

CHAPTER 14: SYSTEM ANALYSIS AND DESIGN

14.1 Introduction

This unit specifies competencies required to develop computer program. It involves understanding of System Analysis and Design fundamentals, understanding approaches to system Development and Project planning, Performing System Analysis, identify Essentials of System Design, understand advanced design concepts, perform system implementation and Understand Current Trends in System Development.

14.2 Performance Report

- Should be design able to differentiate between system analysis and design
- Identified activities and phases involved in SDLC
- Identified tools, techniques and activities of system analysis
- Identified components, stages and types of system design
- Identified data modeling techniques
- Identified different types of advanced system design modelling
- Identified system implementation procedures
- Identified current trends in system development

14.3 Learning Outcome

14.3.1 List of the Learning Outcomes

These are the key learning outcomes, which make up workplace function:

- Understand System Analysis and Design Fundamentals
- Understand Approaches to system Development and Project planning.
- Perform System Analysis
- Identify Essentials of System Design
- Understand advanced Design Concepts
- Perform System Implementation
- Understand Current Trends in System Development

14.3.2 Learning Outcome 1: Understand system analysis and design fundamentals

14.3.2.1 Learning Activities

The following are the performance criteria:

- Definition of system, system design and system Analysis is done.
- Constraints of a system are identified
- Properties of a system are identified Elements of a system are identified
- Classification of systems is done. Types of Information system are identified
- System models are identified
- Categories of Information are identified.

Trainees to demonstrate knowledge in relation to:

- Define system, system design and system analysis
- Constrains of system: Interconnectivity, Objectives of organization
- Properties of a system
Organization, Interaction, Interdependence, Integration
- Elements of a system: Control, Input, Process, Output
- Classification of systems
- Types of Information system: Physical, Open or closed, Adaptive and non-adaptive, Permanent and temporary, System models
- Schematic
- Flow system
- Static system
- Dynamic system: Categories of Information, Strategic, Management, Operational

14.3.2.2 Information Sheet

Systems analysis is effective when all sides of the problem are reviewed. **Systems design** is most effective when more than one solution can be proposed. The plans for the care and feeding of a new system are as important as the problems they solve

Interconnectivity is a concept that is used in numerous fields such as cybernetics, network theory, and non-linear dynamics. The concept can be summarized as that all parts of a system interact with and rely on one another simply by the fact that they occupy the same system, and that a system is difficult or sometimes impossible to analyze through its individual parts considered alone.

Organizational objectives are short-term and medium-term goals that an organization seeks to accomplish. An organization's objectives will play a large part in developing organizational policies and determining the allocation of organizational resources.

A system has three basic elements input, processing and output. The other elements include control, feedback, boundaries, environment and interfaces.

Input: Input is what data the system receives to produce a certain output.

Output: What goes out from the system after being processed is known as Output.

Control: In order to get the desired results it is essential to monitor and control the input, Processing and the output of the system. This job is done by the control.

Processing: The process involved to transform input into output is known as Processing.

Read: Element of a system: <https://brainly.in/question/6902404>

Systems are classified into the following categories:

- Liner and Non-liner Systems
- Time Variant and Time Invariant Systems
- Liner Time variant and Liner Time invariant systems
- Static and Dynamic Systems
- Causal and Non-causal Systems
- Invertible and Non-Invertible Systems
- Stable and Unstable Systems

Read: Classification of system:

https://www.tutorialspoint.com/signals_and_systems/systems_classification.htm

Read: Types of Information system:

<https://www.managementstudyguide.com/types-of-information-systems.htm>

A **schematic**, or schematic diagram is a representation of the elements of a system using abstract, graphic symbols rather than realistic pictures.

Static systems are those whose output depends on the only present value of the input. Static systems are the physically reliable system. Dynamic systems are those whose output depends on the present as well as past value of the input. A **dynamic system** is not physically reliable.

