REPUBLIC OF KENYA

LEARNING GUIDE

FOR

INFORMATION COMMUNICATION TECHNOLOGY (ICT)

LEVEL 6

TVET CDACC
P.O. BOX 15745-00100
NAIROBI

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FOREWORD

The provision of quality education and training is fundamental to the Government's overall strategy for social economic development. Quality education and training will contribute to achievement of Kenya's development blueprint and sustainable development goals. This can only be addressed if the current skill gap in the world of work is critically taken into consideration.

Reforms in the education sector are necessary for the achievement of Kenya Vision 2030 and meeting the provisions of the Constitution of Kenya 2010. The education sector has to be aligned to the Constitution and this has triggered the formulation of the Policy Framework for Reforming Education and Training (Sessional Paper No. 4 of 2016). A key provision of this policy is the radical change in the design and delivery of the TVET training, which is the key to unlocking the country's potential in industrialization. This policy document requires that training in TVET be Competency Based, Curriculum development be industry led, certification be based on demonstration and mastery of competence and mode of delivery allows for multiple entry and exit in TVET programs.

These reforms demand that industry takes a leading role in TVET curriculum development to ensure the curriculum addresses and responds to its competence needs. The learning guide in Information Communication Technology (ICT) enhances a harmonized delivery of the competency-based curriculum for ICT Level 6.

It is my conviction that this learning guide will play a critical role towards supporting the development of competent human resource for the Information Communication Technology (ICT) sector's growth and sustainable development.

PRINCIPAL SECRETARY, VOCATIONAL AND TECHNICAL TRAINING
MINISTRY OF EDUCATION

PREFACE

Kenya Vision 2030 is anticipated to transform the country into a newly industrializing, "middle-income country providing a high-quality life to all its citizens by the year 2030". The Sustainable Development Goals (SDGs) further affirm that the manufacturing sector is an important driver to economic development. The SDG nine that focuses on Building resilient infrastructures, promoting sustainable industrialization and innovation can only be attained if the curriculum focuses on skill acquisition and mastery. Kenya intends to create a globally competitive and adaptive human resource base to meet the requirements of a rapidly industrializing economy through life-long education and training. TVET has a responsibility of facilitating the process of inculcating knowledge, skills and attitudes necessary for catapulting the nation to a globally competitive country, hence the paradigm shift to embrace Competency Based Education and Training (CBET). The Technical and Vocational Education and Training Act No. 29 of 2013 and the Sessional Paper No. 4 of 2016 on Reforming Education and Training in Kenya, emphasized the need to reform curriculum development, assessment and certification to respond to the unique needs of the industry. This called for shift to CBET to address the mismatch between skills acquired through training and skills needed by industry as well as increase the global competitiveness of Kenyan labor force.

The TVET Curriculum Development, Assessment and Certification Council (TVET CDACC), in conjunction with industry/sector experts developed the Occupational Standards, which was the basis of developing competency-based curriculum and assessment of an individual for competence certification for an ICT Level 6. The learning guide is geared towards promoting efficiency in delivery of curriculum.

The learning guide is designed and organized with clear and interactive learning activities for each learning outcome of a unit of competency. The guide further provides information sheet, self-assessment, tools, equipment's, supplies, and materials and references.

I am grateful to the Council Members, Council Secretariat, ICT experts and all those who participated in the development of this learning guide.

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CHAIRMAN, TVET CDACC

ACKNOWLEDGEMENT

This learning guide has been designed to support and enhance uniformity, standardization and coherence in implementing TVET Competency Based Education and training in Kenya. In developing the learning guide, significant involvement and support was received from various organizations.

I recognize with appreciation the critical role of the participants drawn from technical training institutes, universities and private sector in ensuring that this learning guide is in-line with the competencies required by the industry as stipulated in the occupational standards and curriculum. I also thank all stakeholders in the ICT sector for their valuable input and all those who participated in the process of developing this learning guide.

I am convinced that this learning guide will go a long way in ensuring that workers in ICT sector acquire competencies that will enable them to perform their work more efficiently and make them enjoy competitive advantage in the world of work

DR. LAWRENCE GUANTAI M'ITONGA, PhD
COUNCIL SECRETARY/CEO
TVET CDACC

ACRONYMS

CAD	Computer Aided Design
CCTV	Closed Circuit Television
CDACC	Curriculum Development, Assessment and Certification Council
CSS	Cascading Style Sheets
CMS	Content Management System
DMA	Direct Memory Access
DTP	Desktop Publishing
DSS	Decision Support System
EAS	Enterprise Application Software
EMS	Environmental Management Systems
ERP	Enterprise Resource Planning
EULA	End-User License Agreement
FIFO	First In First Out
HTTP	Hypertext Transfer Protocol
ICT	Information Communication Technology
IS	Information System
ISP	Information Security Policy
LAN	Local Area Network
MFA	Multi factor Authentication
MIS	Management Information System
MRF	Maintenance Request Form
PAN	Personal Area Network
OOBE	Out of Box Experience
POST	Power on Self-Test
PPE	Personal Protective Equipment
RAM	Random Access Memory
RTOS	Real Time Operating System
SCM	Software Configuration Management
SDLC	System Development Life Cycle
SSD	Solid State Drive
SSL	Secure Sockets Layer
SSFT	Shortest Seek Time First
TVET	Technical and Vocational Education and Training
URL	Uniform Resource Locator
WAN	Wide Area Network
WYSIWYG	What you see is what you get

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CHAPTER 1: INTRODUCTION

1.1 Background Information

This learning guide has been developed in line with the functions of TVET CDACC as stipulated in Article 45 (1a) of the Technical and Vocational Education and Training (TVET) Act No. 29 of 2013, the Sessional Paper No. 2 of 2015 that embraces Competency Based Education and Training (CBET) system. It is therefore, the sole intent of this document to provide guidelines for a Competency-Based ICT curriculum for Level 6.

This learning guide consists of interactive learning activities, content, self-assessment and relevant and related references that enhances implementing of Information Communication Technology (ICT) Level 6 qualification. It enables the trainee to acquire the competencies that enable him/her to undertake the various processes in ICT. The Guide further provides illustration, web links, case studies, examples and resources on how to implement all the learning outcomes/elements described in the Curriculum and Occupational Standards with a focus to a trainee.

1.2 The Purpose of Developing the Learning Guide

ICT Level 6 curriculum development process was initiated using the DACUM methodology where jobs/occupations were identified. Further, job analysis charts and occupational standards were generated in collaboration with the industry players under the guidance of TVET CDACC (Curriculum Development Assessment and Certification Council). The result of the process was ICT Level 6 curriculum. The curriculum was further broken down to end up with units of learning. To effectively implement ICT Level 6 curriculum, learning guides are required to provide training content and guide the learners and trainers on the learning process aimed at imparting the relevant knowledge, requisite skills and the right attitude to the industry. Learning guides are part of the training materials.

1.3 Layout of the Learning Guide

The learning guide is organized as per chapters. Chapter one presents the background information, and purpose of developing the learner guide. Each of the units of learning/unit of competency is presented as a chapter on its own. Each chapter presents the introduction of the unit of learning/unit of competency, performance standard and list of the learning outcome/elements in the occupational standards.

- **Learning Activities**

For each learning outcome, the learning activities are presented covering the performance criteria statements and trainee's demonstration of knowledge in relation to the range in the occupational standard and content in the curriculum.

- **Information Sheet**

The information sheet is section under each learning outcome that provides the subject matter in relation to definition of key terms, method, processes/procedures/guidelines, content, illustrations (photographs, pictures, video, charts, plans, digital content, and simulation) and case studies.

- **Self-Assessment**

Self-assessment is to the performance criteria, required knowledge, skills and the range as stated in the occupational standards. The section further provides questions and assignments in which trainees demonstrate that they have acquired the required competences and an opportunity to reflect on what they have acquired. It is expected that the trainer keeps a record of their plans, their progress and the problems they encountered which will go in trainee's portfolio. A portfolio assessment consists of a selection of evidence that meets the pre-defined requirements of complexity, authenticity and reliability. The portfolio starts at the beginning of the training and will be the evidence for the development and acquisition of the competence (summative and formative) by the student. It is important to note that Portfolio assessment is highly emphasized in the learning guide

Finally, the guide presents tools, equipment's, supplies and materials for each learning outcome as guided by the performance criteria in occupational standards and content in curriculum. References, relevant links and addendums are provided for further reading. The units of competency comprising this qualification include the following common and core unit of learning:

Common Units of Learning

Table 1: Common Units of Learning

Unit of Learning Code	**Unit of Learning Title**	**Duration in Hours**	**Credit Factors**
IT/CU/ICT/CC/1/6	Apply Basic Electronics	100	10
Total		100	10

Core Units of Learning
Table 2: Core Units of Learning

Unit of Learning Code	Unit of Learning Title	Duration in Hours	Credit Factors
ICT/CU/IT/CR/1/6	Perform computer Networking	180	18
ICT/CU/IT/CR/2/6	Install computer software	150	15
ICT/CU/IT/CR/3/6	Control ICT Security threats	200	20
ICT/CU/IT/CR/4/6	Provide ICT System Support	100	10
ICT/CU/IT/CR/5/6	Perform Website Design	200	20
ICT/CU/IT/CR/6/6	Perform computer repair and maintenance	100	10
ICT/CU/IT/CR/7/6	Manage Database Systems	250	25
ICT/CU/IT/CR/8/6	Perform Management Information System	150	15
ICT/CU/IT/CR/9/6	Perform Graphic Design	200	20
ICT/CU/IT/CR/10/6	Develop Computer Program	300	30
ICT/CU/IT/CR/11/6	Develop Mobile Application	350	35
ICT/CU/IT/CR/12/6	Perform System Analysis and Design	150	15
	Industrial Attachment	480	48
Total		**2810**	**281**
Grand total		**2910**	**291**

The total duration of the course is **3330** hours including 480 hours of industrial attachment.

COMMON UNITS OF COMPETENCY

CHAPTER 2: APPLY BASIC ELECTRONICS

2.1 Introduction

This unit specifies the competencies required to demonstrate basic skills of electronics. It involves identification of electric circuits, electronic components, understand semi-conductor theory, identify and classify memories, apply number systems and identify emerging trends in electronics.

2.2 Performance Standard

- Identified electrical components, quantities and their units of measurement (EMF in volts, Current in Amperes, Power in Watts, Energy in Joules, Resistance in Ohms)
- Constructed a simple circuit for direct current and alternate current
- Identified types of transistors (PNP and NPN) and their operations (forward biasing and reverse biasing)
- Categorized the memories according to their levels, types and hierarchy such as – semi-conductor, magnetic, optical
- Identified the number systems, binary codes and their operations

2.3 Learning Outcome

2.3.1 List of the Learning Outcomes

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

- Identify electric circuits
- Identify Electronic components
- Understand Semi-conductor theory
- Identify and classify memory
- Apply Number Systems
- Emerging trends in Electronics

2.3.2 Learning Outcome 1: Identify electric circuits

2.3.2.1 Learning Activities

The following are the performance criteria:

- Electrical circuits are identified
- Electrical quantities and their units are identified
- Types of electrical circuits are identified

Trainees to demonstrate knowledge in relation to:

- Definition of electrical circuit
- Basic electrical quantities and their units: EMF in volts, Current in Amperes, Power in Watts, Energy in Joules, Resistance in Ohms
- Types of electrical circuits: Simple AC circuits, Simple DC circuits

2.3.2.2 Information Sheet

An electric circuit is a path in which electrons from a voltage or current source flow. The point where those electrons enter an electrical circuit is called the “source” of electrons. The point where the electrons leave an electrical circuit is called the "return" or "earth ground". The exit point is called the "return" because electrons always end up at the source when they complete the path of an electrical circuit. The part of an electrical circuit that is between the electrons' starting point and the point where they return to the source is called an electrical circuit's "load". A load of an electrical circuit may be as simple as those that power home appliances like refrigerators, televisions, or lamps or more complicated, such as the load on the output of a hydroelectric power generating station. A simple, well-designed circuit, has a cell providing current along a path (wire), to a load (resistor) and back to the other end of the cell as shown in diagram.

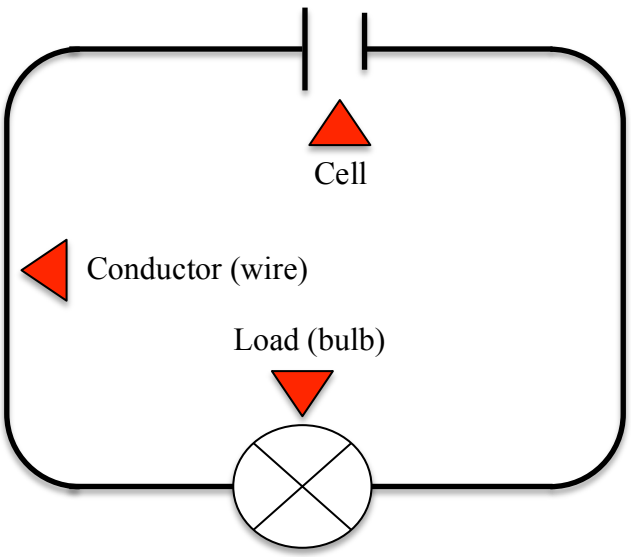
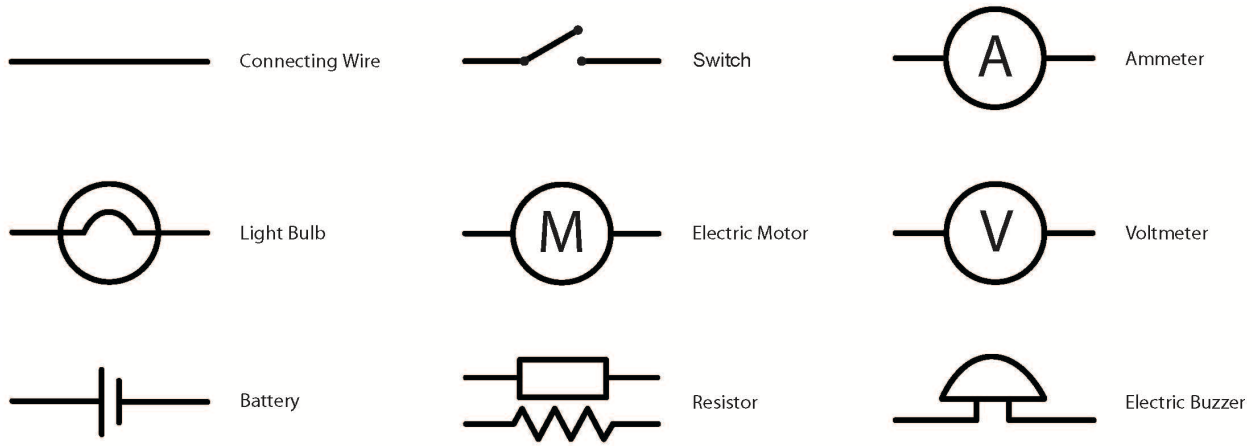


Figure 1: Electrical circuit depicting - load, conductor, cell

An electrical circuit is a path or line through which an electrical current flows. The path may be closed (joined at both ends), making it a loop. A closed circuit makes electrical current flow possible. It may also be an open circuit where the electron flow is cut short because the path is broken. An open circuit does not allow electrical current to flow.

Below is a basic set of symbols that you may find on circuit diagrams:



Source: http://victorysportstraining.com

Figure 2: Symbols of circuit diagrams

It is very important to know the basic parts of a simple circuit and the symbols that relate to them. A simple circuit has conductors, a switch, a load and a power source.

Here are the functions of each part:

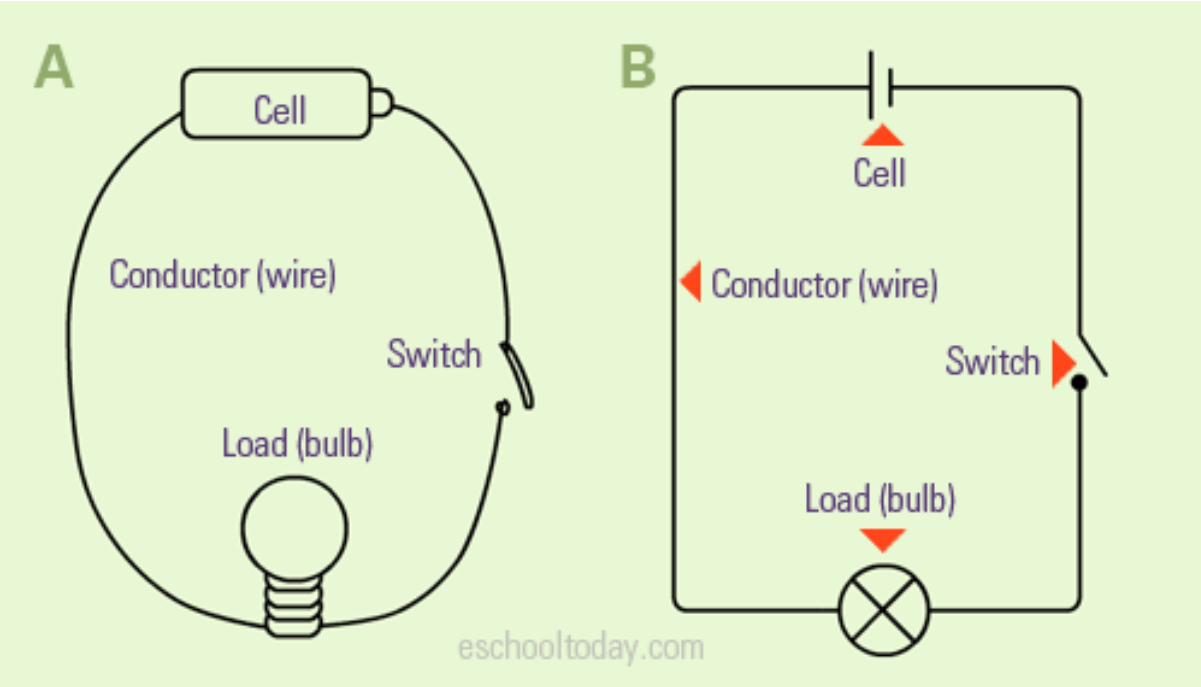
Conductors:
These are usually copper wires with no insulation. They make the path through which the electricity flows. One piece of the wire connects the current from the power source (cell) to the load. The other piece connects the load back to the power source.

Switch:
The switch is simply a small gap in the conductor where you can close or open the circuit. When the switch is closed, the circuit is closed and electricity flows.

The Load:
The load is a small light bulb or buzzer that lights when the circuit is turned on. The load is also known as a resistor.

Cell:
The power source is a cell. (Note that more than one cell put together is known as a battery).

The diagram below shows how a basic circuit looks like.



Source: eschooltoday.com

Figure 3: Basic circuit

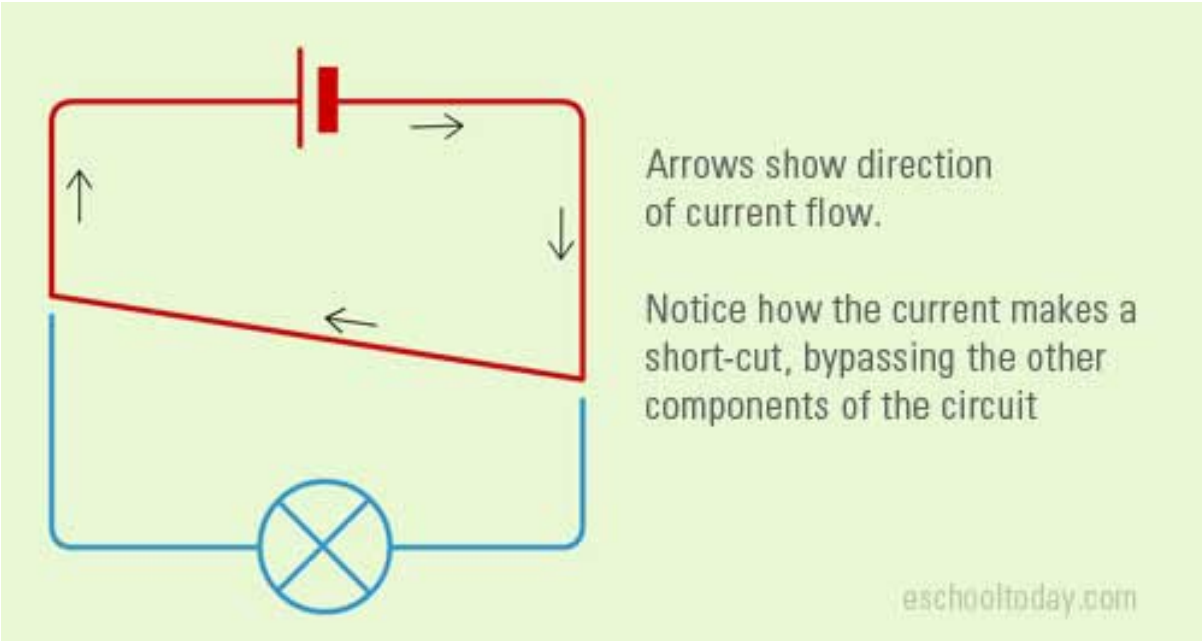
It is important to draw circuits with clean straight lines, as shown in diagram B. Avoid realistic sketches. It is important to know that a circuit can have more than the basic components in the diagram. It can have two or more batteries or two or more bulbs.

A circuit or wiring diagram is a visual display of an electrical circuit.

Electrical and electronic circuits can be complicated. Making a drawing of the connections to all the component parts in the circuit's load makes it easier to understand how circuit components are connected. Drawings for electronic circuits are called "**circuit diagrams**". Drawings for electrical circuits are called "**wiring diagrams**". A schematic is a diagram of an electrical circuit. Schematics are graphical representations of the essential connections in a circuit, but they are not life-like depictions of a circuit. Schematics use symbols to represent components in the circuit. Conventions are used in a schematic to represent the way electricity flows. The common convention we use is from the positive to the negative terminal. The realistic way electricity flows is from the negative to the positive terminal.

