                               | Using the Integrated Test Facilities (ITF)s, new users can submit data to the application system, and obtain feedback on any mistakes they make via the system's error reports.                                                               |

**Q. Discuss 5 Audit Techniques and the advantages of continuous Audit Techniques.**

## 8. AUDIT TRAIL

### 8.1. OBJECTIVES OF AUDIT TRAIL

| Detecting Unauthorised access                                                                                     | Reconstructing Events                                                                                                                                                                                                                             | Personal Accountability                                                                                                                                                                                              |
|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| In real time or after the event.<br>Helps protect the system from outsiders who are attempting to breach control. | used to reconstruct the state that led to events such as system failures, security violations by individuals, or App processing errors.<br><br>Such Knowledge can be used to assign responsibility and to avoid similar situations in the future. | Audit trail is used to monitor user activity at lowest level of detail<br><br>Preventive capability i.e. acts as deterrent for potential violators if they know that their actions are not recorded in an audit log. |

### 8.2. IMPLEMENTING AUDIT TRAIL/ GENERATING AUDIT TRAILS

Info. in Audit Trail is useful for

- Accountants in measuring damage or loss due to App errors, Abuse of authority etc.
- It helps in assessing whether controls in place are adequate or not & need for Additional Control.

Audit logs, however, can generate data in overwhelming detail. Important information can easily get lost among the superfluous detail of daily operation.

Thus, poorly designed logs can be useless.

### 8.3. AUDIT OF VARIOUS I.S. CONTROLS

| Role of I.S. Auditor                                           | Audit of Controls                                                   |
|----------------------------------------------------------------|---------------------------------------------------------------------|
| a) To determine whether objectives of controls are met or not. | a) Auditor shall conduct Risk assessment. Higher risk, more control |
| b) Assess effectiveness of controls                            | b) He shall conduct review of controls i.e. whether                 |

- controls are implemented or not & whether working effectively or not
- c) Has shall also check whether controls are monitored by qualified personnel or not

## 9. SEGREGATION OF DUTIES

- It advocates that Privilege/ Access Rights should be given on "Need to Do" & "Need to know" basis.
- Ensures that single individual do not passes excess privilege that could result in unauthorized activity like fraud or manipulation of data security.
- For example-the person approving the purchase orders should not be allowed to make payment and pass entries in the books at the same time.
- Both preventive & detective control should be place to manage SOD control.

### Examples of SoD Controls

| Transaction Authorization                                     | Split custody of high value assets                                                                                                                                                                                                                             | Periodic review of user rights                                                                                    | Work Flow                                                                                                                                                                                                                                                                                                        |
|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I.S requires 2 or more person to approve certain transactions | Password to an encryption key that protects sensitive data can be split in two halves, one half assigned to two persons, and the other half assigned to two persons, so that no single individual knows the entire password.<br>Two keys for sensitive locker. | Internal audit personnel can periodically review user access rights to identify whether any segregation of duties | Applications that are workflow-enabled can use a second (or third) level of approval before certain high-value or high-sensitivity activities can take place.<br>E.g. workflow application that is used to set up user accounts can include extra mgt. approval steps in requests for administrative privileges. |

When SOD issues (conflicts b/w access rights of individuals) are encountered, Management needs to mitigate the matter. How?

Reduce access privilege of individual user so that conflict no longer exists.

### Introduces new mitigation control

If management determines that the person need to retain privileges which are viewed as conflict, new preventive & detective control needs to be implemented like increased logging of records, reconciliations of data sets etc.

Q. Segregation of Duties (SoD) in an organization allows the individuals to access authorized activities controlled through various controls. Identify few examples of the controls of SoD. [MTP Dec 21]

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 Roll No. 672918  
 Marks 77



**Simran Chanchalani**  
 Roll No. 643358  
 Marks 77



**Olvita**  
 Roll No. 479287  
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**Ravi Muraka**  
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 Marks 76



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 Roll No. 542149  
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**Amarath Kudva**  
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**Anjali Pramod Kumar Gupta**  
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 Roll No. 639052  
 Marks 70



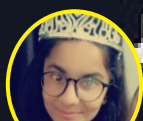
**Naresh**  
 Roll No. 387893  
 Marks 70



**Rahul Janwani**  
 Roll No. 645229  
 Marks 70



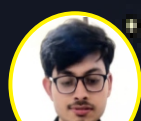
**Nimish Avinash**  
 Roll No. 483256  
 Marks 70



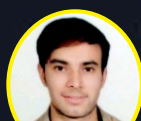
**Tanu**  
 Roll No. 510625  
 Marks 70



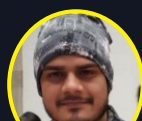
**Suman Kumar Singh**  
 Roll No. 509623  
 Marks 70



**Umang Munjal**  
 Roll No. 635113  
 Marks 69



**Bikash Gelal**  
 Roll No. 153613  
 Marks 69



**Nitesh Kumar**  
 Roll No. 152623  
 Marks 69



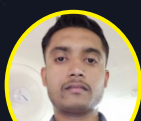
**Kirti Goyal**  
 Roll No. 431837  
 Marks 69



**Harsha Dang**  
 Roll No. 341999  
 Marks 69



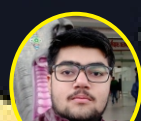
**Vinay Solanki**  
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**Abhishek Upadhay**  
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**Neha Mahavar**  
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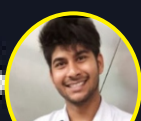
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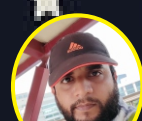
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& during  
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Free Marathon  
Before Exams  
to Revise quickly



After Sales  
support for  
Peace of mind





I Taught, They Learnt. I told them to **Aspire**. They **Performed**.  
You too have a look & try to make Your Parents and Me Proud.

Blessings !!



## About CA Kishan Kumar

- ★ Kishan Kumar is an **Associate member** of The Institute of Chartered Accountants of India.
- ★ He is a **throughout Rankholder** in CA examinations.
- ★ He himself scored **Exemption in Taxation [76]** in his CA Inter Exam..
- ★ He has been **awarded by Nitish Kumar, Hon'ble Chief Minister** of Bihar for his excellence in the field of education.
- ★ Internationally renowned **University of South Wales** has also felicitated him for his aptitude and achievements during his academic life.
- ★ Kishan has worked with **Ernst & Young and PwC (Big 4 Firms)** and uses his practical corporate experience to make the subject more interesting and engaging.
- ★ His students have secured **marks as high as 85** and hundreds have scored exemptions.
- ★ He is committed to make meaningful contribution to the life of promising CA aspirants.

## OUR STARS

**AIR 19**



**Rahul n Shenoy**  
Roll No. 543536  
**Marks 85**



**Dharini Vasudev Bhal**  
Roll No. 672918  
**Marks 77**



**Simran Chanchalani**  
Roll No. 643358  
**Marks 77**



**Olvita**  
Roll No. 479287  
**Marks 76**

**CA KISHAN KUMAR CLASSES**



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