Watch: Difference between static and dynamic systems: <https://youtu.be/xJHJbo3VnmY>

Read: Categories of information:

<http://jhigh.co.uk/Using%20Information/13%20Categories%20of%20Informaiton%20Systems.html>

14.3.2.3 Self-Assessment

- i. What are the elements of system? Explain each of them.
- ii. What is the difference between a static and dynamic system?
- iii. _____ is a concept that is used in numerous fields such as cybernetics, network theory, and non-linear dynamics.
 - A. Interconnectivity
 - B. System
 - C. System analysis
 - D. Both of above
- iv. A system has three basic elements:
 - A. Input
 - B. Processing
 - C. Output
 - D. Both of above
 - E. None of above

- v. _____ are those whose output depends on the only present value of the input.
Static systems are the physically reliable system.
- A. Schematic
 - B. Static Systems
 - C. Operating System

14.3.2.4 Tools, Equipment, Supplies and Materials

Computer, Software, Mobile phone, Tablet

14.3.2.5 References

- <https://www.yourdictionary.com/systems-analysis-design>
- <https://www.definitions.net/definition/interconnectivity>
- <https://www.quora.com/What-is-the-difference-between-a-static-and-dynamic-system>
- <http://jhigh.co.uk/Using%20Information/13%20Categories%20of%20Informaiton%20Sytems.html>
- Systems Analysis and Design in a Changing World authored by Stephen D. Burd , John W. Satzinger , Robert Jackson published by Cengage Learning, Inc
- Systems Analysis and Design authored by Scott Tilley, Harry J. Rosenblatt

14.3.3 Learning Outcome 2: Understand approaches to system development and project planning environment

14.3.3.1 Learning Activities

The following are the performance criteria:

- System development Approaches are identified
- System development methodologies are identified
- System development life cycle models are identified
- Activities involved in SDLC are identified.
- SDL phases are identified.
- Project planning concepts are identified

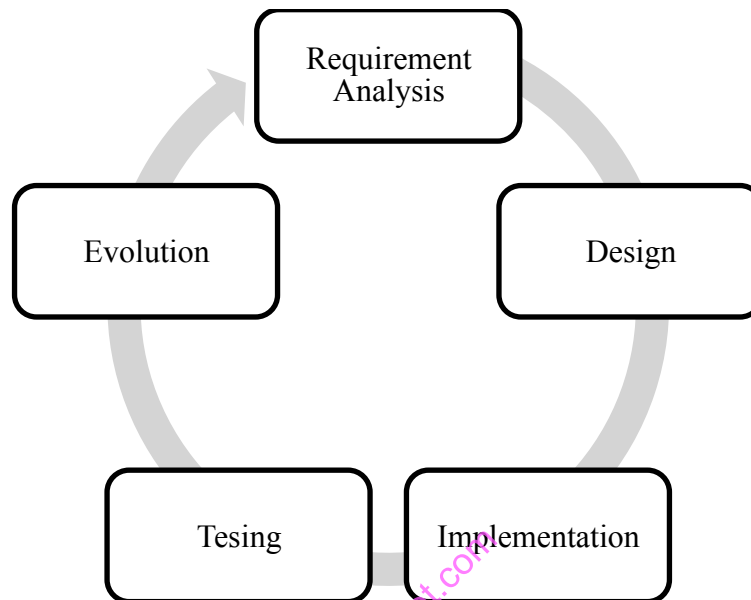
Trainees to demonstrate knowledge in relation to:

- System development approaches
- System development methodologies
- System development life cycle models
- Activities involved in SDLC
- SDLC phases
- Project planning concepts

14.3.3.2 Information Sheet

The systems development life cycle (SDLC), also referred to as the application development life-cycle, is a term used in systems engineering, information systems and software

engineering to describe a process for planning, creating, testing, and deploying an information system. The systems development lifecycle concept applies to a range of hardware and software configurations, as a system can be composed of hardware only, software only, or a combination of both. There are usually six stages in this cycle: analysis, design, development and testing, implementation, documentation, and evaluation.



Source: blog.usejournal.com/

Figure 97: Software System Development Lifecycle

Activities such as budgets, requirements gathering, and documentation writing, are included in the cycle, as well as the more technical elements. SDLC usually begins with determining customer business needs, which is followed by implementation and testing.