Circuit diagrams utilise special symbols recognised by everyone who uses the drawings. The symbols on the drawings show how components like resistors, capacitors, insulators, motors, outlet boxes, lights, switches, and other electrical and electronic components are connected together. The diagrams are a big help when workers try to find out why a circuit does not work correctly.

flow to the other end of the cell. When this happens the high voltage causes the wires to heat up and catch fire.



Source: eschooltoday.com

Figure 6: Short circuit

A fuse is simply a strip of alloy wire (made of bismuth and tin), which is connected to the circuit. The fuse is usually designed to take specific volumes of electricity (voltage). For example is a 3amp fuse is fixed into a circuit it cannot take any more than 3amps of electricity. If for any reason, there is a surge or increase in the voltage, the fuse will melt immediately and break. This will stop the flow of high voltage and prevent any potential damage to the circuit or device.

Electromotive force, also called **EMF** (and measured in volts), refers to voltage generated by a battery or by the magnetic force according to **Faraday's Law**, which states that a time varying magnetic field will induce an electric current.

Ampere or Amp (symbol: A) is the unit of electrical current. The Ampere unit is named after Andre-Marie Ampere from France. One Ampere is defined as the current that flows with electric charge of one Coulomb per second. 1 A = 1 C/s

The electric Power, P is equal to the energy consumption E divided by the consumption time t:

$$P = \frac{E}{t}$$

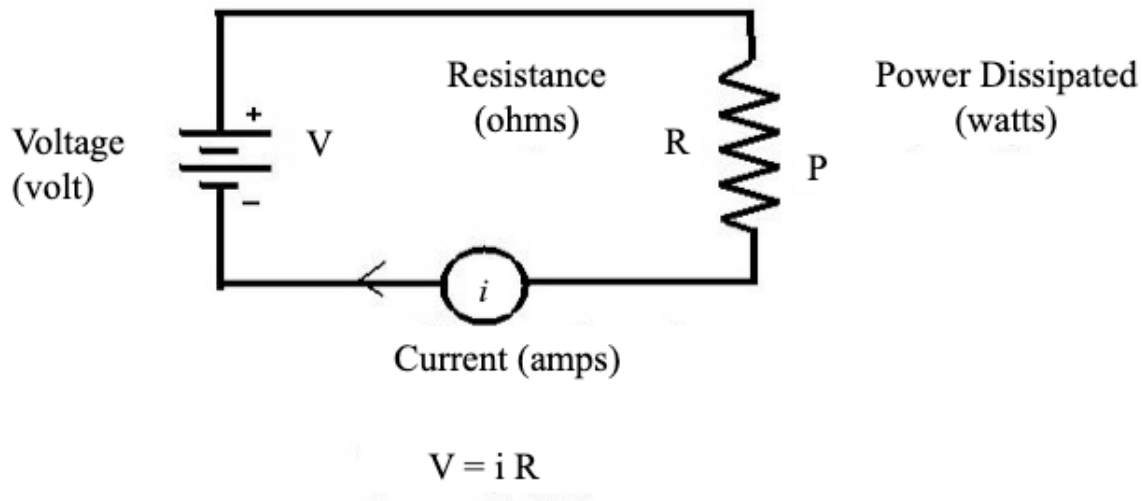
P is the electric power in Watt (W).
E is the energy consumption in Joule (J).
t is the time in seconds (s).

Joule, unit of work or energy in the International System of Units (SI), is equal to the work done by a force of one newton acting through one metre.

Resistance is a measure of the opposition to current flow in an electrical circuit. Resistance is measured in Ohms, symbolized by the Greek letter Omega **(Ω).**

Ohm's Law is V = IR, where V = voltage, I = current, and R = resistance.

Ohm's Law allows you to determine characteristics of a circuit, such as how much current is flowing through it, if you know the voltage of the battery in the circuit and how much resistance is in the circuit.



Source: https://www.online-sciences.com

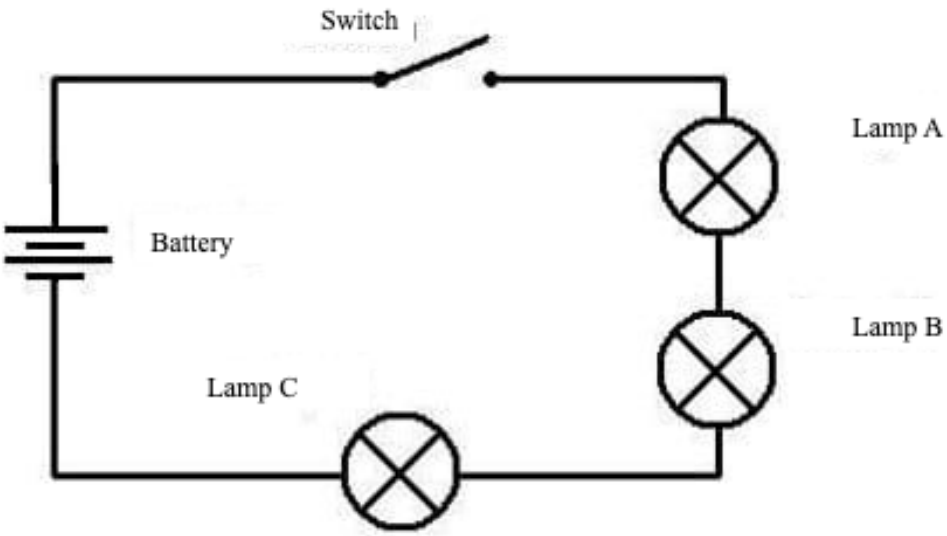
Figure 7: Ohm's Law

Watch: Ohms Law, Resistance, and its applications:
https://www.toppr.com/guides/physics/electricity/ohms-law-and-resistance/
https://learn.sparkfun.com/tutorials/voltage-current-resistance-and-ohms-law/all

In a **Direct Current** (DC) the electrons flow in one direction. Batteries create a direct current because the electrons always flow from the 'negative' side to the 'positive' side. A DC Circuit uses steady current components like resistors and resistor combinations; transient components like inductors and capacitors; indicating meters like moving coil voltmeters and ammeters; power supply battery sources, and so on. For analyzing these circuits, different tools like ohms law, voltage and current laws like KCL, KVL, and network theorems like Thevinens, Nortons, Mesh analysis, etc. are used.

In a simple DC circuit, a resistive load as a bulb is connected between the positive and negative terminals of the battery. The battery supplies the required power to the bulb and allows a user to place a switch to turn on or off according to the requirement.

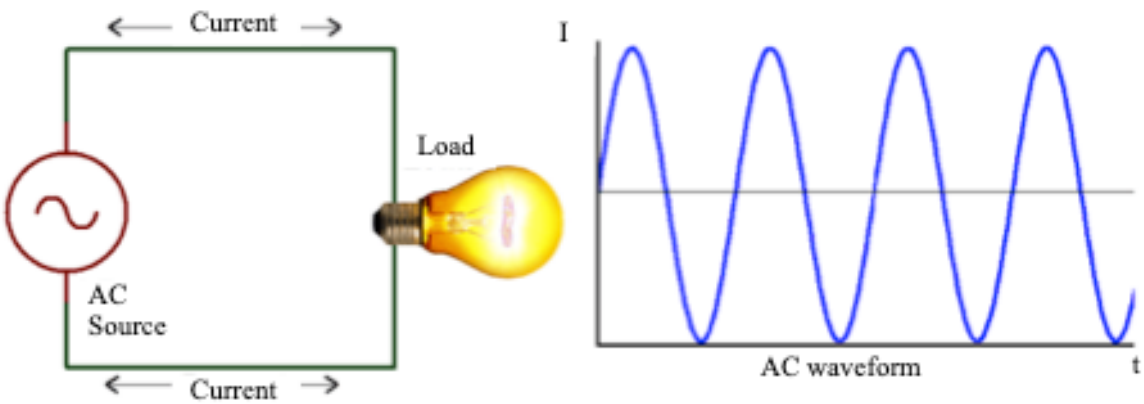
Resistive loads represent the lighting loads that are connected in various configurations to analyze the DC circuits. The way of connecting loads certainly changes the circuit characteristics.



Source: http://lmsshule.cloudapp.net

Figure 8: DC circuit

Alternating Current (AC) pushes the electrons back and forth, changing the direction of the flow several times per second. Unlike DC current, AC voltage or current changes its direction periodically as it increases from zero to maximum, and decreases back to zero, then negatively continue to maximum, and then again back to zero.



Source: https://circuitdigest.com

Figure 9: AC Circuit

Watch: Introduction to circuits and Ohm's Law:
https://www.khanacademy.org/science/ap-physics-1/ap-circuits-topic/current-ap/v/circuits-part-1

Watch: Understand electric circuits:
https://youtu.be/VnnpLaKsqGU
https://youtu.be/8RJ6Kdk8KDo

Read: Fundamental relationship between voltage, current and resistance in an electrical or electronic circuit is called Ohm's Law: https://www.electronics-tutorials.ws/dccircuits/dcp_1.html

Watch: Electrical measuring instruments:
https://www.youtube.com/watch?v=T_gCVuEPYPE
https://www.youtube.com/watch?v=cxIrBT-UJwc
https://www.youtube.com/watch?v=BTd4x1UFMLY

Table 3: Formula for electrical circuits

Quantity	Formula	Notations
Electric current	$I=\frac{Q}{t}$	• I is the current • Q is the charge flowing • t is the time period
Resistance	$R = \rho.\frac{L}{A}$	• R is the resistance • ρ is the resistive value of the wire • L is the length of the wire • A is the cross-sectional area
Voltage	$\Delta V = I.R$	• ΔV is the electric potential difference
Power	$P = \frac{\Delta E}{t}$	• P is the power • ΔE is the energy gain or loss • t is the time period
Series circuit	$R_{eq} = R_1 + R_2 + R_3 + \ldots$	• R_{eq} is the total resistance of the resistors places in series • R_1, R_2… are the resistors places in series
Parallel circuit	$R_{eq} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$	• R_{eq} is the total resistance of the resistors places in parallel • R_1, R_2… are the resistors places in parallel

2.3.2.3 Self-Assessment

i. What is electric circuit?
ii. What is Ohm?
iii. What is the difference between Ampere and Ohm?
iv. Current is:
   A. The flow of charged particles through a conducting medium
   B. The flow of a conductor through charged particles
   C. The random movement of electrons from atom to atom

D. Only present when there is no voltage
E. Faster than the speed of light

v. The two types of current are:
A. Direct and Alternating
B. Indirect and Alternating
C. Direct and Attenuating
D. None of the above

vi. Prepare a circuit using 2 bulbs and 2 AA batteries.

vii. Identify different equipment in the workshop or classroom and categorize if they are AC or DC devices.

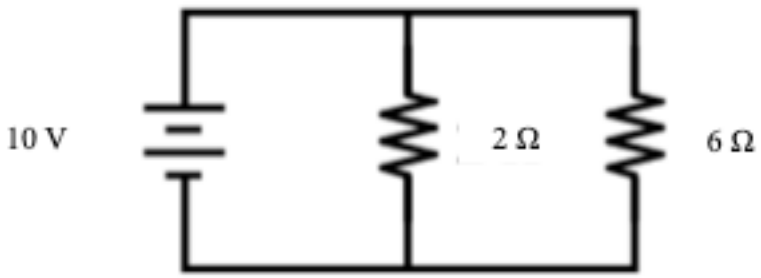
viii. True or False: An electric circuit is a closed loop or pathway that allows electric charges to flow.

ix. If additional resistor is connected in an existing parallel circuit, the total resistance
A. Remains the same
B. Decreases by the value of the added resistor
C. Increases by the value of the added resistor
D. Decreases (Answer)

x. Calculate resistance of an electrical circuit with 10 Volts and current of 5mA.

xi. A 4 Ω and a 6 Ω resistor are connected in series, the current is measured to be 4 A.
A. Draw a diagram of this circuit.
B. What is the voltage drop across the 4 Ω resistor?
C. What is the voltage drop across the 6 Ω resistor?
D. What is the total voltage of the power source?
E. What is the total power dissipated by the circuit?

xii. In the circuit shown, what is the current through the 2-ohm resistor?



Source: https://www.nutsvolts.com

xiii. Which Power Condition Occurs When The Voltage Level Drops Below 120 Volts And Stays Below For An Extended Period Of Time?

2.3.2.4 Tools, Equipment, Supplies and Materials

Bulb, battery, soldering wire, soldering iron, printed circuit board, ammeter, volt meter, connecting wires, wire stripper, pliers, wire cutter, screw driver, driller, clamps, vise

2.3.2.5 References

- https://www.eolss.net/Sample-Chapters/C05/E6-08-29.pdf
- https://study.com/academy/lesson/what-is-electric-current-definition-unit-types.html

- https://phys.libretexts.org/Bookshelves/University_Physics/Book%3A_University_Physics_(OpenStax)/Map%3A_University_Physics_II_-_Thermodynamics%2C_Electricity%2C_and_Magnetism_(OpenStax)/15%3A_Alternating-Current_Circuits/15.2%3A_Simple_AC_Circuits
- https://www.rapidtables.com/electric/electric_power.html
- https://eschooltoday.com/science/electricity
- Digital Electronics authored by Roger L. Tokheim published by McGraw-Hill Education – Europe
- Basic Digital Electronics: Explains digital systems functions and how digital circuits are used to build them, authored by Alvis J. Evans, published by Master Publishing (1996)

2.3.3 Learning Outcome 2: Identify electronic components

2.3.3.1 Learning Activities

The following are the performance criteria:

- Identification of electrical components is done as per the standards procedures
- Characteristic of electronic components are identified
- Applications of electronic components are identified
- Characteristics of integrated circuit are identified

Trainees to demonstrate knowledge in relation to:

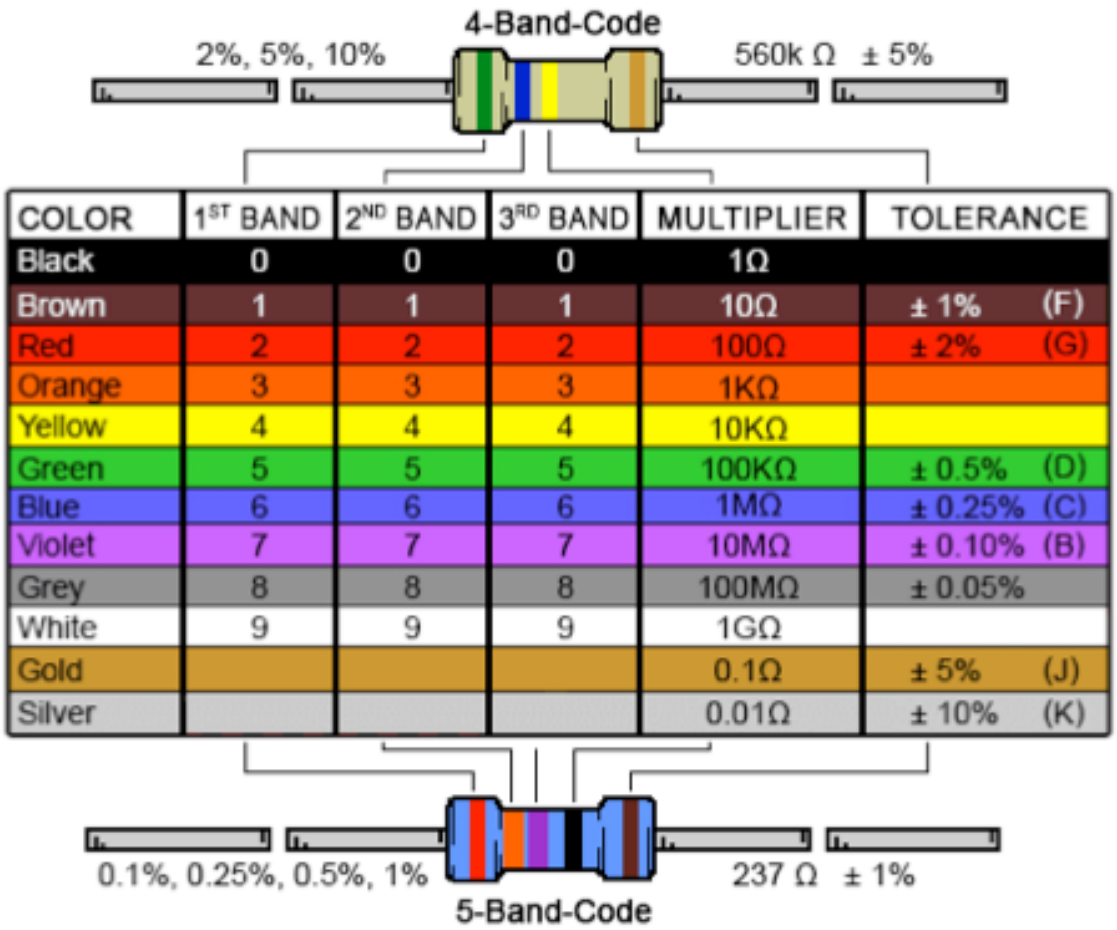
- Identification of electronic components: Resistor, Capacitor, Diode, Inductor
- Characteristic of electronic components
- Application of electronic components

2.3.3.2 Information Sheet

Resistor: The resistor is an inevitable part of a circuit. It is meant for reducing the current and voltage in the circuit parts. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat, may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment. Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within integrated circuits.

Resistors are identified using the standard colour code chart.



COLOR	1ST BAND	2ND BAND	3RD BAND	MULTIPLIER	TOLERANCE
Black	0	0	0	1Ω	
Brown	1	1	1	10Ω	± 1% (F)
Red	2	2	2	100Ω	± 2% (G)
Orange	3	3	3	1KΩ	
Yellow	4	4	4	10KΩ	
Green	5	5	5	100KΩ	± 0.5% (D)
Blue	6	6	6	1MΩ	± 0.25% (C)
Violet	7	7	7	10MΩ	± 0.10% (B)
Grey	8	8	8	100MΩ	± 0.05%
White	9	9	9	1GΩ	
Gold				0.1Ω	± 5% (J)
Silver				0.01Ω	± 10% (K)

Source: http://nye6b4.holzdingens.de

Figure 10: Resistors standard colour code chart

A capacitor is a body that can store an electrical charge. It consists of two conducting plates facing each other and separated by an insulating material. This insulating material is also called dielectric material. When a charge is stored in one plate, an equal and opposite charge is inducted on the other plate and thus a potential difference is set up between the plates.

The effect of a capacitor is known as capacitance. While some capacitance exists between any two electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit. The capacitor was originally known as a condenser or condensator.

The unit of measurement for capacitance is Farad but this unit is much too large for practical work. It is usually measured in microfarads (uF) or picofarads (pF). The formula of calculating capacitance is

C= [(0.224 KA)(n-1)]/d where

C = capacitance in pF

K = dielectric constant of material between plates
A = area of one side of the plates square inches
d = separation of plate in inches
n = number of plates

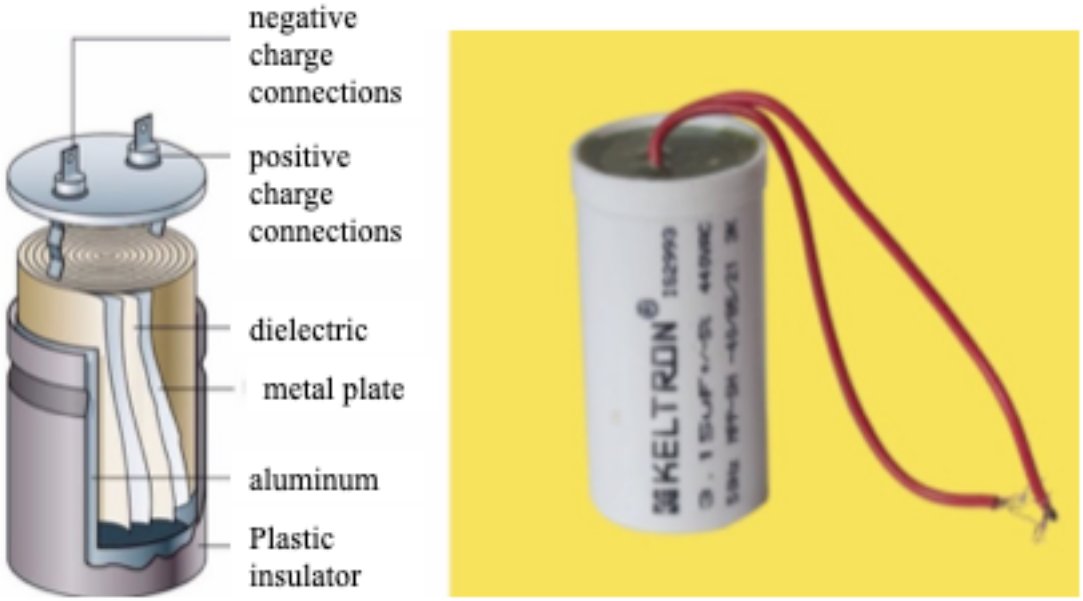
The potential difference V developed when a charge Q is stored depends directly on the value of Q and inversely with the capacitance C of the cap.

$V = Q/C$

They are used in timing circuits as it takes time for a cap. to be charged up. They are used to smooth varying DC power supplies by acting as a reservoir of charge. They are also used in filter circuits because they easily pass AC signals but they block DC signals.