Read: Concepts project management: <https://pmbasics101.com/7-essential-project-planning-concepts/>

Read: System methodology:

https://www.dlsweb.rmit.edu.au/Toolbox/knowmang/content/gathering_data/systems_development_methodologie.htm

14.3.3.3 Self-Assessment

- i. What is SDLC?
- ii. List the approached sin SDLC
- iii. SDLC stand for:
 - A. Systems Development Life Cycle
 - B. System Debugging Life Cycles
 - C. System Design Life Cycle
- iv. How is the component of maintenance incorporated in the SDLC model

12.3.3.4 Tools, Equipment, Supplies and Materials

Data Dictionary, Decision Trees, Decision Tables, software, computer

14.3.3.5 References

- https://www.dlsweb.rmit.edu.au/Toolbox/knowmang/content/gathering_data/systems_development_methodologie.htm
- Systems Analysis and Design in a Changing World authored by Stephen D. Burd, John W. Satzinger, Robert Jackson published by Cengage Learning, Inc.
- Systems Analysis and Design authored by Scott Tilley, Harry J. Rosenblatt

14.3.4 Learning Outcome 3: Perform system analysis

14.3.4.1 Learning Activities

The following are the performance criteria:

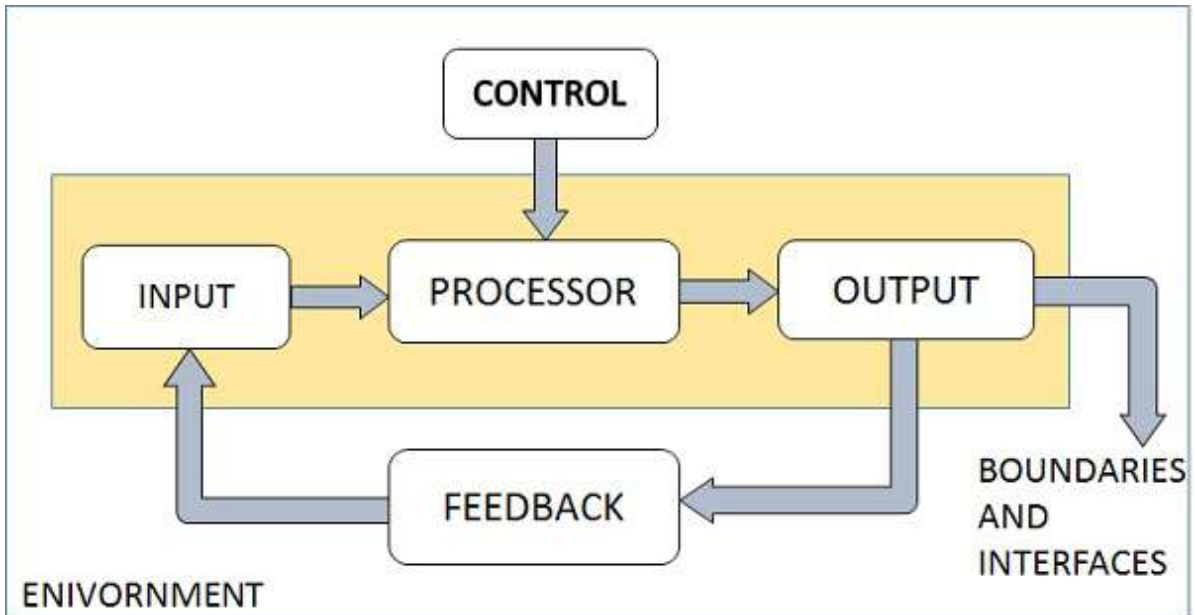
- Overview of system analysis is done.
- Attributes of structured analysis are identified
- Tools and techniques of system analysis are identified.
- Activities performed during System analysis are identified

Trainees to demonstrate knowledge in relation to:

- Overview of system Analysis
- Role of a system Analyst
- Attributes of structured analysis
- Graphic, Logical, Process division
- High level to lower level approach
- Tools for system analysis
- Data Flow Diagrams, Data Dictionary, Decision Trees, Decision Tables, Structured English, Pseudocode
- Activities performed during System analysis
- Gather detailed Information
- Define requirements
- Prioritize requirements
- Develop user-interface dialogs
- Evaluate requirement with users
- Define functional requirements

12.3.4.2 Information Sheet

Systems Analysis. It is a process of collecting and interpreting facts, identifying the problems, and decomposition of a system into its components. System analysis is conducted for the purpose of studying a system or its parts in order to identify its objectives.



Source: www.tutorialspoint.com

Figure 98: System analysis

Read: System analysis overview:

https://www.tutorialspoint.com/system_analysis_and_design/system_analysis_and_design_overview.htm

A **systems analyst** is a person who uses analysis and design techniques to solve business problems using information technology. Systems analysts may serve as change agents who identify the organizational improvements needed, design systems to implement those changes, and train and motivate others to use the systems.

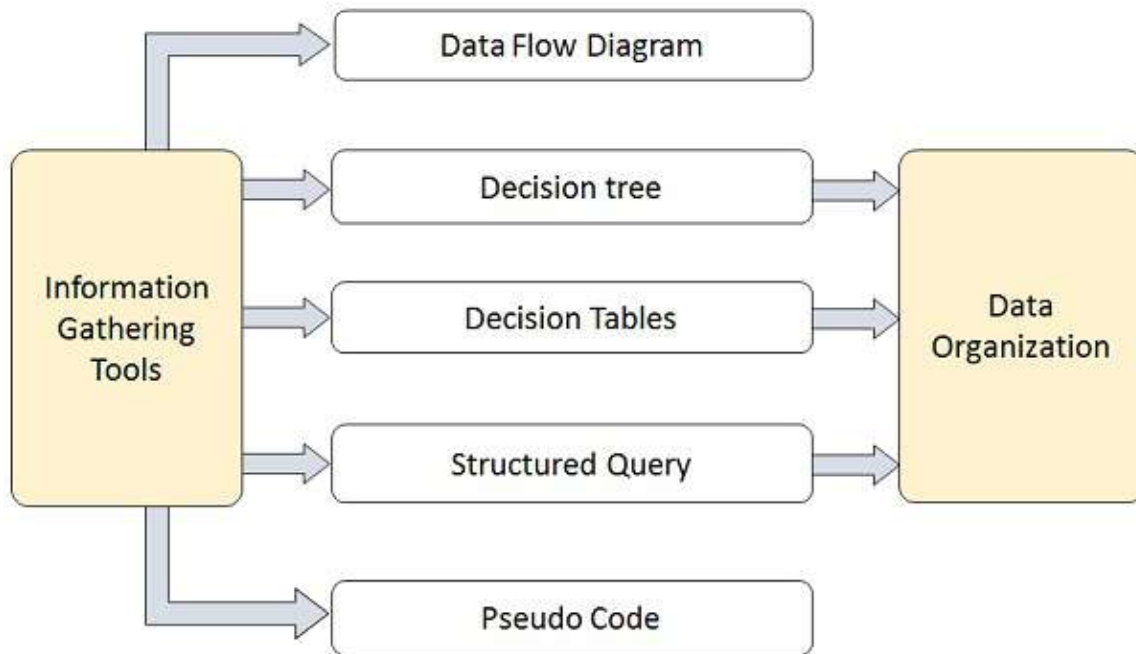
Structured Analysis is a development method that allows the analyst to understand the system and its activities in a logical way.

- It is graphic which specifies the presentation of application.
- It divides the processes so that it gives a clear picture of system flow.
- It is logical rather than physical i.e., the elements of system do not depend on vendor or hardware.
- It is an approach that works from high-level overviews to lower-level details.

During Structured Analysis, various tools and techniques are used for system development.