Source: https://honestversion.com

Figure 11: Capacitors



Source: https://technologyspace.online

Figure 12: Parts of a capacitor

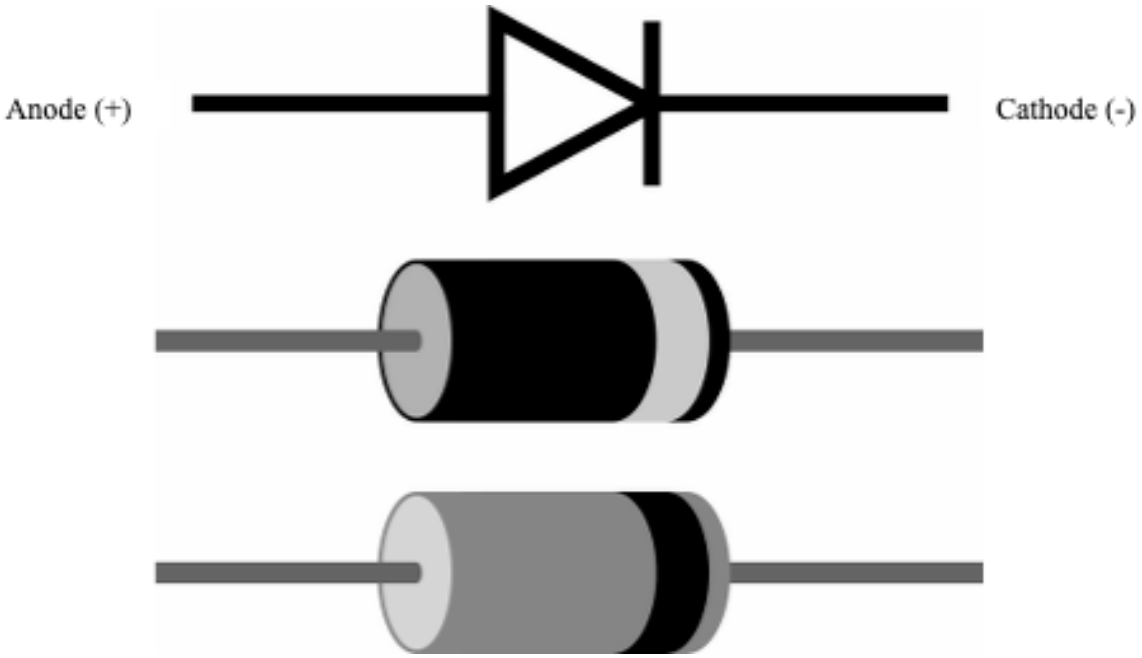
There are many different types of cap. that are used for different types of applications. They are electrolytic cap, ceramic cap., tantalum cap., polyester cap., polystyrene cap. and safety cap.

Read: Introduction to capacitor: https://www.electronics-project-design.com/Capacitors.html

Watch: Introduction to capacitor: https://youtu.be/4Hg7SLhetXM

Watch: How to prepare a capacitor: https://youtu.be/tktrzx3r_WY

Diode in small signal application of which the current requirement is less than 100mA; 1N4148 is a typical choice. It has a forward voltage drop of 0.7V and is made from Silicon type.



Source: https://www.electrical4u.com

Figure 13: Diode

An inductor: Like capacitors, inductors also store energy in one part of AC cycle and return it during the next part of the cycle.

Source: https://www.tutorialspoint.com

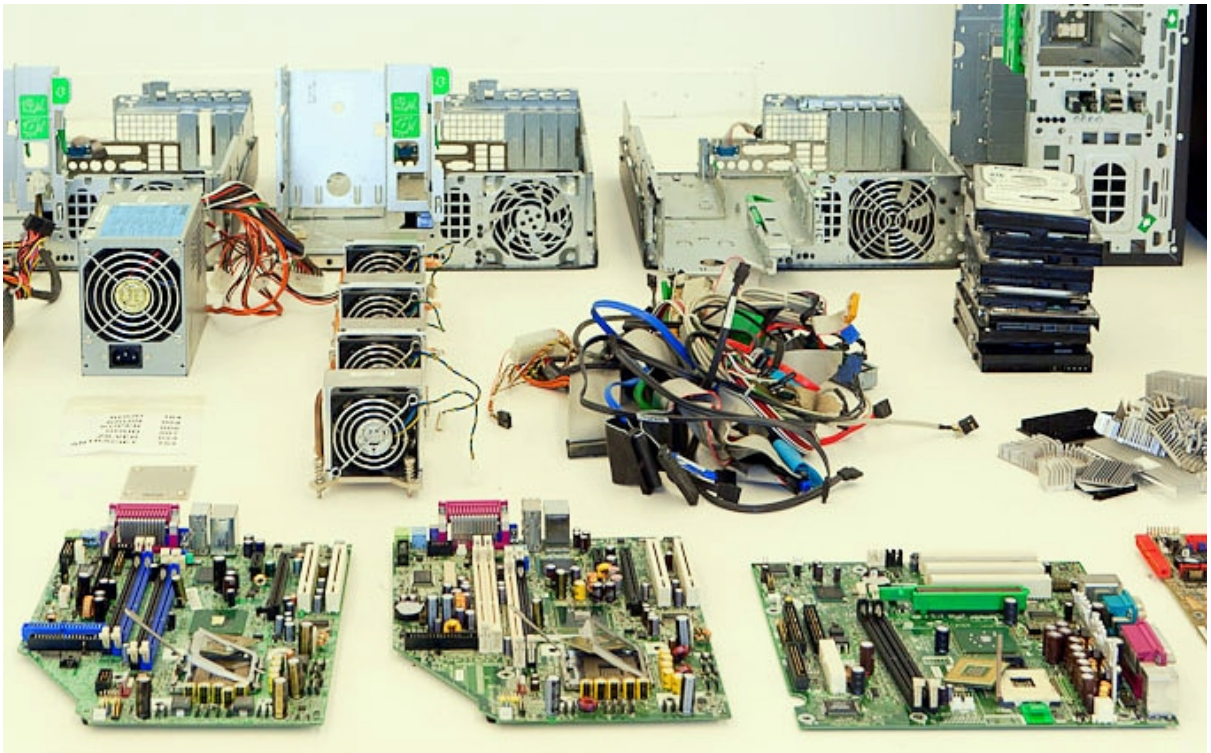
Figure 14: Inductor

Read: Electronic components:
https://www.electroschematics.com/8247/electronic-components-an-easy-to-use-guide/

Passive electronic components are those that do not have gain or directionality. They are also called Electrical elements or electrical components. Examples include resistors, capacitors, diodes, and inductors.

Active components are those that have gain or directionality. Examples include transistors,

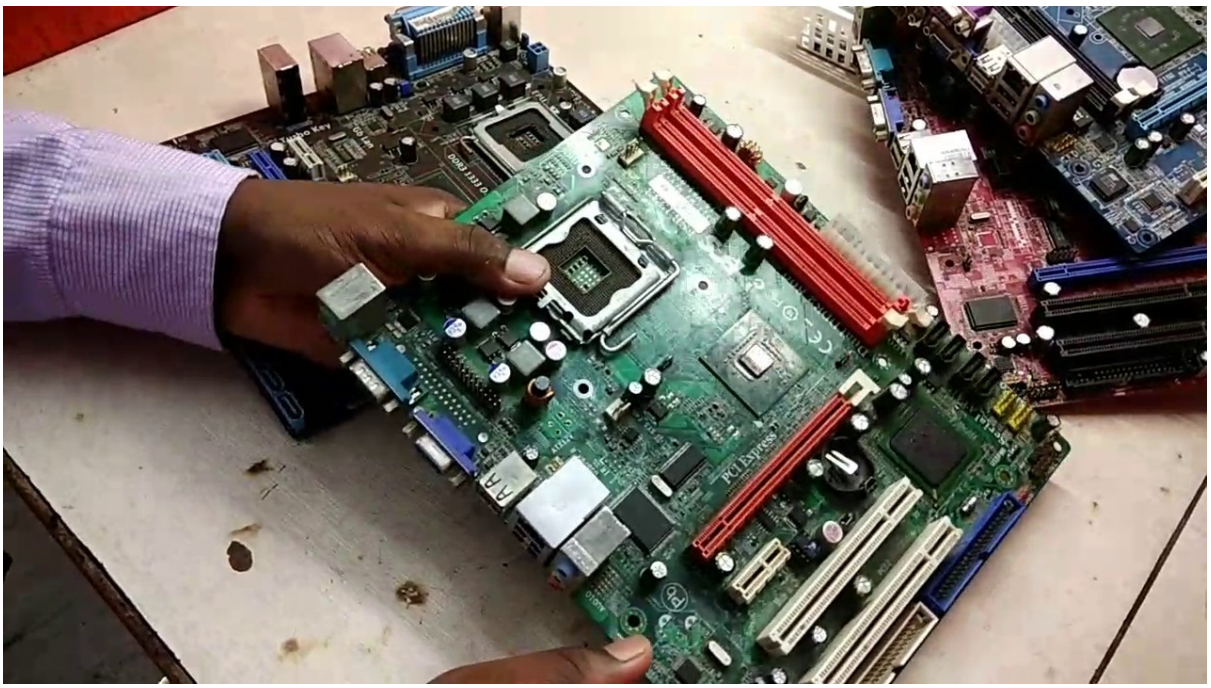
integrated circuits or ICs, logic gates.



Source: http://www.chipsetc.com

Figure 15: Electrical components in computers

Watch: The electronic components on a motherboard: https://youtu.be/OEL5laB3hfU



Source: http://wapvd.co

Figure 16 : Motherboard of a desktop

2.3.3.3 Self-Assessment

i. What are electronic components and their application in a computer?

ii. Explain briefly electronic components.

iii. Capacitors are electronic components capable of storing and delivering electrical charges. They are classified accordingly to the material used on their manufacturing process. From the options below, which one ISN'T a type of capacitor:

A. Electrolytic
B. Tantalum
C. Polyester
D. Ceramic
E. None of the above

iv. A 50 000 μF capacitor is charged by a constant current of 100 mA to a potential difference of 12 volts.

- What is the charge on the capacitor?
- How long did it take to charge up the capacitor?
- What is the energy in the capacitor?
- What is the energy supplied by the source?
- How does this compare with the energy held by the capacitor?

vi. What are the electronic components found in a motherboard of a desktop? Identify them and list their use.

vii. Take a desktop motherboard and identify the various components and label the parts such as capacitor, resistors etc.

viii. Made from a variety of materials, such as carbon, this inhibits the flow of current.

A. Resistor
B. Capacitor
C. Inductor
D. Choke

ix. This is a type of semiconductor that only allows current to flow in one direction. It is usually used to rectify AC signals (conversion to DC).

A. Univac
B. Diode
C. Transformer
D. Inductor

x. The capacitor capacitance is measured thru a unit called:

A. Ohm
B. Farad
C. Hertz
D. Watt
E. None of the above

2.3.3.4 Tools, Equipment, Supplies and Materials

Motherboard, capacitor, diode, inductor, conductors e.g. copper, gold, silver

2.3.3.5 References

- https://www.electroschematics.com/8247/electronic-components-an-easy-to-use-guide/
- http://www.rajswasthya.nic.in/RHSDP%20Training%20Modules/CSIO%20Modules/Radiographers/ELCTRONIC%20COMPONENTS.pdf
- http://www.electronicsandyou.com/blog/electronic-components-parts-and-their-function.html
- https://www.electronics-project-design.com/Capacitors.html
- Digital Electronics authored by Roger L. Tokheim published by McGraw-Hill Education – Europe
- Electronics, Principles and Applications, authored by Charles A Schuler, published by McGraw-Hill/Glencoe

2.3.4 Learning Outcome 3: Understand semi-conductor theory

2.3.4.1 Learning Activities

The following are the performance criteria:

- Explanation of semiconductor theory is done
- Structure of matter is described
- Electrons in conductors and semiconductors are explained
- Types of semiconductor materials are identified
- P-type and N-type materials are explained
- Description of P-N junction diodes operations is done
- Types and operations of transistors are identified

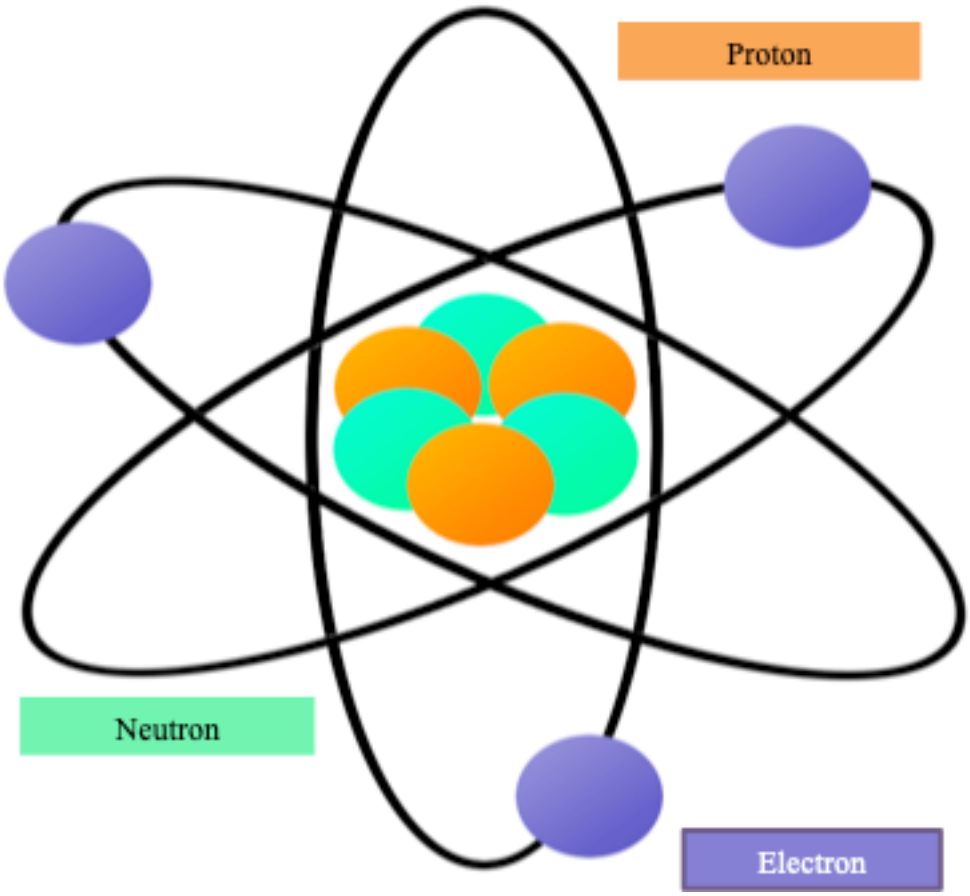
Trainees to demonstrate knowledge in relation to:

- Definition of semiconductor and related terms: Atom, Atomic structure
- Description of the structure of matter
- Explanation of electrons in conductors and semiconductors
- Types of semiconductors materials: Silicon, Germanium
- Explanation of P-type and N-types materials
- Description of P-N junction diodes operations: Forward biasing, Reverse biasing
- Operations of transistors: PNP type, NPN type

2.3.4.2 Information Sheet

A semiconductor is a physical substance that is designed to manage and control the flow of current in electronic devices and equipment. It neither allows freely flowing electric current nor repels it completely. A semiconductor is in between a conductor and insulator and is commonly used in the development of electronic chips, computing components and devices. It is generally created using silicon, germanium or other pure elements.

Atoms are composed of subatomic particles among which are the charged particles known as electrons and protons.



Source: https://learn.sparkfun.com

Figure 17: Parts of an atom

Watch: Atomic structure: https://youtu.be/EMDrb2LqL7E

Read: Structure of the atom: https://courses.lumenlearning.com/boundless-chemistry/chapter/the-structure-of-the-atom/

Matter can be defined as physical substance that has mass; occupies space; is composed of atoms; and is ultimately convertible to energy. A significant conversion of matter to energy, however, occurs only at speeds approaching that of the speed of light, a fact encompassed in the famous statement formulated by Albert Einstein (1879-1955), $E = mc^2$.

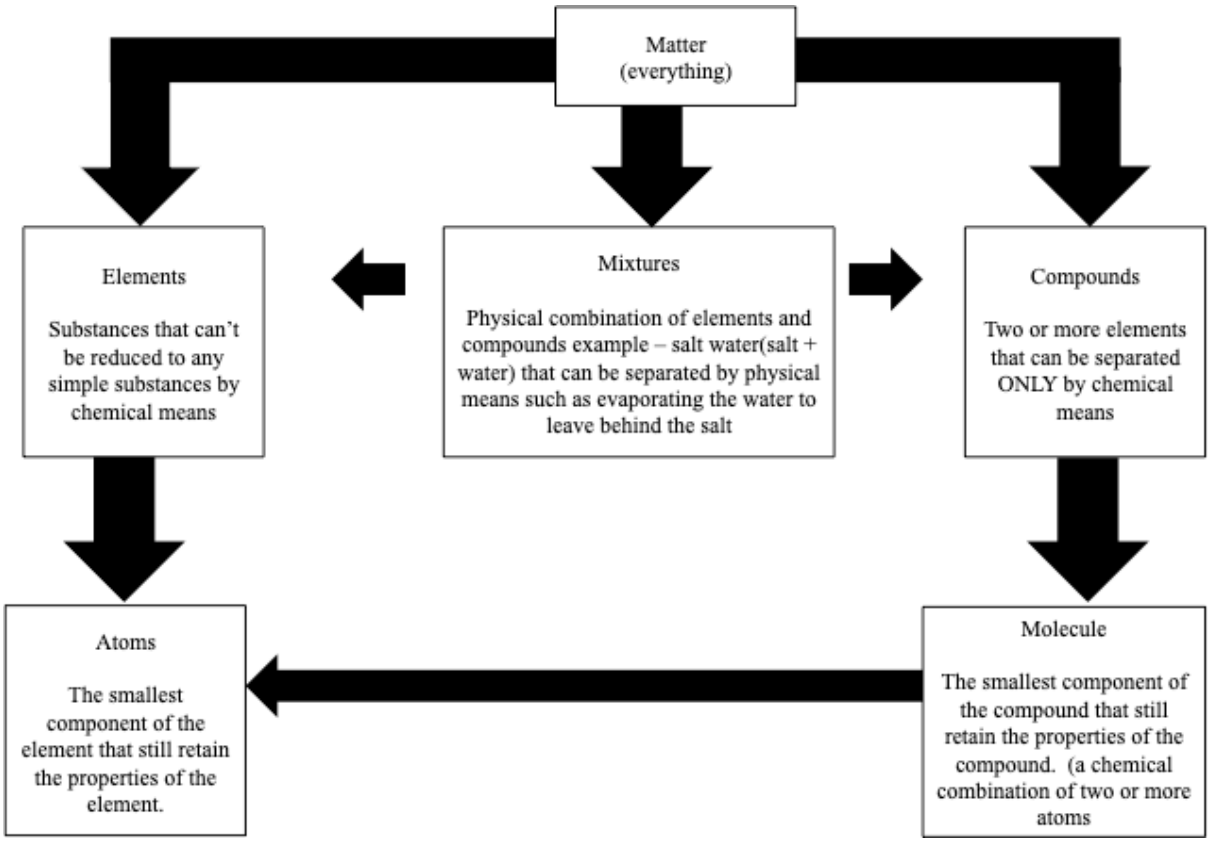


Figure 18: Classification of matter

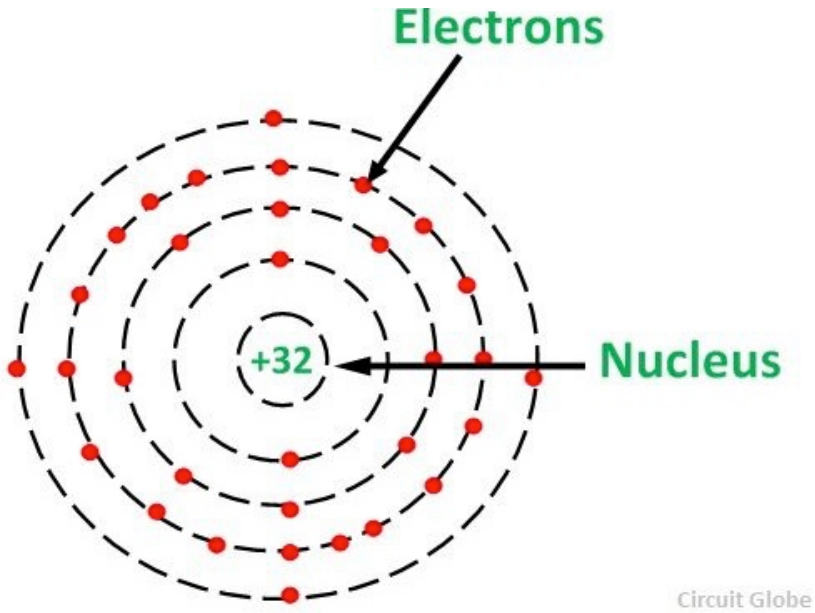
Read: Structure of matter:
https://www.physicsclassroom.com/class/estatics/Lesson-1/The-Structure-of-Matter
https://www.encyclopedia.com/science/news-wires-white-papers-and-books/structure-matter

Metals such as copper typify conductors, while most non-metallic solids are said to be good insulators, having extremely high resistance to the flow of charge through them. "**Conductor**" implies that the outer **electrons** of the atoms are loosely bound and free to move through the material.

The Semiconductors, such as Germanium, Silicon, Carbon, Selenium, etc. are the materials, which are neither conductors nor insulators. Their conductivity lies in between or middle of the conductivity of conductors and insulators. Semiconductors have some useful properties and are being extensively used for the preparation of solid-state devices like the diode, transistor, etc. **Silicon and Germanium,** which belong to the fourth group element, behave like a semiconductor. Each atom of silicon and germanium share an electron with their neighbours. A Silicon atom and its neighbours share a pair of electrons in covalent bonding. Whenever a covalent bond breaks, an electron-hole pair is formed. To remove the valence electrons from the outer shells, a semiconductor atom needs the energy of the other.

Germanium was discovered in 1886. It is an earth element recovered from the ash of certain coaks or from the flue dust of zinc smelters. The recovered germanium is in the form of Germanium dioxide powder. It is then converted into pure Germanium.