They are:

- Data Flow Diagrams
- Data Dictionary
- Decision Trees
- Decision Tables
- Structured English
- Pseudocode



Source: www.tutorialspoint.com

Figure 99: Structured analysis tools

Read: Structured analysis tools:

https://www.tutorialspoint.com/system_analysis_and_design/system_analysis_and_design_structured.htm

14.3.4.3 Self-Assessment

- i. Define system analysis?
- ii. What is system analyst?
- iii. Explain structure analysis tools?
- iii. _____ is the process of understanding and specifying in detail what the information system should accomplish.
 - A. Systems Design
 - B. Automation
 - C. Systems Analysis
 - D. Strategic Planning
- iv. A ____ is a IT professional who uses analysis and design techniques to solve business problems using information technology
 - A. Systems Analyst
 - B. Database Administrator
 - C. Project Manager
 - D. Network Administrator
- v. A(n) ____ to the SDLC is used when the exact requirements of a system or the users' needs are not well understood
 - A. Systems Development Life Cycle
 - B. Adaptive Approach
 - C. Predictive Approach

- D. Unified Process
- vi. A(n) ____ is a representation of an important aspect of the real world.
 - A. Model
 - B. System Development Methodology
 - C. Tool
 - D. Iteration

14.3.4.4 Tools, Equipment, Supplies and Materials

Data Flow Diagrams, Decision Tables, Data Dictionary, Decision Trees

14.3.4.5 References

- https://www.tutorialspoint.com/system_analysis_and_design/system_analysis_and_design_overview.htm
- Systems Analysis and Design in a Changing World authored by Stephen D. Burd, John W. Satzinger, Robert Jackson published by Cengage Learning, Inc
- Systems Analysis and Design authored by Scott Tilley, Harry J. Rosenblatt

14.3.5 Learning Outcome 4: Identify essentials of system design

14.3.5.1 Learning Activities

The following are the performance criteria:

- Design with Software specification requirements (SRS) document
- Components of system design are identified
- Inputs and outputs of System Design are identified
- Stages of system design are identified
- Types of system design are identified
- Data Modeling techniques are identified

Trainees to demonstrate knowledge in relation to:

- Design with Software specification requirements (SRS) document
- Components of system design, Quality, Timeliness, Cost-Effectiveness, Inputs
- Statement of work, Requirement determination plan, Current situation analysis
- Proposed system requirements including a conceptual data model, modified DFDs, and Metadata (data about data), Outputs
- Infrastructure and organizational changes for the proposed system.
- A data schema, often a relational schema.
- Metadata to define the tables/files and columns/data-items.
- A function hierarchy diagram or web page map that graphically describes the program structure.
- Actual or pseudocode for each module in the program.
- A prototype for the proposed system, Stages of system design, Requirements determination, Requirements specifications, Feasibility Analysis, Final Specifications, Hardware study, System Design, Types of system design Logical, Physical, Architectural,

Detailed, Data Modeling techniques, Conceptual, Relational, Object Oriented

14.3.5.2 Information Sheet

A **Software Requirements Specification (SRS)** is a document that describes the nature of a project, software or application. In simple words, SRS document is a manual of a project provided it is prepared before you kick-start a project/application. This document is also known by the names SRS report, software document. A software document is primarily prepared for a project, software or any kind of application.

Read: Software requirements specification: <https://krazytech.com/projects/sample-software-requirements-specificationsrs-report-airline-database>

This triangular approach aides both development teams, who become more aware of management's priorities, and project managers, who are forced to take a more realistic view of the system design process in terms of quality, cost and meaningful deadlines.

A project can implement one or more system designs. The purpose of defining each system in this way is to provide a precise, manageable explanation of the work to be done during construction and testing. For example, a completed design for a website may include drawings of sample screenshots, flowcharts showing linking connections, or a Flash demo.

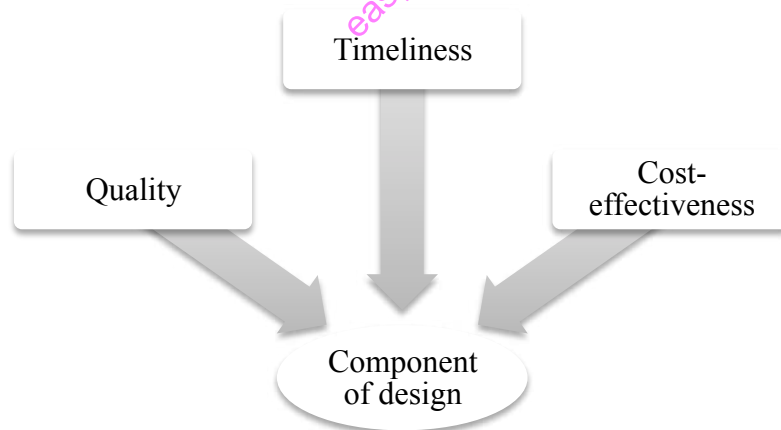


Figure 100: Components of system design

Read: Components of system design: <https://info.knowledgeleader.com/the-3-components-of-a-successful-systems-design>
<https://medium.com/the-andela-way/system-design-in-software-development-f360ce6fcbb9>

Read: System design components:

https://www.tutorialspoint.com/system_analysis_and_design/system_analysis_and_design_overview.htm

Outputs and Inputs

The main aim of a system is to produce an output, which is useful for its user.

Inputs are the information that enters into the system for processing.

Output is the outcome of processing.

Read: Stages of system design :

https://www.tutorialspoint.com/system_analysis_and_design/system_analysis_and_design_overview.htm

Physical System may be static or dynamic in nature. For example, desks and chairs are the physical parts of computer center, which are static. A programmed computer is a dynamic system in which programs, data, and applications can change according to the user's needs.

Read: Types of system:

https://www.tutorialspoint.com/system_analysis_and_design/system_analysis_and_design_overview.htm

Data modeling is the process of creating a data model for the data to be stored in a Database.

Conceptual data model is essentially a set of technology independent specifications about the data and is used to discuss initial requirements with the business stakeholders.

Relational : The most common model, the relational model sorts data into tables, also known as relations, each of which consists of columns and rows.

Object Oriented: This model defines a database as a collection of objects, or reusable software elements, with associated features and methods.

14.3.5.3 Self-Assessment

- i. _____ is the process of creating a data model for the data to be stored in a Database.
 - A. Data modeling
 - B. Unified Modeling
 - C. Design modeling
- ii. Explain briefly software requirements specification?
- iii. _____ may be static or dynamic in nature. For example, desks and chairs are the physical parts of computer center, which are static.
 - A. Data modeling
 - B. Physical System
 - C. Conceptual data model
 - D. Both of above
- v. The ____ is an object-oriented system development methodology offered by IBM's Rational Software.
 - A. Unified Process
 - B. Structured System

- C. Class Diagram
- D. Entity-Relationship Diagram

14.3.5.4 Tools, Equipment, Supplies and Materials

Computer, Dataflow Diagrams, Data dictionary

14.3.5.5 References

- https://www.tutorialspoint.com/system_analysis_and_design/system_analysis_and_design_overview.htm
- Systems Analysis and Design in a Changing World authored by Stephen D. Burd , John W. Satzinger , Robert Jackson published by Cengage Learning, Inc
- Systems Analysis and Design authored by Scott Tilley, Harry J. Rosenblatt

14.3.6 Learning Outcome 5: Understand advanced design concepts

14.3.6.1 Learning Activities

The following are the performance criteria:

- Types of Advance Design modeling are identified
- File Organization and access methods are identified
- Design strategies are identified
- System design Security and control measures are identified
- Structured Design concepts are identified

Trainees to demonstrate knowledge in relation to:

- Types of Advance Design modeling
- File Organization Methods: Serial, Sequential, Direct, Indexed
- File access methods: Sequential, Direct
- System security Control: Privacy, Integrity
- System Control Measures: Backup, Physical Access, Logical
- Structured Design Concepts: Input, Output, User interface, Modularization

14.3.6.2 Information Sheet

The types of Data Modeling techniques are:

- Entity Relationship (E-R) Model
- UML (Unified Modeling Language)

File organization is very important because it determines the methods of access, efficiency, flexibility and storage devices to use. There are four methods of organizing files on a storage media.

Read: File organizing:

<https://peda.net/kenya/css/subjects/computer-studies/form-three/driac2/data-processing/fom>

When a **file** is used, information is read and **accessed** into computer memory and there are several ways to access this information of the file.