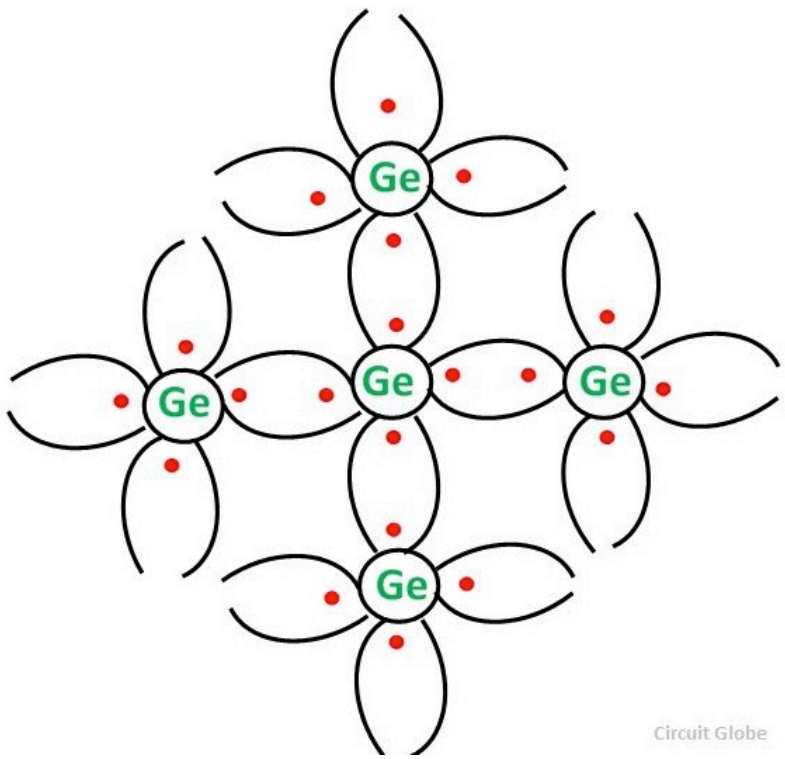
The atomic structure of Germanium is shown below:



Source: https://circuitglobe.com

Figure 19: Atomic structure of Germanium

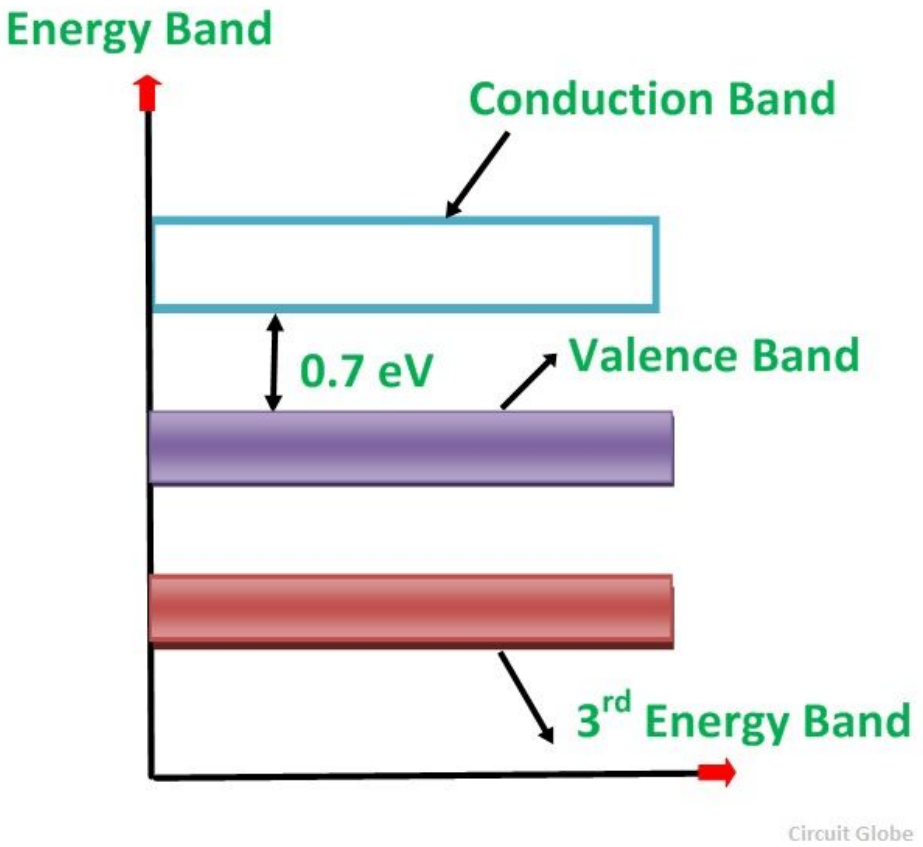
Its atomic number is 32. It has 32 protons in the nucleus and 32 electrons distributed in the four orbits around the nucleus. The number of electrons in the first, second, third and fourth orbit are 2, 8, 18 and 4 respectively. It is clear that the Germanium has four valence electrons. The various Germanium atoms are held together through covalent bonds as shown in the figure below.



Source: https://circuitglobe.com

Figure 20: Germanium atomic bond

The energy band diagram of Germanium is shown below.



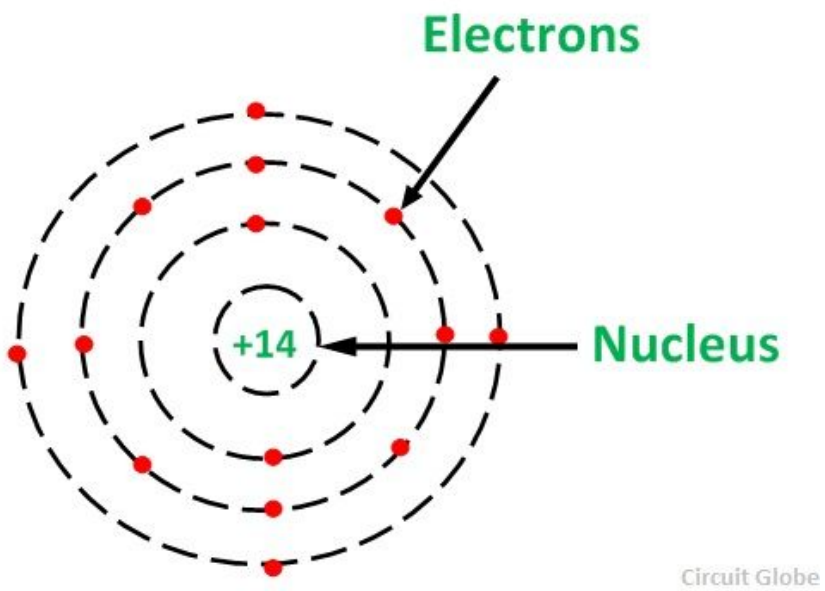
Source: https://circuitglobe.com

Figure 21: Energy bond for Germanium

The forbidden energy gap (i.e. Gap between the valence band and conduction band) in this material is very small. Hence, a very small energy is sufficient to lift the electrons from the valence band to the conduction band.

Silicon is the element available in most of the common rocks. Actually, sand is silicon dioxide. It is treated chemically and reduced to pure silicon, which can be used for the preparation of electronic devices.

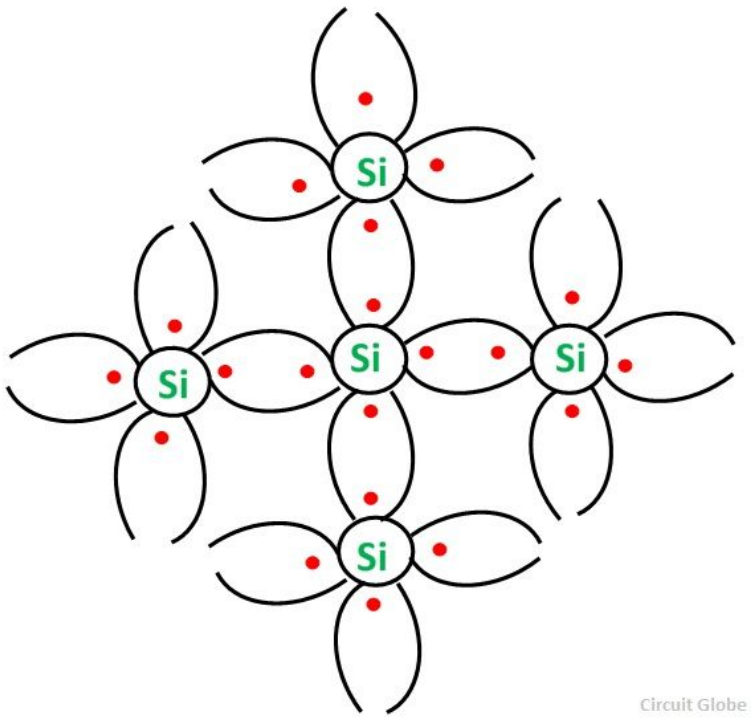
The figure below shows the atomic structure of silicon.



Source: https://circuitglobe.com

Figure 22: Atomic structure of Silicon

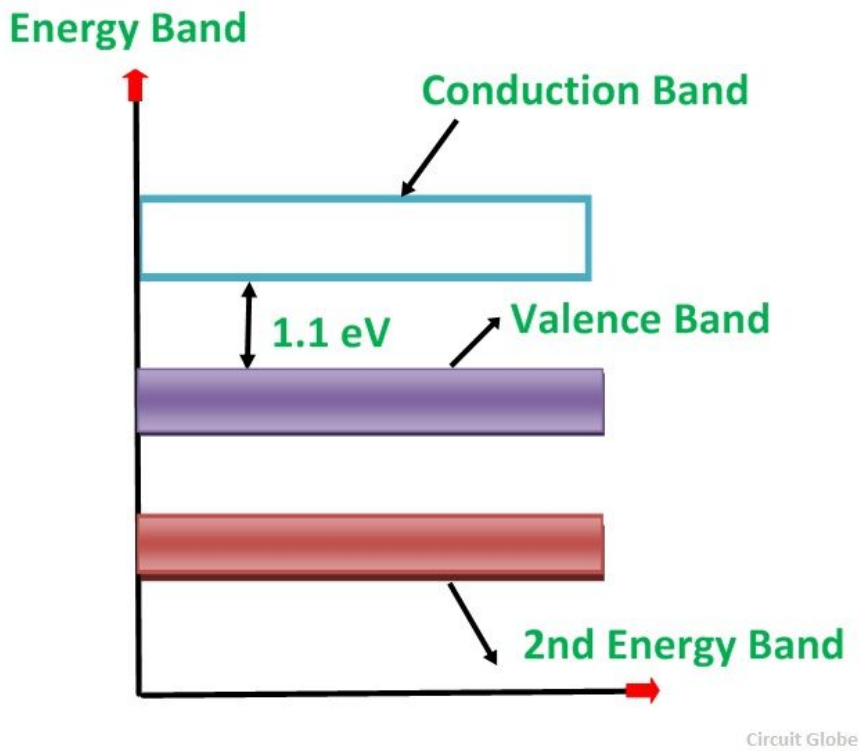
Its atomic number is 14. Therefore, it has 14 protons in the nucleus and 14 electrons distributed in the three orbits around the nucleus. The number of electrons in the first, second and third orbit are 2, 8 and 4 respectively. The various silicon atoms are held together through covalent bonds as shown in the figure below.



Source: https://circuitglobe.com

Figure 23: Silicon atomic bond

The **energy band diagram** of the silicon material is shown below.



Source: https://circuitglobe.com

Figure 24: Energy bond of Silicon

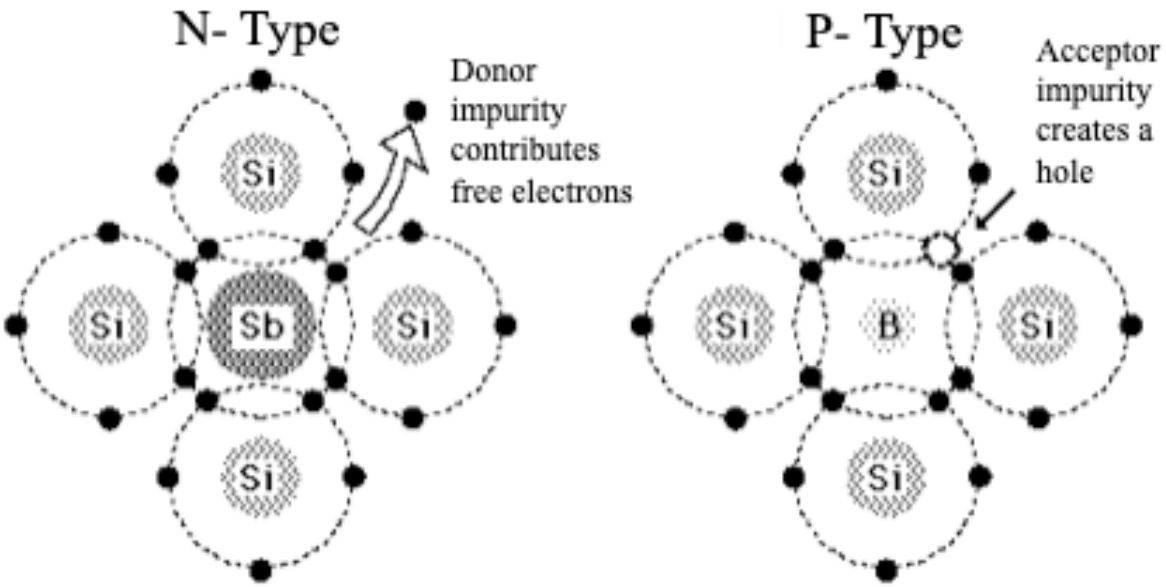
The forbidden energy gap in this material is quite small. It also needs a small energy to lift the electrons from the valence band to the conduction band.

Therefore, even at room temperature, a minute quantity of valence electrons is lifted to the conduction band and constitute current conduction if a high electric field is applied. However, at room temperature, the number of electrons lifted to the conduction band in the case of silicon is quite less than germanium.

This is the reason why silicon semiconductor devices are preferred over germanium devices.

An extrinsic semiconductor is one that has been doped; during manufacture of the semiconductor crystal a trace element or chemical called a doping agent has been incorporated chemically into the crystal, for the purpose of giving it different electrical properties than the pure semiconductor crystal, which is called an intrinsic semiconductor. In an extrinsic semiconductor it is these foreign dopant atoms in the crystal lattice that mainly provide the charge carriers which carry electric current through the crystal. The doping agents used are of two types, resulting in two types of extrinsic semiconductor. An electron donor dopant is an atom which, when incorporated in the crystal, releases a mobile conduction electron into the crystal lattice. An extrinsic semiconductor which has been doped with electron donor atoms is called an n-type semiconductor, because the majority of charge carriers in the crystal are negative electrons. An electron acceptor dopant is an atom which

accepts an electron from the lattice, creating a vacancy where an electron should be called a hole which can move through the crystal like a positively charged particle. An extrinsic semiconductor which has been doped with electron acceptor atoms is called a p-type semiconductor, because the majority of charge carriers in the crystal are positive holes.



Source: http://semiconductordevice.net

Figure 25: N-type and C-type semiconductors

The **N-type** semiconductor has a large number of electrons in the conduction band and less number of holes in the valence band, so electrons are called majority carriers and holes are called minority carriers.

The **P-type** semiconductor has a large number of holes in the conduction band and less number of electrons in the valence band, so holes are called majority carriers and electrons are called minority carriers.

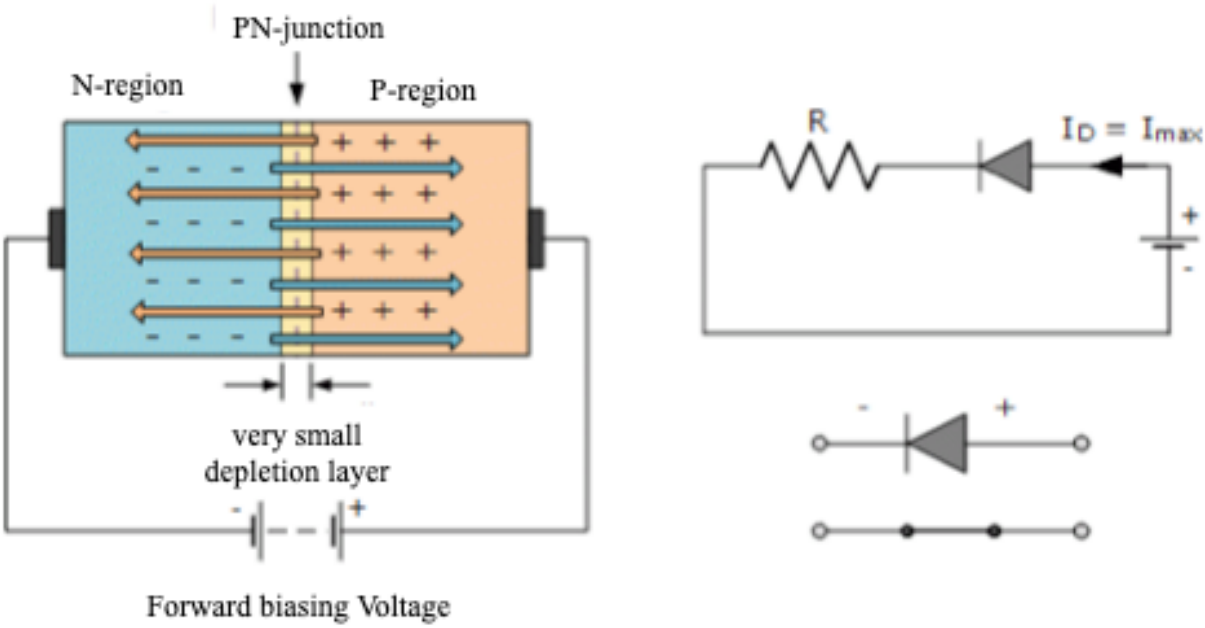
Doping is the key to the extraordinarily wide range of electrical behavior that semiconductors can exhibit, and extrinsic semiconductors are used to make semiconductor electronic devices such as diodes, transistors, integrated circuits, semiconductor lasers, LEDs, and photovoltaic cells. Sophisticated semiconductor fabrication processes like photolithography can implant different dopant elements in different regions of the same semiconductor crystal wafer, creating semiconductor devices on the wafer's surface. For example a common type of transistor, the n-p-n bipolar transistor, consists of an extrinsic semiconductor crystal with two regions of n-type semiconductor, separated by a region of p-type semiconductor, with metal contacts attached to each part.

Table 4: Table for semiconductor - donor and acceptor atoms

	Intrinsic semiconductor	Donor atoms	Acceptor atoms
Group IV semiconductors	Silicon, Germanium	Phosphorus, Arsenic, Antimony	Boron, Aluminum, Ga llium
Group III-V semiconductors	Aluminum phosphide, Aluminum arsenide, Gallium arsenide, Gallium nitride	Selenium, Tellurium, Silicon, Germanium	Beryllium, Zinc, Cad mium, Silicon, Germa nium

Watch: Introduction to N-type and P-type semi conductors:
https://youtu.be/CM0C7gWMcyw

A **PN-junction diode** is formed when a P-type semiconductor is fused to an N-type semiconductor creating a potential barrier voltage across the diode junction.



Source: https://www.electronics-tutorials.ws/diode/diode_3.html

Figure 26: PN-junction diode

Forward Bias: The voltage potential is connected positive (+ve) to the P-type material and negative (-ve) to the N-type material across the diode that has the effect of **decreasing** the PN junction diode's width.

Reverse Bias: The voltage potential is connected negative, (-ve) to the P-type material and positive, (+ve) to the N-type material across the diode that has the effect of **increasing** the PN junction diode's width.

Why does computers use semi-conductors?

Computer chips, both for CPU and memory, are composed of semiconductor materials. Semiconductors make it possible to miniaturize electronic components, such as transistors. Not only does miniaturization mean that the components take up less space, it also means that they are faster and require less energy.

Examples of components and devices that utilize semiconductors and semiconductor materials include the following:

- Integrated circuit
- Keyboard and mouse
- Monitor
- Processor
- Memory chip
- Transistor

Silicon is used in most semiconductors for computer and electronic components, as is it considered to be the best semiconductor material.

Watch: Introduction to semi-conductor: https://youtu.be/gUmDVe6C-BU

Watch: How semi-conductors are manufactured: https://youtu.be/R0nlBJ_IVc4

Watch: Understand why silicon is used in computer chips: https://youtu.be/8W9CA1QENqg

Read: Understand the use of semi-conductors: https://ethw.org/Semiconductors

2.3.4.3 Self-Assessment

i. Differentiate between forward bias and reverse bias.

ii. Define PN-junction diode.

iii. A semiconductor is formed by _____ bonds.

   A. Covalent
   B. Electrovalent
   C. Co-ordinate
   D. None of the above

iv. Differentiate between P-type and N-type semiconductors.

v. Identify the use of semi-conductors in computer.

vi. What are the alternatives for silicon semi-conductor in electronic devices like computers?

vii. Demonstrate the difference between conductor, semi-conductors and insulator using appropriate workshop equipment.

viii. A semiconductor has _____temperature coefficient of resistance.