Sequential Access: It is the simplest access method. Information in the file is processed in order, one record after the other. This mode of access is by far the most common; for example, editor and compiler usually access the file in this fashion.

Direct access: method also known as relative access method a fixed-length logical record that allows the program to read and write record rapidly in no particular order. The direct access is based on the disk model of a file since disk allows random access to any file block. For direct access, the file is viewed as a numbered sequence of block or record.

Read: File access method: <https://www.geeksforgeeks.org/operating-system-file-access-methods/>

Security controls are safeguards or countermeasures to avoid, detect, counteract, or minimize security risks to physical property, information, computer systems, or other assets. They can be classified by several criteria.

Integrity models keep data pure and trustworthy by protecting system data from intentional or accidental changes. Integrity models have three goals:

- Prevent unauthorized users from making modifications to data or programs
- Prevent authorized users from making improper or unauthorized modifications
- Maintain internal and external consistency of data and programs

Access control is a security technique that regulates who or what can view or use resources in a computing environment.

Physical access control limits access to campuses, buildings, rooms and physical IT assets

Logical access control limits connections to computer networks, system files and data.

14.3.6.3 Self-Assessment

- i. What is integrity model?
- ii. What is file organizing?
- iv. Differentiate file organizing and file control methods?
- v. What are the difference between direct access and sequential access?
- vi. The types of Data Modeling techniques are
 - A. Entity Relationship Model
 - B. Unified Modeling Language
 - C. Data structure
 - D. Both of above
 - E. None of Above

- vii. _____ It is the simplest access method. Information in the file is processed in order, one record after the other.
- A. Direct access
 - B. Sequential Access
 - C. Integrity models
 - D. Both of above
 - E. None
- viii. _____ keep data pure and trustworthy by protecting system data from intentional or accidental changes.
- A. Integrity models
 - B. Direct access
 - C. Security Control
 - D. None
- ix. _____ is very important because it determines the methods of access, efficiency, flexibility and storage devices to use.
- A. File organization
 - B. Entity Relationship
 - C. File access
 - D. Both of above
 - E. None of above

14.3.6.4 Tools, Equipment, Supplies and Materials

Computer, Software, Data flow Diagrams, Structure english

14.3.6.5 References

- <https://www.open.edu/openlearn/science-maths-technology/introduction-software-development/content-section-6>
- <http://www.pearsonitcertification.com/articles/article.aspx?p=2218577&seqNum=3>
- <https://searchsecurity.techtarget.com/definition/access-control>
- Systems Analysis and Design in a Changing World authored by Stephen D. Burd , John W. Satzinger , Robert Jackson published by Cengage Learning, Inc
- Systems Analysis and Design authored by Scott Tilley , Harry J. Rosenblatt

14.3.7 Learning Outcome 6: Perform system implementation

14.3.7.1 Learning Activities

The following are the performance criteria:

- System implementation procedures are identified
- Types of the system testing are identified
- Deployment procedures of the system are identified

Trainees to demonstrate knowledge in relation to:

- System implementation procedures, Program Development, Quality Assurance, Data Conversion
- Types of the system testing - Software, Unit, Integration, Usability
- Deployment procedures of the system - Installation, Documentation, Training, Maintenance

14.3.7.2 Information Sheet

Program Development: The process of formulating, improving, and expanding educational, managerial, or service-oriented work plans (excluding computer program development).

The Quality Assurance: Strategy defines the quality standards for the project and determines how they are satisfied.

Data conversion is the process of translating data from one format to another while retaining its viability and quality.