   A. Positive

B. Zero
C. Negative
D. None of the above

ix. The most commonly used semiconductor is.
A. Germanium
B. Silicon
C. Carbon
D. Sulphur

x. When a pure semiconductor is heated, its resistance.
A. Goes up
B. Goes down
C. Remains the same
D. Can't say

2.3.4.4 Tools, Equipment, Supplies and Materials

Silicon, Germanium, diode, semiconductor materials, pliers, rubber, copper wire, gold wire, glass

2.3.4.5 References

- https://www.encyclopedia.com/science/news-wires-white-papers-and-books/structure-matter
- https://byjus.com/physics/semiconductors-and-insulators/
- https://www.electronics-tutorials.ws/diode/diode_3.html
- https://circuitglobe.com/semiconductors.html
- Semiconductor Devices: Physics and Technology 3rd Edition authored by by Simon M. Sze , Ming-Kwei Lee, published by Wiley; 3 edition 2012
- Circuit Engineering: The Beginner's Guide to Electronic Circuits, Semi-Conductors, Circuit Boards, and Basic Electronics, authored by Solis Tech published by Solis Tech 2016

2.3.5 Learning Outcome 4: Identify and classify memory activities

2.3.5.1 Learning Activities

The following are the performance criteria:

- Types of memories are identified
- Memory hierarchy is identified
- Levels of memory storage are identified
- Classification of memories is done

Trainees to demonstrate knowledge in relation to:

- Definition of memory: Classification of memories RAM, ROM, DAM
- Types of memories: Semiconductor memories, Magnetic memories

2.3.5.2 Information Sheet

In computing, **memory** refers to the computer hardware integrated circuits that store information for immediate use in a computer; it is synonymous with the term "primary storage."

Read: The history of computer (memory and storage):
https://www.computerhistory.org/timeline/memory-storage/

Watch: How to computer memory works? Volatile and non- volatile memory: https://youtu.be/TQCr9RV7twk

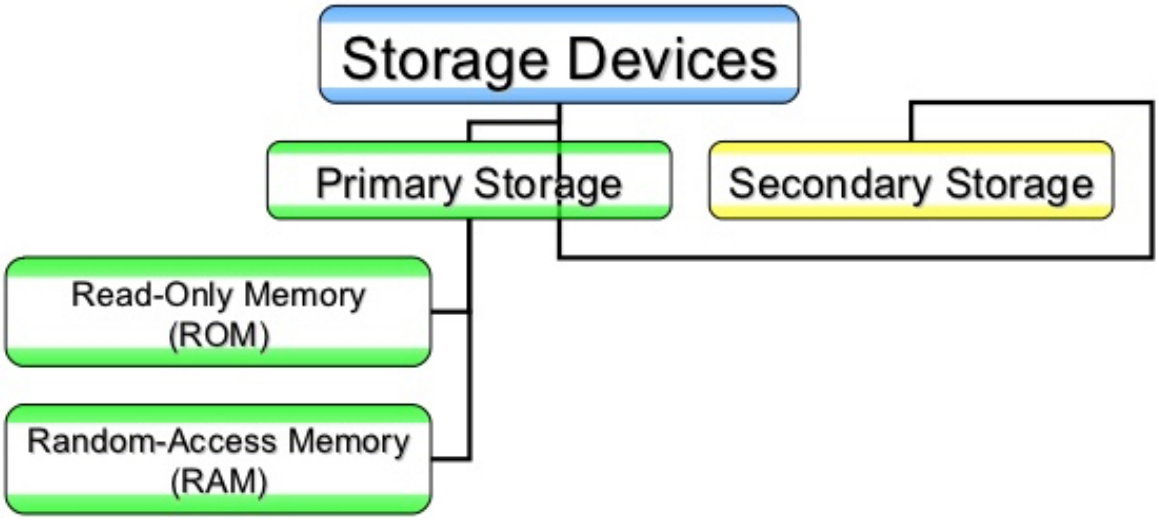
In computer architecture, the memory hierarchy separates computer storage into a hierarchy based on response time. Since response time, complexity, and capacity are related, the levels may also be distinguished by their performance and controlling technologies. Memory hierarchy affects performance in computer architectural design, algorithm predictions, and lower level programming constructs involving locality of reference.

Designing for high performance requires considering the restrictions of the memory hierarchy, i.e. the size and capabilities of each component. Each of the various components can be viewed as part of a hierarchy of memories (m1,m2,...,mn) in which each member mi is typically smaller and faster than the next highest member mi+1 of the hierarchy. To limit waiting by higher levels, a lower level will respond by filling a buffer and then signaling for activating the transfer.

There are four major storage levels.

- Internal – Processor registers and cache.
- Main – the system RAM and controller cards.
- On-line mass storage – Secondary storage.
- Off-line bulk storage – Tertiary and Off-line storage.

Computer memory or storage can be classified in three ways: primary, secondary an offline:



Source: https://www.slideshare.net

Figure 27: Classification of computer memory storage

Primary memory is the computer's main memory, which is directly accessible by the CPU and often much faster than secondary storage. RAM will hold the loaded operating system, plus all running applications and files. Examples of primary memory / storage:

- Random Access Memory (RAM) – solid state
- Read Only Memory (ROM) – solid state

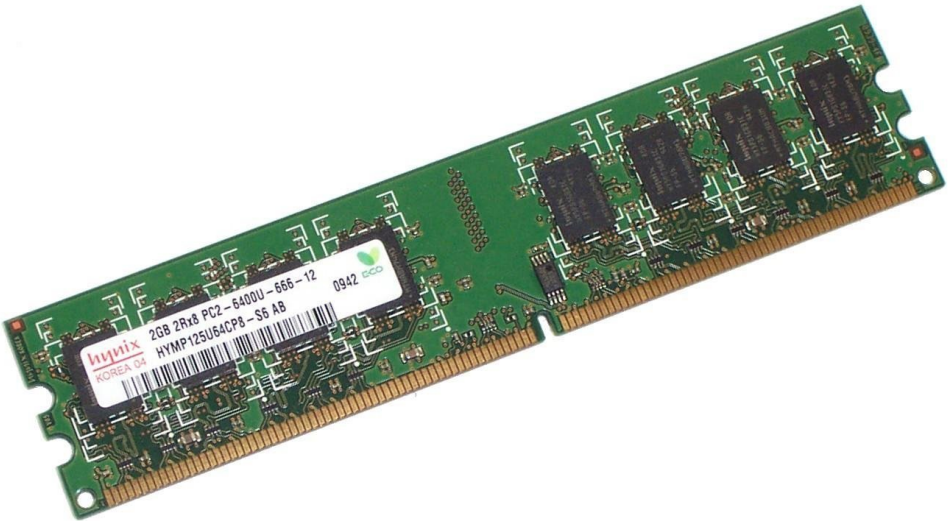
Secondary storage is a non-volatile medium that holds data until it is deleted or overwritten. It is sometimes referred to as external memory and auxiliary storage. Secondary storage is where programs and data are kept on a long-term basis. Examples of secondary memory / storage:

- Hard Disk Drive (HDD) – magnetic storage
- Solid State Drive (SSD) – solid state

Off-line refers to non-volatile storage that can be easily removed from the computer. This is often used to transport data and keep backups for protection. Examples of off-line memory / storage:

- CD, DVD, Blu-ray – optical storage
- USB Flash Drive – solid state
- Removable HDD / SSD

RAM is an acronym for Random Access Memory, a type of computer memory that can be accessed randomly; that is, any byte of memory can be accessed without touching the preceding bytes.



Source: https://www.archmemory.com

Figure 28: Random Access Memory (RAM)

The larger the RAM size of a computer, the faster it runs since it is faster to carry out orders and operations. In reality the RAM never runs out of memory, but it gets slower and slower when too much memory is stored until the computer freezes or restart (restarting your computer means that the data stored in the RAM will disappear).

There are 2 types of RAM, the dynamic RAM (DRAM) and the static RAM (SRAM).

Dynamic RAM: Dynamic RAM chips consist of a number of transistors and capacitors, which have different functions:

- Transistor- this acts like a switch, it allows the chip to control circuitry to read the capacitor or change the capacitor's value.
- Capacitors- this holds the bits of the information.

This type of RAM has to be refreshed continuously every (approximate) 15 microseconds otherwise it will lose its value.

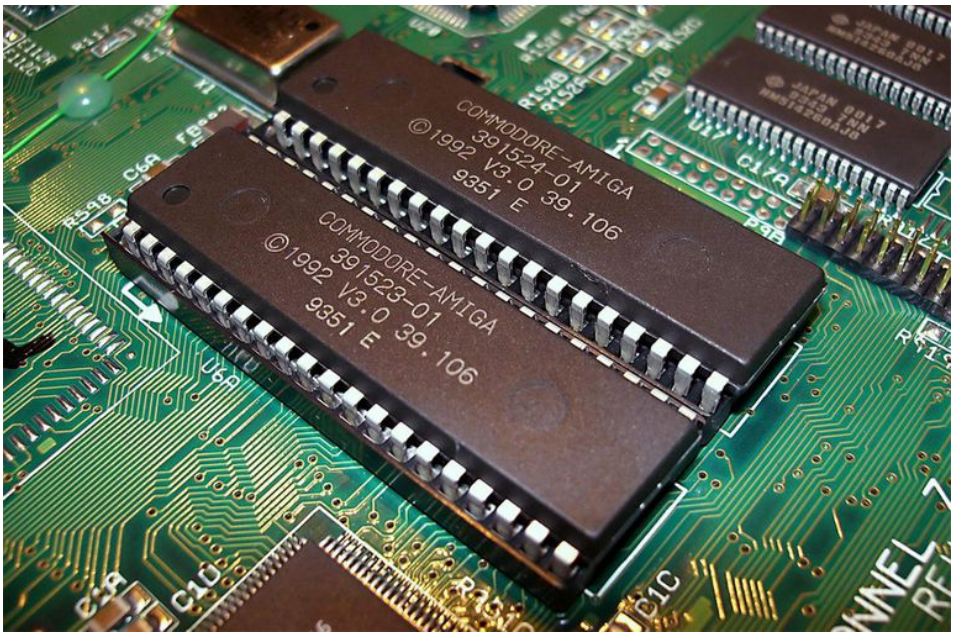
Static RAM: This type of RAM doesn't need to be constantly refreshed. SRAM is faster than DRAM when it comes to data access. Static RAM costs more than DRAM, consumes more power than DRAM, lower storage capacity than DRAM.

Table 5: Difference between SRAM and DRAM

SRAM	DRAM
• SRAM has lower access time, so it is faster compared to DRAM.	• DRAM has higher access time, so it is slower than SRAM.
• SRAM is costlier than DRAM.	• DRAM cost less compared to SRAM.
• SRAM requires constant power supply, which means this type of memory	• DRAM offers reduced power consumption, due to the fact that the

consumes more power.	information is stored in the capacitor.
• Due to complex internal circuitry, less storage capacity is available compared to the same physical size as DRAM memory chip.	• Dues to the small internal circuitry in the one-bit memory cell of DRAM, the storage capacity is available.
• SRAM has low packaging density.	• DRAM has high packaging density.

Short for Read Only Memory, ROM is a storage medium that is used with computers and other electronic devices. As the name indicates, data stored in **ROM may only be read.**



Source: https://tiktokmedias.blogspot.com

Figure 29: Read Only Memory (ROM)

Watch: Understand the difference between RAM and ROM memory: https://youtu.be/CPOcSGgSxiQ

Table 6: Difference between RAM and ROM

RAM	ROM
• Used in the computer's regular operations, after loading the OS.	• Used mostly in a computer's start-up process.
• With RAM, writing data is a fast process.	• Writing data to ROM is very slow.
• RAM is a type of volatile memory, meaning the stored data is lost when powering off.	• ROM is a type of non-volatile memory, meaning that the data will not be lost when power is removed.
• A RAM chip can store quite a lot of data, up to 16 GB.	• ROM chips usually store only a few megabytes of information, around 4 MB per

	chip.
• There are two main types of RAM: dynamic (DRAM) and static (SRAM).	• ROM types include EPROM, EEPROM, PROM and Mask ROM.

Digital Asset Management (DAM) is a business process for organizing, storing and retrieving rich media and managing digital rights and permissions. Rich media assets include photos, music, videos, animations, podcasts and other multimedia content.
Semiconductor memory is a type of semiconductor device tasked with storing data.

Magnetic storage or magnetic recording is the storage of data on a magnetized medium. Magnetic storage uses different patterns of magnetization in a magnetizable material to store data and is a form of non-volatile memory. The information is accessed using one or more read/write heads.

Read: Memory Storage: https://anatcomputerscience.wordpress.com/chapter-6/

2.3.5.3 Self-Assessment

i. Define semiconductor memory.
ii. What is DAM?
iii. Differentiate between ROM and RAM.
iv. Review a RAM and identify its components
v. Review a ROM and identify its components
vi. In your workshop, differentiate between – CD, DVD and a blue – ray memory device for offline storage.
vii. Why is a hard drive and pen drive known as 'secondary storage'?
viii. What does the word 'volatile' mean when used in computing?
ix. All of following are non-volatile memory except
    A. ROM
    B. PROM
    C. Flash memory
    D. RAM
x. Computer memory is measured in terms of:
    A. Bits
    B. Bytes
    C. Cells
    D. Units
xi. Identify the RAM and the ROM component of a CPU.
xii. Review the market on the various sizes of RAM and ROM available for desktop computers. Evaluate their advantages and disadvantages.
xiii. You are an IT Technician, a user's computer turns on but there is no display. How will you fix the issue?
xiv. Storage, which stores or retains data after power off is called-

A. Volatile storage
B. Non-volatile storage
C. Sequential storage
D. Direct storage
E. None of these

xv. Which of the following memories must be refreshed many times per second?
A. EPROM
B. ROM
C. Static RAM
D. Dynamic RAM

2.3.5.4 Tools, Equipment, Supplies and Materials

Semiconductor, RAM, Computer, Memory, screw driver

2.3.5.5 References

- https://searchcontentmanagement.techtarget.com/definition/What-is-digital-asset-management
- Computer Fundamentals, authored by Anita Goel published by Pearson 2010
- Computer System Architecture 3rd Edition, Authored by M. Morris Mano, published Pearson 2007

2.3.6 Learning Outcome 5: Apply Number Systems

2.3.6.1 Learning Activities

The following are the performance criteria:

- Types of number systems are identified
- Base conversion is done as per the standard procedures
- Binary arithmetic operations are done
- Binary codes are identified
- Representation of decimals in BCD is done
- BCD arithmetic is performed

Trainees to demonstrate knowledge in relation to:

- Definition of number system and binary code
- Types of number systems: Decimal, Binary, Octal, Hexadecimal
- Base conversion
- Binary arithmetic: Addition, Subtraction, Multiplication, Division
- Binary codes: 8421 BCD, Excess-3
- Represent decimal numbers in BCD
- BCD arithmetic: Addition, Subtraction, Multiplication, Division

2.3.6.2 Information Sheet

Number systems are the technique to represent numbers in the computer system architecture;

every value that you are saving or getting into/from computer memory has a defined number system. Computer architecture supports following number systems: The types are:
1. Decimal System
2. Binary System
3. The Octal System
4. The Hexadecimal System.

In **decimal system** the base (or radix) is 10, since any position can contain one of ten digits. The system therefore has a carrying factor of 10 and each digit indicates a value, which depends on the position it occupies, for example;

In 6421 the digit 6 signifies 6 x 1000
In 4621 the digit 6 signifies 6 x 100
In 4261 the digit 6 signifies 6 x 10 and in 4216 the digit 6 signifies 6

The decimal system uses ten digits to record the number. The ten digits are 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 and any number (used) is based upon power of 10.

For example 5281 is made up of:
$(5 \times 10^3) + (2 \times 10^2) + (8 \times 10^1) + (1 \times 10^0)$
$= 5000 + 200 + 80 + 1 = 5281.$

Whereas decimal system uses ten digits to record the number, the binary system uses only two digits (for recording the number) that is 0 and 1, and its base is 2 (whereas that of decimal system is 10). Although in everyday life, people generally use the decimal number system for counting, it is more convenient to use the binary number system in a computer because electronic components are usually in one of two states, which can be used to represent 0 and 1, the two digits used in the binary system.

The computer does not have a large number of symbols for representing data. It has only **two, 0 and 1 (called binary digits or bits).** These correspond to the two electronic or magnetic states used in computer circuits and storage.

For example if a punched paper tape is used in the computer, a hole in a tape may allow electrical contact to be made (ON) and the absence of a hole in the tape does not allow electrical contact to be made (OFF). Therefore a hole can represent 1 and no hole can represent 0. Binary system is more compact than the decimal system of coding as the latter will need large size of the storage medium and relative complexity of the reading device.

Given below is the table of construction of Binary numbers:

Table 7: Binary numbers

Binary Numbers				Equivalent Decimal Number	Explanation
2^3	2^2	2^1	2^0		
			1	1	$2^0 = 1$
		1	0	2	$2^1 + 0 = 2$
		1	1	3	$2^1 + 2^0 = 3$
	1	0	0	4	$2^2 + 0 + 0 = 4$
	1	0	1	5	$2^2 + 0 + 2^2 = 5$
	1	1	0	6	$2^2 + 2^1 + 0 = 6$
	1	1	1	7	$2^2 + 2^1 + 2^0 = 7$
1	0	0	0	8	$2^3 + 0 + 0 + 0 = 8$
1	0	0	1	9	$2^3 + 0 + 0 + 2^2 = 9$

Source: http://www.businessmanagementideas.com

Convert 10110111 to decimals

1	0	1	1	0	1	1	1		
128	64	32	16	8	4	2	1		
								1*1 =	1
								1*2 =	2
								1*4 =	4
								0*8 =	0
								1*16 =	16
								1*32 =	32
								0*64 =	0
								1*128 =	128
								Add	183
10110111 = 183 decimal									

Source: https://owlcation.com

Let the decimal number be 217.

(a) To find the binary equivalent proceed as follows:

		Remainder
2	217	
2	108	1
2	54	0
2	27	0
2	13	1
2	6	1
2	3	0
2	1	1
	0	1

Source: http://www.businessmanagementideas.com

Start binary number with last digit. Therefore the binary equivalent of 217 is 11011001.

(b) Convert .8125 into binary number.

1	.8125
	X2
1	.6250
	X2
0	.2500
	X2
1	.5000
	X2
	.0000

Decimal .8125 = .1101 in binary

Source: http://www.businessmanagementideas.com

Convert decimal number 217.8125 into binary number

From (a) and (b) above =

Decimal number	Binary Number
$(217.8125)_{10}$	$(11011001.1101)_2$

The octal system (base 8) and hexadecimal system (base 16) are of importance because they can be used as shorthand for binary numbers. This is because three binary digits can be represented by the numbers 0 to 7 i.e., the octal range, while four binary digits can be represented by the numbers 0 to 9 and A to F.

Octal	761			365			6437101						
Binary	111	110	001	011	110	101	110	100	011	111	001	000	001

To illustrate:

Binary number 111 = $2^2 + 2^1 + 2^0$ = 4+2+1 = 7

Binary number 110 = $2^2 + 2^1 + 0$ = 4+2+0 = 6 and so on.

That is,

111	110	001

Binary cab be represented by only 761 in the octal system, therefore, octal system can be used as shorthand for binary numbers.

Source: http://www.businessmanagementideas.com

Table 8: Octal binary conversion table

Octal	Binary
0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

Source: http://www.businessmanagementideas.com

Read: On octal conversion: http://www.businessmanagementideas.com

The hexadecimal system has a base 16 and the digits 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and letters A, B, C, D, E, F are used. The letters A, B, C, D, E and F represent the decimal numbers 10, 11, 12, 13, 14 and 15 respectively.

When hexadecimal is used to represent a binary number, the individual hexadecimal digits represent successive groups of four binary digits starting at the point. This is similar to the conversion from binary to octal, in which each set of three bits is translated to an octal digit.

Table 9: Binary conversion table

Decimal	Hexadecimal	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

Source: http://www.businessmanagementideas.com

Read: Types of number systems: http://www.businessmanagementideas.com/information-technology/computers/4-main-types-of-number-system-computer/10285
Watch: Base conversion: https://youtu.be/Fpm-E5v6ddc
Read: Base conversion: https://www.tutorialspoint.com/computer_logical_organization/number_system_conversion.htm

Binary arithmetic operation starts from the least significant bit.

Watch: Binary Arithmetic: https://youtu.be/-1gffkPjwXg

A binary code represents text, computer processor instructions, or any other data using a two-symbol system. The two-symbol system used is "0" and "1" from the binary number system.

8421 code: A weighted code in which each decimal digit 0 through 9 is represented by a four-bit codeword. The bit positions in each codeword are assigned weights, from left to right, of 8, 4, 2, and 1.

Excess-3 code: An 8421 code for which the weighted sum of the four bits in each codeword is three greater than the decimal digit represented by that codeword. For example, 9 is represented by 1100, the weighted sum of which is $8\times1 + 4\times1 + 2\times0 + 1\times0 = 12$

To represent the sign of a number in **binary-coded decimal (BCD)**, the number 0000 is used to represent a positive number, and 1001 is used to represent a negative number. The remaining 14 combinations are invalid signs.

In computing and electronic systems, **binary-coded decimal (BCD)** is a class of binary encodings of decimal numbers where each decimal digit is represented by a fixed number of bits, usually four or eight. Special bit patterns are sometimes used for a sign or for other indications.

Watch: BCD arithmetic: https://youtu.be/yPu57aSj9kA

2.3.6.3 Self-Assessment

i. What is BCD? Explain.
ii. What is the difference between binary and BCD?
iii. Why is BCD called 8421 code?
iv. What is binary code?
v. Convert the binary number 1011010 to hexadecimal.
   A. 5C
   B. 5A
   C. 5F
   D. 5B

vi. What is the result when a decimal 5238 is converted to base 16?

A. 1388
B. 1476
C. 327.375
D. 12166

vii. An Excess-3 code to BCD (Binary-coded decimal) code converter is a device which converts an exceess-3 code input, represented by a, b, c and d

A. Follow the same rule and create a truth table for "excess-3" code to BCD

B. Derive each input a, b, c, and d as a function of the inputs w, x, y and z (see following truth table)

C. Model the converter circuit at gate level in structural style.

w	x	y	z	a	b	c	d
0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	1
0	1	0	1	0	0	1	0
0	1	1	0	0	0	1	1
0	1	1	1	0	1	0	0
1	0	0	0	0	1	0	1
1	0	0	1	0	1	1	0
1	0	1	0	0	1	1	1
1	0	1	1	1	0	0	0
1	1	0	0	1	0	0	1

viii. The binary equivalent of the decimal number 10 is _____

A. 0010
B. 10
C. 1010
D. 010

ix. A computer language that is written in binary codes only is _____

A. Machine language
B. C
C. C#
D. Pascal

1.3.6.4 Tools, Equipment, Supplies and Materials

Computer, LCR meter

2.3.6.5 References

- https://www.encyclopedia.com/computing/dictionaries-thesauruses-pictures-and-press-releases/excess-3-code
- Electronics, Principles and Applications, authored by Charles A Schuler, published by McGraw-Hill/Glencoe

- Computer System Architecture 3rd Edition, Authored by M. Morris Mano, published Pearson

2.3.7 Learning Outcome 6: Emerging trends in electronics

2.3.7.1 Learning Activities

The following are the performance criteria:

- Description of emerging trends is done
- Challenges of emerging trends are explained
- Explanation on coping with the emerging trends is done

Trainees to demonstrate knowledge in relation to:

- Description of emerging trends
- Explanation of challenges of emerging trends
- Coping with the emerging trends

2.3.7.2 Information Sheet

The era of electronics began with the invention of the transistor in 1947 and silicon-based semiconductor technology. Seven decades later, we are surrounded by electronic devices and, much as we try to deny it, we rely on them in our everyday lives.

The performance of silicon-based devices has improved rapidly in the past few decades, mostly due to novel processing and patterning technologies, while nanotechnology has allowed for miniaturization and cost reduction.

For many years silicon remained the only option in electronics. But recent developments in materials-engineering and nanotechnology have introduced new pathways for electronics. While traditional silicon electronics will remain the main focus, alternative trends are emerging. These include:

2-D electronics: Interest in the field started with the discovery of graphene, a structural variant of carbon. Carbon atoms in graphene form a hexagonal two-dimensional lattice, and this atom-thick layer has attracted attention due to its high electrical and thermal conductivity, mechanical flexibility and very high tensile strength. Graphene is the strongest material ever tested.

In 2010, the Royal Swedish Academy of Sciences decided to award the Nobel Prize in Physics to Andre Geim and Konstantin Novoselov for their “groundbreaking experiments” in graphene research.

Graphnene may have started this 2D revolution in electronics, but silicene, phosphorene and stanene, atom-thick allotropes of silicon, phosphorus and tin, respectively, have a similar honeycomb structure with different properties, resulting in different applications.

All four have the potential to change electronics as we know it, allowing for miniaturization, higher performance and cost reduction. Several companies around the globe, including Samsung and Apple, are developing applications based on grapheme.
Organic electronics: The development of conducting polymers and their applications resulted in another Nobel prize in 2000, this time in chemistry. Alan J. Heeger, Alan G. MacDiarmid and Hideki Shirakawa proved that plastic can conduct electricity.

Unlike conventional inorganic conductors and semiconductors, organic electronic materials are constructed from organic (carbon-based) molecules or polymers using chemical synthesis. Organic electronics is not limited to conducting polymers, but includes other organic materials that might be of use in electronics. These include a variety of dyes, organic charge-transfer complexes, and many other organic molecules.

In terms of performance and industrial development, organic molecules and polymers cannot yet compete with their inorganic counterparts. However, organic electronics have some advantages over conventional electronic materials. Low material and production costs, mechanical flexibility, adaptability of synthesis processes and biocompatibility make organic electronics a desirable choice for certain applications.

Commercially available high-tech products relying on organic semiconductors, such as curved television screens, displays for smartphones, coloured light sources and portable solar cells, demonstrate the industrial maturity of organic electronics. In fact, several high-tech companies, including LG Electronics and Samsung, have invested in cheap and high-performance organic-electronic devices. It is expected that the organic electronics market will grow rapidly in the coming years.

Memristors: In 1971 Leon Chua reasoned from symmetry arguments that there should be a fourth fundamental electronic circuit-board element (in addition to the resistor, capacitor and inductor), which he called memristor, a portmanteau of the words memory and resistor. Although Chua showed that memristors have many interesting and valuable properties, it wasn't until 2007 that a group of researchers from Hewlett Packard Labs found that the memristance effect can be present in nanoscale systems under certain conditions. Many researchers believe that memristors could end electronics as we know it and begin a new era of "ionics".

While commonly available transistor functions use a flow of electrons, the memristor couples the electrons with ions, or electrically charged atoms. In transistors, once the flow of electrons is interrupted (for example by switching off the power) all information is lost. Memristors "memorize" and store information about the amount of charge that has flowed through them, even when the power is off.

The discovery of memristors paves the way to better information storage, making novel memory devices faster, safer and more efficient. There will be no information loss, even if

the power is off. Memristor-based circuits will allow us to switch computers on and off instantly, and start work straight away.

For the past several years, Hewlett Packard has been working on a new type of computer based on memristor technology. HP plans to launch the product by 2020.

Spintronics: Spintronics, a portmanteau word meaning "spin transport electronics", is the use of a fundamental property of particles known as "electron spin" for information processing. Electron spin can be detected as a magnetic field with one of two orientations: up and down. This provides an additional two binary states to the conventional low and high logic values, which are represented by simple currents. Carrying information in both the charge and spin of an electron potentially offers devices with a greater diversity of functionality.

So far, spintronic technology has been tested in information-storage devices, such as hard drives and spin-based transistors. Spintronics technology also shows promise for digital electronics in general. The ability to manipulate four, rather than only two, defined logic states may result in greater information-processing power, higher data transfer speed, and higher information-storage capacity.

It is expected that spin transport electronic devices will be smaller, more versatile and more robust compared with their silicon counterparts. So far this technology is in the early development stage and, irrespective of intense research, we have to wait a couple of years to see the first commercial spin-based electronic chip.

Molecular electronics: The ultimate goal of electrical circuits is miniaturization. Also known as single molecule electronics, this is a branch of nanotechnology that uses single molecules or collections of single molecules as electronic building blocks.

Molecular electronics and the organic electronics described above have a lot in common, and these two fields overlap each other in some aspects. To clarify, organic electronics refers to bulk applications, while molecular-scale electronics refers to nano-scale, single-molecule applications.

Conventional electronics are traditionally made from bulk materials. However, the trend of miniaturization in electronics has forced the feature sizes of the electronic components to shrink accordingly. In single-molecule electronics, the bulk material is replaced by single molecules. The smaller size of the electronic components decreases power consumption while increasing the sensitivity (and sometimes performance) of the device. Another advantage of some molecular systems is their tendency to self-assemble into functional blocks. Self-assembly is a phenomenon in which the components of a system come together spontaneously, due to an interaction or environmental factors, to form a larger functional unit.

Several molecular electronic solutions have been developed, including molecular wires, single-molecule transistors and rectifiers. However, molecular electronics is still in the early research phase, and none of these devices has left the laboratory.

The world is quickly and constantly transforming as new technologies continue to enter the market. This rapid pace of change is perhaps felt most heavily in the electronics industry which brings in the biggest and newest innovations every year. Following, we'll look at the five foremost challenges electronic companies must look forward to:

Brief Product Life Cycles: Technology isn't evolving for its own sake. It's responding to the wants and needs of consumers hungry for products that perfectly suit their day-to-day lives. Thus, companies in Electronics Manufacturing Services and contract manufacturers are required to have quality processes in place for new product introduction. To make sure product launches hit set goals on quality, volume and release, it's important to use closed-loop communication concepts between engineering, sales and manufacturing.

Intricate International Supply-Chain: It is obvious now that we live in a global economy. Those who are positioned best to deal with the complexities of international sales are those best positioned to succeed in the long run. Now, it is common for components to skate across multiple continents—sometimes more than three—before arriving at their end point. Companies must be prepared to deal with varying international standards along with the twin issues of compliance and traceability that are prone to raise operational problems.

Demand: The worst of the global economic crisis is fortunately in the rear view mirror, so it is expected that the demand for electronics should continue to rise. While cyclical fluctuations and economic dips are responsible for large shifts in demand, on a smaller level technology is highly susceptible to changing local conditions because tech is now so heavily tied to consumer demand. Consumer demand is an uncertain thing, determined by the vagueness of perceived value and swiftly fleeting tastes. For that reason, production capabilities must remain lean and able to shift quickly with uncertain demand.

Environmental Issues: This is no longer a world where companies' margins are freely raised above the concerns of the environment. New standards and regulations are pushing electronic manufacturers to consider their 'social responsibility' when making decisions both small and large. A manufacturing consultant says some Electrical Engineering Master's programs are now including sustainable engineering strategies in their curriculum to accommodate the growing trend of environmental awareness. The entire life cycle of a product must be considered; from manufacturing, with the use of harmful chemicals and human exposure; to consumer use, with the consumption of energy; to the end of its life, with waste disposal and complex disassembly.

Tighter Margins: Consumers have benefited from a global marketplace that has emphasized competition to bring in the latest and greatest innovations and lower prices. On the supply side, however, this has to lead to shrinking margins. Gains in efficiency and organization

have slowed and there is not enough differentiation between products to stave off this growing trend of commoditization. Electronic manufacturers must deal with this downward pressure on operating margins as lights continue to turn on across the world.

2.3.7.3 Self-Assessment

i. Describe emerging trends in the electronics from a consumer perspective.

ii. Discuss the challenges of implementing emerging trends in Kenya digital space.

iii. Keeping in mind the changing dynamics in the electronic sector, what are the changes you envisage in computer hardware? Prepare a report, basis research on the latest trend of using electronic components in computer desktops

iv. Select latest Internet generation technology
   A. Edge
   B. 3G
   C. 5G
   D. 4G LTE
   E. 3.75G

v. IIoT stands for _____
   A. Industrial Internet of Things
   B. Internet Internet of Things
   C. Intelligence Internet of Things
   D. Internal Internet of Things

vi. Which possibility automatically communicates with other vehicles?
   A. Transportation and logistics
   B. Energy and utilities
   C. Automotive
   D. Connected supply chain

vii. Which possibility is the highest contributor to cost overhead for manufacturing facilities?
   A. Transportation and logistics
   B. Energy and utilities
   C. Plant control flow operation
   D. Energy management and resource optimization

2.3.7.4 Tools, Equipment, Supplies and Materials

Computer, Internet

2.3.7.5 References

- http://www.ece.utexas.edu/events/emerging-trends-electronic-packaging-and-challenges-modeling
- https://www.weforum.org/agenda/2015/08/5-next-trends-in-electronics/
- Emerging Trends in Electrical, Electronic and Communications Engineering by hardback published by Springer International Publishing AG, 2017

CORE UNITS OF COMPETENCY

CHAPTER3: NETWORKING

3.1 Introduction

This unit specifies the competencies required to perform computer networking. It involves identification of network types and Components, Connection of networking devices, configuration of network devices, network testing, configuration of network types, perform network security, monitor network connectivity and maintain network.

3.2 Performance Standard

- Identified network components during the site survey such as network typology, network components - router, switches, hubs etc.
- Tested the strength and connectivity of cables and equipment
- Identified network types as per the network design
- Installed and configured network software according to user manuals
- Implement the network security policy
- Identified and implemented network security measures
- Identified and deployed monitoring tools

3.3 Learning Outcome

3.3.1 List of the Learning Outcomes

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

- Identify network type and components
- Connection network devices
- Configuration of network devices
- Network testing
- Configuration of Network types
- Perform Network security
- Monitor Network connectivity and performance
- Maintain Network

3.3.2 Learning Outcome 1: Identify network type and components

3.3.2.1 Learning Activities

The following are the performance criteria:

- Site survey is conducted to determine the user needs and establish network topology
- Network components are identified according to the site survey
- Network design is developed according to the site survey

Trainees to demonstrate knowledge in relation to:

- Definition of Network
- Definition of network terms

- Network topologies: Star, Ring, Mesh, Hybrid, Point-to-Point
- Network types: WAN, LAN, PAN, MAN
- Components of a network: Switches/Hubs, Routers, Ports, Media, Computers
- Categories of computer network: Peer, Client Server

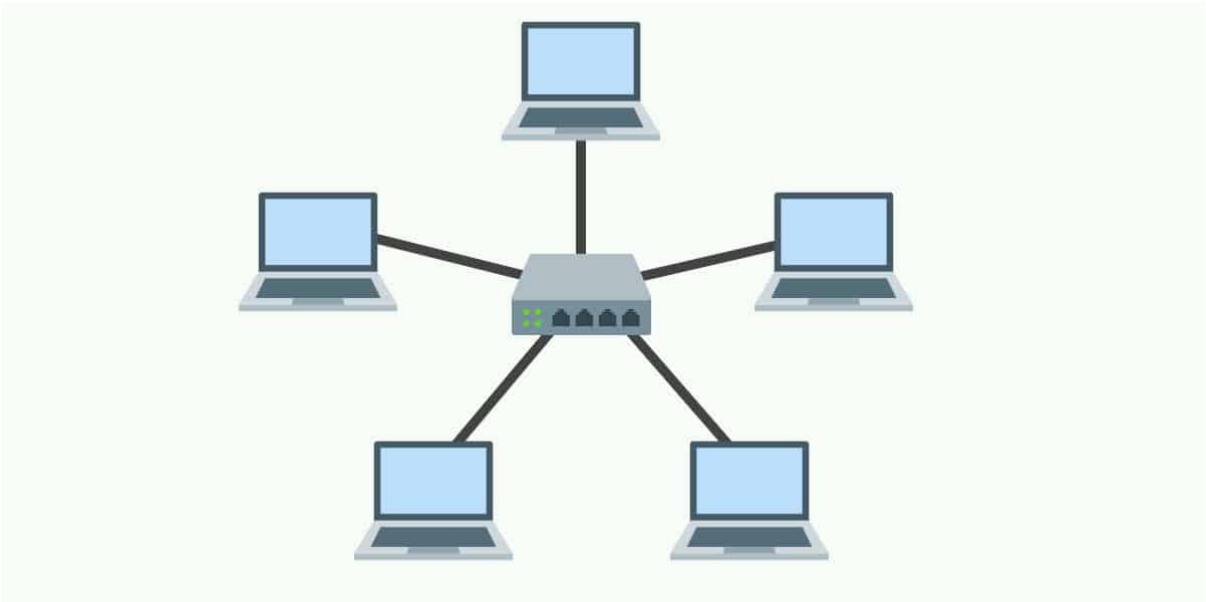
3.3.2.2 Information Sheet

A **computer network** is a set of computers connected together for the purpose of sharing resources. The most common resource shared today is connection to the Internet. Other shared resources can include a printer or a file server.

Watch: Introduction to different types of networks: https://youtu.be/svkGASq8mNM

Network topology is the arrangement of the elements (links, nodes, etc.) of a communication network. A wide variety of physical topologies have been used in LANs, including ring, bus, mesh and star. Conversely, mapping the data flow between the components (nodes) determines the logical topology of the network. Following are some of the topologies:

A **star topology** is a topology for a **Local Area Network (LAN)** in which all nodes are individually connected to a central connection point, like a hub or a switch. A star takes more cable than e.g. a bus, but the benefit is that if a cable fails, only one node will be brought down.

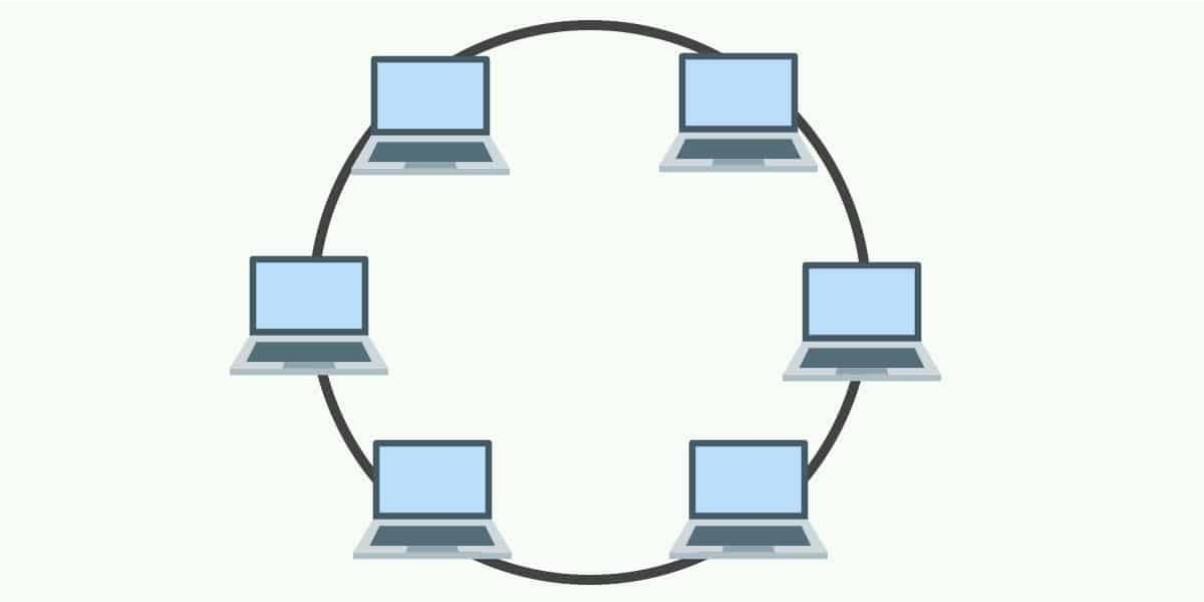


Source: https://www.comparitech.com/net-admin/network-topologies-advantages-disadvantages/

Figure 30: Star typology

Watch: Introduction to star topology: https://youtu.be/6ogqMji-_NA

A **ring network** is a network topology in which each node connects to exactly two other nodes, forming a single continuous pathway for signals through each node - a ring. Data travels from node to node, with each node along the way handling every packet of information between the components.

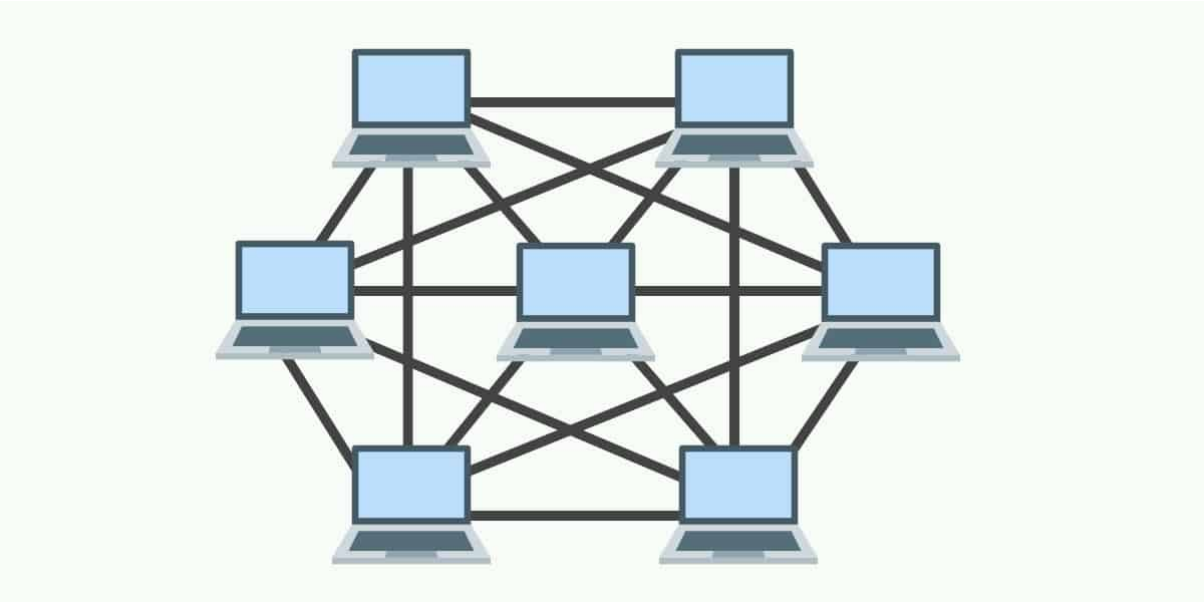


Source: https://www.comparitech.com/net-admin/network-topologies-advantages-disadvantages/

Figure 31: Ring typology

Watch: Introduction to ring network: https://youtu.be/ZEhN8b50X64

Mesh topology is a type of networking where all nodes cooperate to distribute data amongst each other.

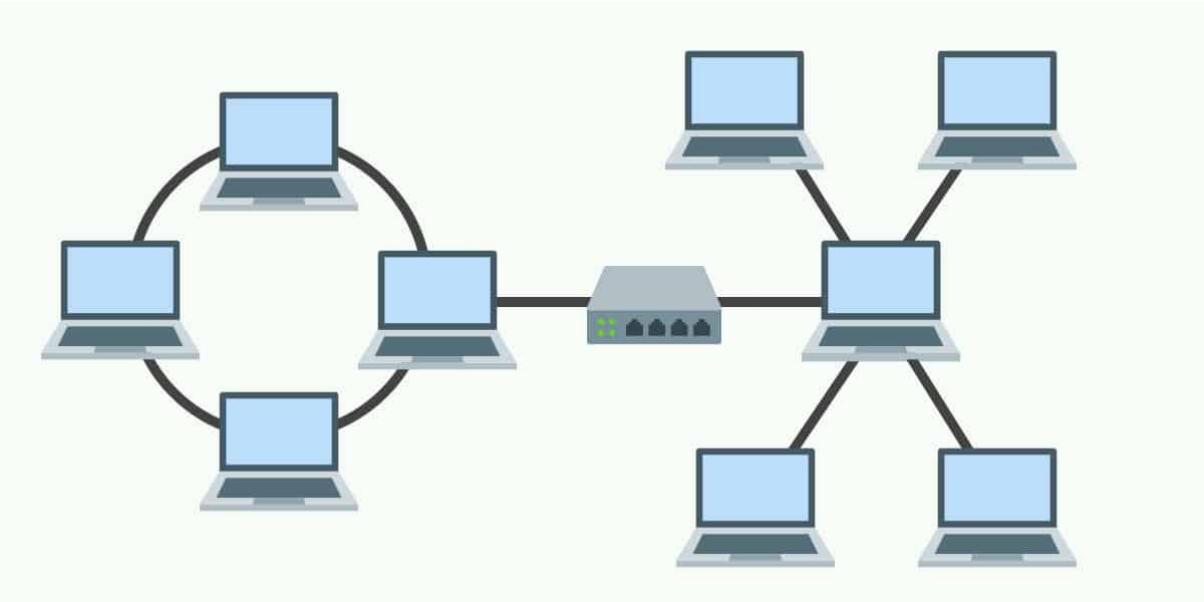


Source: https://www.comparitech.com/net-admin/network-topologies-advantages-disadvantages/

Figure 32: Mesh typology

Watch: Introduction to mesh topology: https://youtu.be/tYLU755T6_I

A **hybrid topology** is a type of network topology that uses two or more differing network topologies. These topologies include a mix of bus topology; mesh topology, ring topology, star topology, and tree topology.