Read: Type of system testing: <https://www.guru99.com/system-testing.html>

14.3.7.3 Self-Assessment

- i. What is program development?
- ii. What is data conversion?
- iii. In the implementation phase of System Analysis and Design, following are included:
 - A. Parallel run
 - B. Sizing
 - C. Specification freeze
 - D. All of these
- iv. System Implementation is necessary because:
 - A. Human never gets it right the first time
 - B. The Deployment may change over time
 - C. The User's needs may change over time
 - D. All of the above
- v. Which of the following is/are true about Close-out review or Post-implementation review?
 - A. Understanding of cost-benefits

- B. Goals achieved vis-à-vis targets
 - C. User friendliness of the system
 - D. All of these
- vi. Unit implementation of software does not involve:
- A. Source coding and compiling
 - B. Linking and creation of machine code files
 - C. Writing program codes for interfaces and compilation
 - D. All of the above

14.3.7.4 Tools, Equipment, Supplies and Materials

Data dictionary, Software, Computer

14.3.7.5 References

- https://www.sqa.org.uk/e-learning/ProjMan03CD/page_09.htm
- <https://www.guru99.com/system-testing.html>
- Systems Analysis and Design in a Changing World authored by Stephen D. Burd , John W. Satzinger , Robert Jackson published by Cengage Learning, Inc
- Systems Analysis and Design authored by Scott Tilley , Harry J. Rosenblatt

14.3.8 Learning Outcome 7: Understand current trends in system development

14.3.8.1 Learning Activities

The following are the performance criteria:

- Frameworks, components and services are identified
- Model driven architecture is understood
- Adaptive methodologies to development are understood
- Software principles and practices are identified

Trainees to demonstrate knowledge in relation to:

- Frameworks, components and services are identified
- Object Frameworks
- Component standards and infrastructure
- Service Standards
- Model driven architecture is understood: MDA Approach, MDA tools
- Adaptive methodologies to development are understood
- Agile Software Development
- Software principles and practices are identified Abstraction, Models and Modelling, Patterns, Reuse methodologies

14.3.8.2 Information Sheet

A **framework** is a set of components working together so they address a number of problems in one or more domains.

Object-oriented (OO) application frameworks are a promising technology for reifying proven software designs and implementations in order to reduce the cost and improve the quality of software.

System infrastructure frameworks: such as operating system and communication frameworks, and frameworks for user interfaces and language processing tools. System infrastructure frameworks are primarily used internally within a software organization and are not sold to customers directly.

Read: Component and infrastructure: <http://sahet.net/htm/swdev4.html#componentfw>

Model-driven architecture (MDA) is a type of approach to software design, development and implementation.

A **model-driven approach** focus on models to work with systems, including understating, designing, constructing, deploying, operating, maintaining, and modifying them.

Basically, **an MDA tool** is a tool used to develop, interpret, compare, align, measure, verify, transform.

Read: Model-driven: https://en.m.wikipedia.org/wiki/Model-driven_architecture

Agile software development refers to a group of software development methodologies based on iterative development, where requirements and solutions evolve through collaboration between self-organizing cross-functional teams.

Abstraction is the act of representing essential features without including the background details or explanations.

Software models are ways of expressing a software design. Usually some sort of abstract language or pictures are used to express the software design. For object-oriented software, an object modeling language such as UML is used to develop and express the software design.

Read: Software principle:

<https://medium.com/omarelgabrys-blog/software-engineering-software-process-and-software-process-models-part-2-4a9d06213fdc>

14.3.8.3 Self-Assessment

- i. What model-driven architecture?
- ii. _____ is a set of components working together so they address a number of problems in one or more domains.
A framework
A. Object-oriented
B. A model-driven
C. Both of above
- iii. Agile Software Development is based on
A. Incremental Development
B. Iterative Development
C. Linear Development
D. Both Incremental and Iterative Development
- iv. Which one of the following is not an agile method?
A. XP
B. 4GT
C. AUP
D. All of the mentioned
- v. Agility is defined as the ability of a project team to respond rapidly to a change.
A. True
B. False

14.3.8.4 Tools, Equipment, Supplies and Materials

Computer, software

14.3.8.5 References

- <http://www.informit.com/articles/article.aspx?p=27123>
- <https://www.dre.vanderbilt.edu/~schmidt/CACM-frameworks.html>
- <http://sahet.net/htm/swdev4.html#componentfw>
- <http://www.methodsandtools.com/archive/archive.php?id=5>
- Systems Analysis and Design in a Changing World authored by Stephen D. Burd, John W. Satzinger, Robert Jackson published by Cengage Learning, Inc
- Systems Analysis and Design, authored by Scott Tilley, Harry J. Rosenblatt