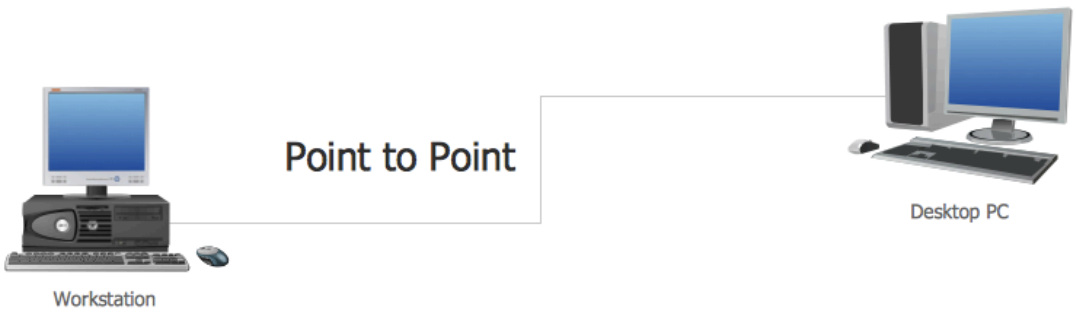


Source: https://www.comparitech.com/net-admin/network-topologies-advantages-disadvantages/

Figure 33: Hybrid typology

Watch: Introduction to hybrid topology and benefits:
https://youtu.be/ZAPvScCty8c
https://youtu.be/5XtGfcqrZXE

Point-to-Point Topology Point-to-point (PTP) topology connects two nodes directly together.



Source: https://www.conceptdraw.com/How-To-Guide/point-to-point-network-topology

Figure 34: Point-to-point typology

Watch: Introduction to point-to-point typology or PTP or P2P: https://youtu.be/_ZnZlaIe0uI

A computer network can be categorized by their size. A **computer network** is mainly of **four types**:

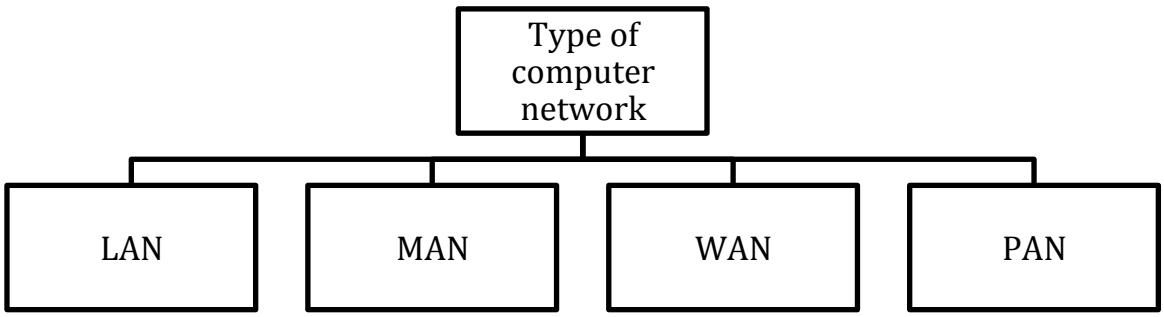


Figure 35: Classification of network types

- LAN (Local Area Network)
- PAN (Personal Area Network)
- MAN (Metropolitan Area Network)
- WAN (Wide Area Network)

Local Area Network (LAN) is a group of computers connected to each other in a small area such as building, office. LAN is used for connecting two or more personal computers through a communication medium such as twisted pair, coaxial cable, etc. It is less costly as it is built with inexpensive hardware such as hubs, network adapters, and ethernet cables. The data is transferred at an extremely faster rate in Local Area Network. Local Area Network provides higher security.

Source: https://www.javatpoint.com

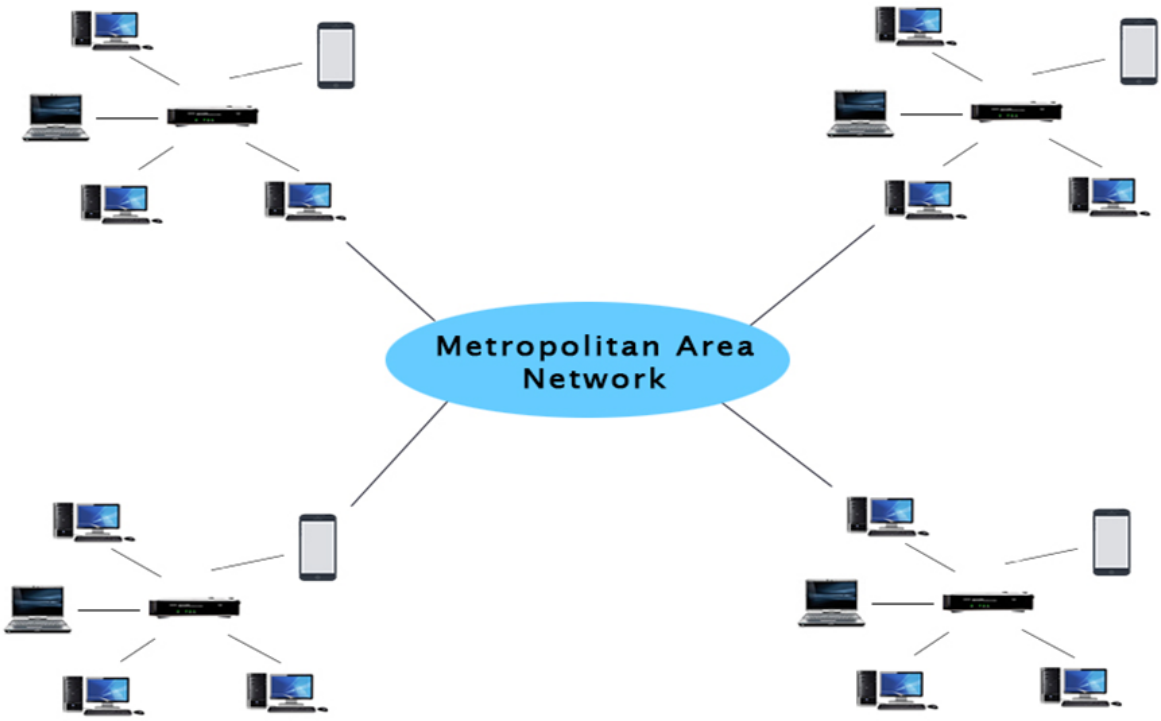
Figure 36: LAN

Personal Area Network (PAN) is a network arranged within an individual person, typically within a range of 10 meters. Personal Area Network is used for connecting the computer devices of personal use are known as Personal Area Network. **Thomas Zimmerman** was the first research scientist to bring the idea of the Personal Area Network. Personal Area Network covers an area of **30 feet**. Personal computer devices that are used to develop the personal area network are the laptop, mobile phones, and media player and play stations.

Source: https://www.javatpoint.com

Figure 37: PAN

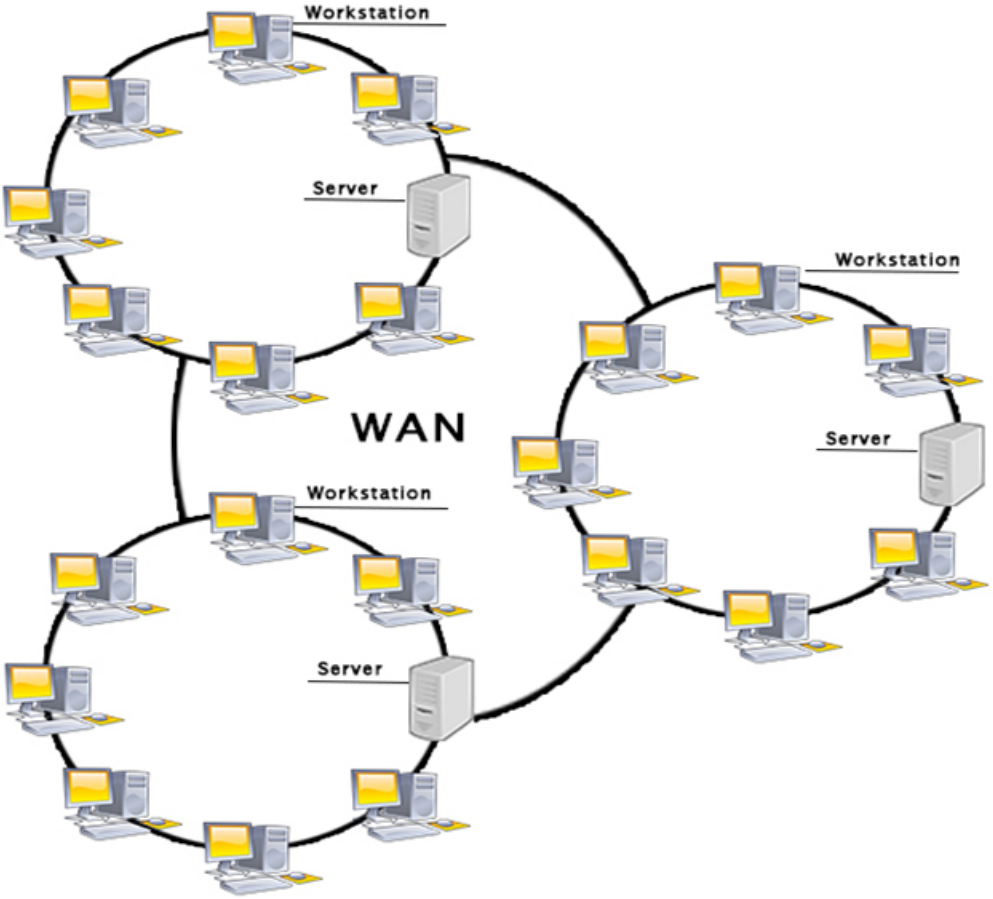
Metropolitan Area Network (MAN) is a network that covers a larger geographic area by interconnecting a different LAN to form a larger network. Government agencies use MAN to connect to the citizens and private industries. In MAN, various LANs are connected to each other through a telephone exchange line the most widely used protocols in MAN are RS-232, Frame Relay, ATM, ISDN, OC-3, ADSL, etc. It has a higher range than Local Area Network (LAN).



Source: https://www.javatpoint.com

Figure 38: MAN

Wide Area Network (WAN) is a network that extends over a large geographical area such as states or countries. A Wide Area Network is quite bigger network than the LAN. A Wide Area Network is not limited to a single location, but it spans over a large geographical area through a telephone line, fibre optic cable or satellite links. The Internet is one of the biggest WAN in the world. A Wide Area Network is widely used in the field of Business, government, and education.



Source: https://www.javatpoint.com

Figure 39: WAN

Read: On different types of networks apart from WAN, PAN, LAN, MAN
https://www.belden.com/blog/smart-building/11-types-of-networks-explained-vpn-lan-more

Computer network components include the major parts that are needed to install a network both at the office and home level. Before delving into the installation process, you should be familiar with each part so that you could choose and buy the right component that fits with your network system.

Network media is the actual path over which an electrical signal travels as it moves from one component to another. A **computer network** is a digital telecommunications network which allows nodes to share resources. In computer networks, computing devices exchange data with each other using connections (data links) between nodes. These data links are

established over cable media such as wires or optic cables, or wireless media such as Wi-Fi.

Switch is a telecommunication device grouped as one of computer network components. Switch is like a Hub but built in with advanced features. It uses physical device addresses in each incoming messages so that it can deliver the message to the right destination or port.

Source: https://www.lambda-tek.com

Figure 40: Switch

Hub is a device that splits a network connection into multiple computers. It is like a distribution center. When a computer request information from a network or a specific computer, it sends the request to the hub through a cable. The hub will receive the request and transmit it to the entire network. Each computer in the network should then figure out whether the broadcast data is for them or not.

Source: http://www.certiology.com

Figure 41: Hub

When we talk about computer network components, the other device that used to connect a LAN with an Internet connection is called **Router.** When you have two distinct networks (LANs) or want to share a single Internet connection to multiple computers, we use a Router.

Source: https://www.lifewire.com

Figure 42: Router

A **network port** is a number that identifies one side of a connection between two computers. Computers use **port** numbers to determine to which process or application a message should be delivered. As **network** addresses are like street address, **port** numbers are like suite or room numbers.

Source: https://basri.my

Figure 43: Port

Network media is the actual path over which an electrical signal travels as it moves from one component to another. Types of **network media**,

- Twisted-pair cable
- Coaxial cable
- Fiber-optic cable
- Wireless.

Read: Basics of network media: https://www.vskills.in/certification/tutorial/basic-network-

support/network-media/

A **computer network** is a set of computers connected together for the purpose of sharing resources. The most common resource shared today is connection to the Internet. Other shared resources can include a printer or a file server. The Internet itself can be considered a computer network.

Watch: Introduction to computer network: https://study.com/academy/lesson/what-is-a-computer-network-types-definition-quiz.html

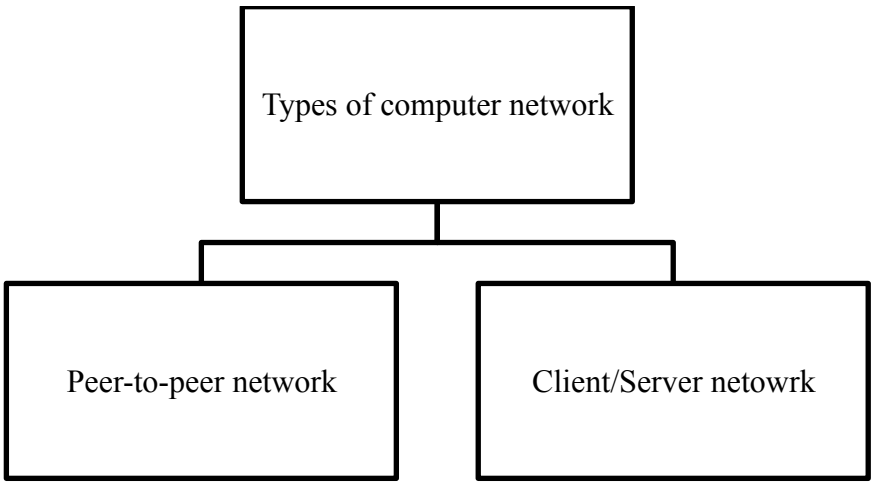
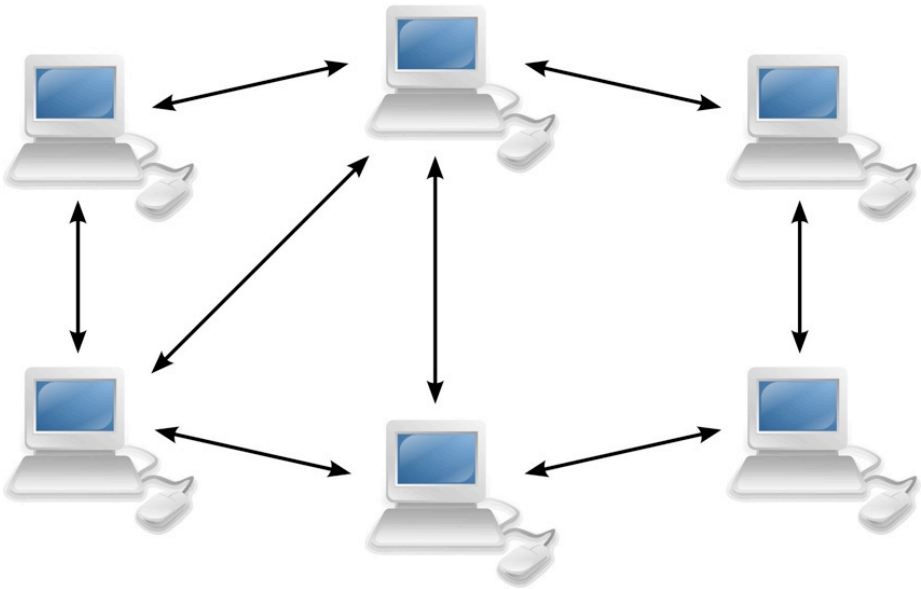


Figure 44: Types of computer network

Peer-to-Peer network is also called Workgroup. In Workgroup there is no dedicated server. All Computers are equal, Every Computers Works Both as a Client and a Server.



Source: http://www.cyberagentsinc.com

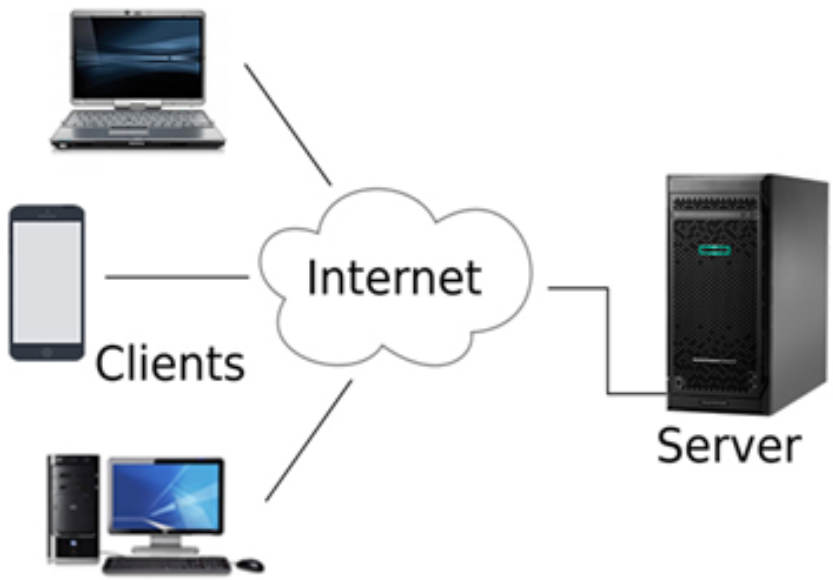
Figure 45: Peer-to-peer network

Read: Introduction to peer-to-peer network:
https://www.onlinelms.org/mod/book/view.php?id=43&chapterid=452

Watch: Introduction to peer-to-peer network: https://youtu.be/wyVEqnDKIC0

Watch: How to Test Network using different tool: https://youtu.be/7zWswXer8i4

Client/Server network is a network model designed for the end users called clients, to access the resources such as songs, video, etc. from a central computer known as Server the central controller is known as a server while all other computers in the network are called clients a server performs all the major operations such as security and network management a server is responsible for managing all the resources such as files, directories, printer, etc. All the clients communicate with each other through a server. For example, if client1 wants to send some data to client 2, then it first sends the request to the server for the permission. The server sends the response to the client 1 to initiate its communication with the client 2.



Source: https://www.javatpoint.com
Figure 46: Client or server network

Read: Computer network architecture: https://www.javatpoint.com/computer-network-architecture

3.3.2.3 Self-Assessment

i. What is client/server network?
ii. Define HUB, SWITCH, ROUTER
iii. What is a LAN?
iv. What is the benefit of the Networking?
   A. File Sharing

B. Easier access to Resources
C. Easier Backups
D. All of the Above

v. Each LAN type has its own strategy in sending of
   A. Bits
   B. Bytes
   C. Data
   D. Frames

vi. Describe star topology. What is the disadvantage of a star topology?

vii. What is Hybrid network?

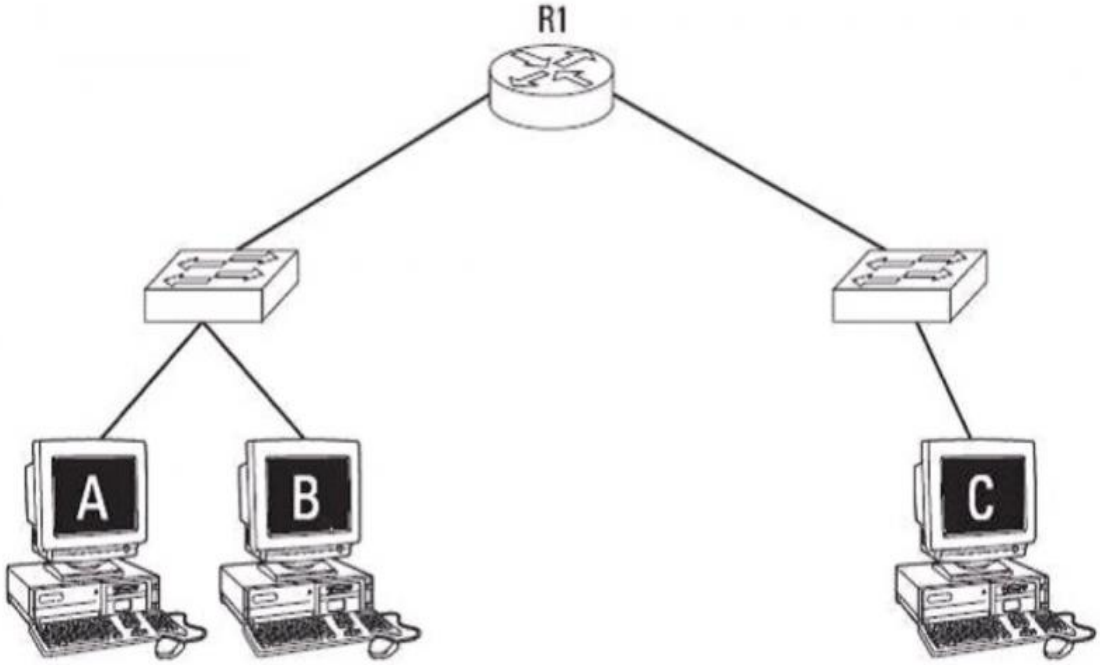
viii. What type of network is used for communicating data across states, countries, or the whole world?

ix. What is peer-to-peer network?

x. Name the different types of network topologies and brief its advantages.

xi. Prepare ring topology in packet tracer.

xii. How many broadcast domains and collision domains are there in the diagram below?



Source: https://www.networkbulls.com

A. 1 broadcast domain and 5 collision domains
B. 2 broadcast domain and 5 collision domains
C. 1 broadcast domain and 5 collision domains
D. 2 broadcast domain and 5 collision domains

xiii. You connect a laptop to an available port on a Cisco Catalyst switch. By default, how long does it take that port to start forwarding traffic?
   A. 0 seconds
   B. 15 seconds
   C. 30 seconds
   D. 50 seconds

xiv. One of your clients is a Cyber Café owner. He has 10 laptops in a single room. He wants the laptops to be connected with each other and the printer. What will be your recommendation? What are the resources you will need?

xv. What steps do you take when troubleshooting a networking issue?

xvi. What are the first things you check when a user is experiencing problems accessing the network?

xvii. A new switch is bought. What must the network technician do to install the new switch and make it work as a replacement for the failed device? Is this easy or hard to do? Why is it easy or hard?

3.3.2.4 Tools, Equipment, Supplies and Materials

Patch Panels, Network Connectors, Network Testers, A punch down tool, Wiring Systems., Fiber Optic., Network Switches, URL Encode, RJ45, Switches, Computer, Gateway, bridges, antistatic gloves

3.3.2.5 References

- https://www.javatpoint.com/types-of-computer-network
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- Network Topology: Star Network, Grid Network, Tree and Hypertree Networks, Spanning Tree Protocol, Metro Ethernet, Token Ring, Mesh Networking, authored by Books Llc, published by General Books LLC, 2010

3.3.3 Learning Outcome 2: Connection network devices

3.3.3.1 Learning Activities

The following are the performance criteria:

- Tools, materials and devices for network are identified according to the network type
- Network connection is done according National and International Communication standards
- Strength and connectivity tests of cables and equipment is done as per the network type

Trainees to demonstrate knowledge in relation to:

- Definition of network devices
- Identification of Network connection Media: Wired, Wireless
- Characteristics of connection medium

- Network devices: Switches/Hubs, Ports, Computers
- Connect network devices

3.3.3.2 Information Sheet

Network devices are components used to connect computers or other electronic devices together so that they can share files or resources like printers. Devices used to setup a Local Area Network (LAN) are the most common type of network devices used by the public. A LAN requires a hub, switch, and router.

Read: Details on computer network devices: https://www.slideshare.net/RAJESHSADHUKHA01/computer-networking-devices-16572482

A wired network is a common type of wired configuration. Most wired networks use Ethernet cables to transfer data between connected PCs. In a small-wired network, a single router may be used to connect all the computers. Larger networks often involve multiple routers or switches that connect to each other.

Read: Wired network: https://andersontech.com/three-critical-reasons-choose-wired-network-small-business/

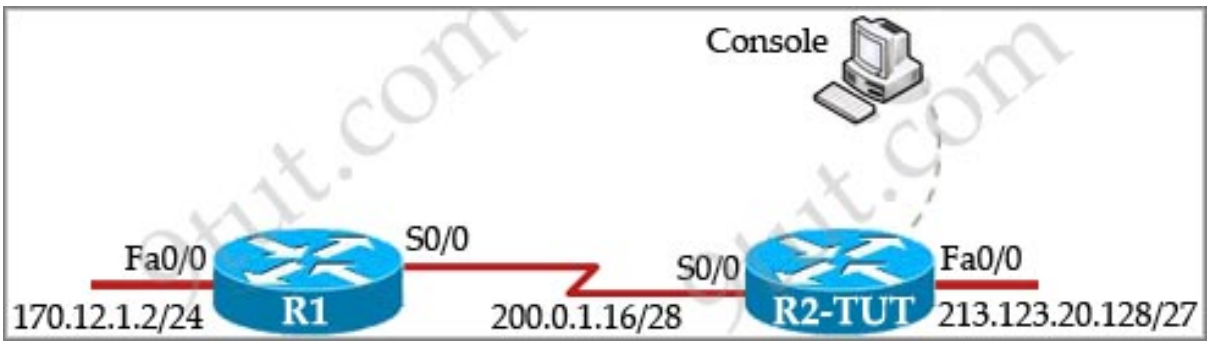
A **wireless network** is a computer network that uses wireless data connections between network nodes. A **medium** is a third-party or element through which a message is communicated.

Watch: Introduction of wireless and wired network: https://youtu.be/u21lNHy072U

3.3.3.3 Self-Assessment

i. What are Routers?
ii. What is the difference between Hub, Switch, and Router?
iii. How a switch is different from a Hub?
iv. Configure a new router within your lab.
v. List the benefits of wired versus wireless network.
vi. **Case situation:** You are a consultant to a small size hotel. You have been called to check the Internet WIFI network. According to your client, some of their guests are facing challenges with connecting their computer devices to the WIFI. How will you address the situation? What are the steps that you will consider?
vii. Set up a wireless network for connecting 10 devices in your lab.
viii. **Case situation:** You are a consultant at a coffee shop for their IT system. Your client is keen on providing their customer free Internet via WIFI. What will be your suggestions? What are the key challenges that you should make your client caution about?

ix. **Case Study on Network Typology:** TUT Company recently installed a new router in their office. Complete the network installation by performing the initial router configurations and configuring RIPv2 routing using the router command line interface (CLI) on the R2-TUT. Following are the details for your reference.



Source: https://www.9tut.com/59-ccna-configuration-sim-question/comment-page-5

Name of the router is **R2-TUT**
Enable-secret password is **cisco1**
The password to access user EXEC mode using the console is **cisco2**
The password to allow telnet access to the router is **cisco3**
IPV4 addresses must be configured as follows:
Ethernet network 213.123.20.128/27 – router has last assignable host address in subnet
Serial network is 200.0.1.16/28 – router has last assignable host address in the subnet. Interfaces should be enabled.
Router protocol is **RIPv2**

x. You need to connect two computers for file sharing. Is it possible to do this without using a hub or router?

xi. What happens when you use cables longer than the prescribed length?

xii. You are connecting a cubicle farm to your network. You install NICs in all the workstations and run cables to a workgroup hub. You then connect the MDI port on the workgroup hub to the main hub with a standard patch cable. Upon powering up the cubicle farm computers, none of them can see the servers on the network. What could you replace to solve this problem?

xii. Briefly explain how wireless-networking systems can avoid collisions where possible?

xiii. The meaning of straight-through cable is:
A. Four wire pairs connect to the same pin on each end
B. The cable which directly connects computer-to-computer
C. Four wire pairs not twisted with each other
D. The cable which is not twisted

xiv. What is the function of a router?
A. Converting the data from one format to another
B. Forward the packet to the up links
C. Error detection in data
D. None of the above

xv. What does router do in a network?
   A. Forwards a packet to all outgoing links
   B. Forwards a packet to the next free outgoing link
   C. Determines on which outing link a packet is to be forwarded
   D. Forwards a packet to all outgoing links except the originated link

xvi. Which of the following cables can be used to connect a PC and a Hub?
   A. Rollover cable
   B. Straight cable
   C. Cross cable
   D. Any of the above

3.3.3.4 Tools, Equipment, Supplies and Materials

Installation and termination, Network and Ethernet cables, Punch down Tools, Wiring Systems, Fiber optic, Network Switches, Network Connectors

3.3.3.5 References

- https://www.geeksforgeeks.org/network-devices-hub-repeater-bridge-switch-router-gateways/
- https://andersontech.com/three-critical-reasons-choose-wired-network-small-business/
- Cabling Part 1: LAN Networks and Cabling Systems, 5th Edition authored by Andrew Oliviero, published by Sybex, 2015
- Network Design Basics for Cabling Professionals authored by BICSI published by McGraw-Hill Professional; 1 edition

3.3.4 Learning Outcome 3: Configuration of network devices

3.3.4.1 Learning Activities

The following are the performance criteria:

- Network software is installed and configured according to user manuals.
- IP addressing scheme, subnet masking and routing protocol configuration is done
- Network segmentation is determined as per the network design.
- Network privileges are allocated according to the network configuration.

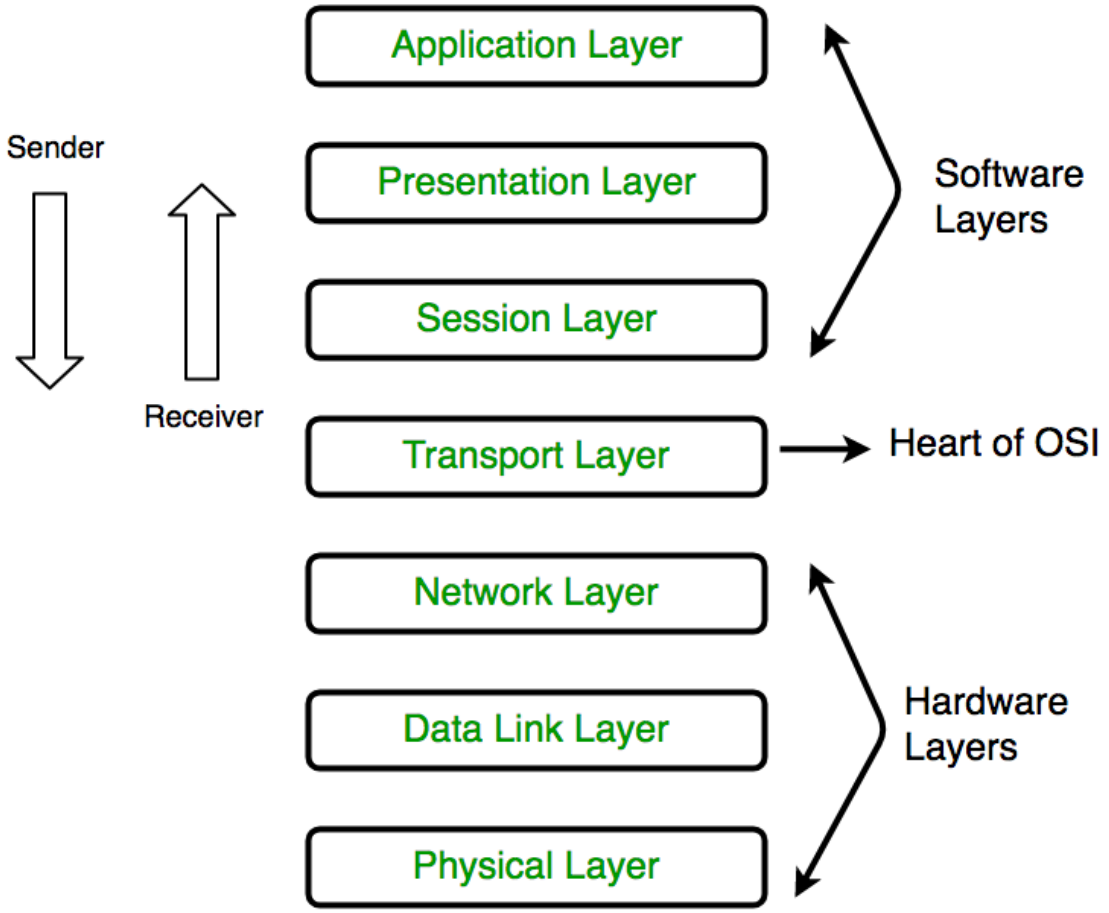
Trainees to demonstrate knowledge in relation to:

- Definition of configuration
- Network Architecture: OSI, TCP/IP Protocol Suite, Ethernet, Network protocols. TCP/IP, UDP, HTTP, FTP, DCIP, DHCP
- Network Operating system
- Connect and configure network devices

3.3.4.2 Information Sheet

Network configuration is the process of setting a network's controls, flow and operation to support the network communication of an organization and/or network owner. This broad term incorporates multiple configuration and setup processes on network hardware, software and other supporting devices and components.
The Open Systems Interconnection model (OSI) is a conceptual model that characterizes and standardizes the communication functions of a telecommunication or computing system without regard to its underlying internal structure and technology.

Read: OSI model: https://www.geeksforgeeks.org/layers-osi-model/



Source: https://www.geeksforgeeks.org
Figure 47: Open Systems Interconnection (OSI) Model

The TCP/IP Protocol suite is a set of protocols used on computer networks today (most notably on the Internet). It provides an end-to-end connectivity by specifying how data should be packetized, addressed, transmitted, routed and received on a TCP/IP network. This functionality is organized into four abstraction layers and each protocol in the suite resides in a particular layer.

Read: TCP/IP Protocol suite: https://study-ccna.com/tcpip-suite-of-protocols/

TCP/IP technically applies to network communications in which the TCP transport is used to deliver data across IP networks. Known as a connection-oriented protocol, TCP works by establishing a virtual connection between two devices via a series of request and reply messages sent across the physical network.

Source: https://www.iplocation.net

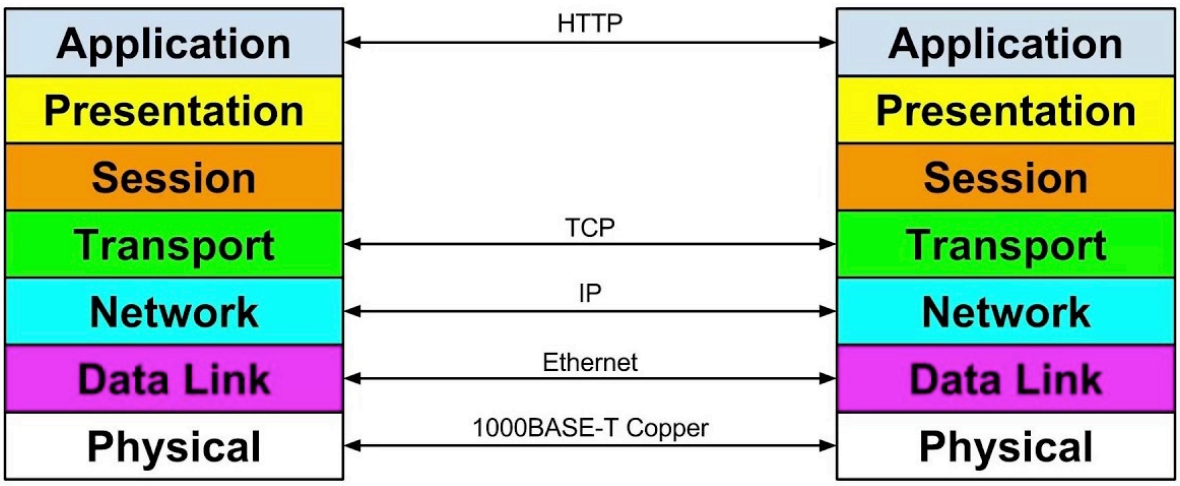
Figure 48: TCP/IP

Read: TCP/IP: https://www.lifewire.com/transmission-control-protocol-and-internet-protocol-816255

Watch: TCP/IP explained: https://youtu.be/PpsEaqJV_A0

Ethernet is the technology that is most commonly used in wired local area networks (LANs). A LAN is a network of computers and other electronic devices that covers a small area such as a room, office, or building. It is used in contrast to a Wide Area Network (WAN), which spans much larger geographical areas.

Network protocols are formal standards and policies made up of rules, procedures and formats that define communication between two or more devices over a network. Network protocols conduct the action, policies, and affairs of the end-to-end process of timely, secured and managed data or network communication.



Source: nikemurphycs.com

Figure 49: Network protocols

Watch: Network protocols: https://youtu.be/QrNnRJqTMO8

User Datagram Protocol (UDP) is an alternative communications protocol to **Transmission**

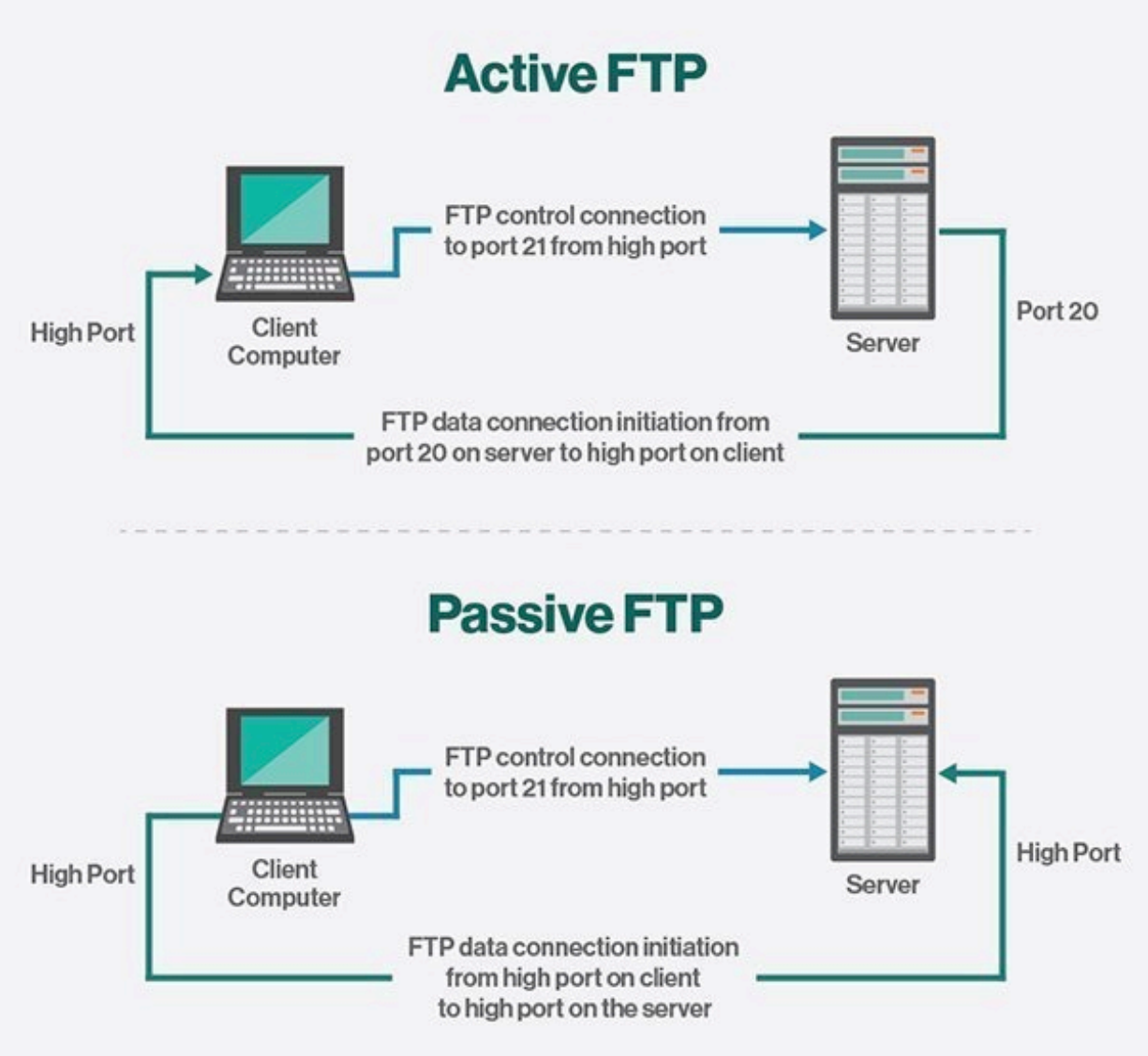
Control Protocol (TCP) used primarily for establishing low-latency and loss-tolerating connections between applications on the Internet.

Watch: UDP**:** https://youtu.be/qIycyyxCnF0

File Transfer Protocol (FTP) is a standard Internet protocol for transmitting files between computers on the Internet over TCP/IP connections.

FTP is a client-server protocol that relies on two communications channels between client and server: a command channel for controlling the conversation and a data channel for transmitting file content. Clients initiate conversations with servers by requesting to download a file. Using FTP, a client can upload, download, delete, rename, move and copy files on a server.

FTP sessions work in passive or active modes. In active mode, after a client initiates a session via a command channel request, the server initiates a data connection back to the client and begins transferring data. In passive mode, the server instead uses the command channel to send the client the information it needs to open a data channel. Because passive mode has the client initiating all connections, it works well across firewalls and Network Address Translation (NAT) gateways.



Source: https://searchnetworking.techtarget.com

Figure 50: Active and passive FTP

HTTP means Hypertext Transfer Protocol. **HTTP** is the underlying protocol used by the World Wide Web and this protocol defines how messages are formatted and transmitted, and what actions Web servers and browsers should take in response to various commands.

Read: Introduction to HTTP:
https://www.webopedia.com/TERM/H/HTTP.html
https://study-ccna.com/http-https/
https://www.w3schools.com/whatis/whatis_http.asp

The Dynamic Host Configuration Protocol is a network management protocol used on UDP/IP networks whereby a DHCP server dynamically assigns an IP address and other network configuration parameters to each device on a network so they can communicate with other IP networks.

This entire process is centralized so that TCP/IP configuration can also be completed from a central location. DHCP has "pool of IP addresses" from which it allocates the IP address to the network devices. DHCP cannot recognize if any device is configured manually and assigned with the same IP address from the DHCP pool. In this situation, it throws "IP address conflict" error.

DHCP environment requires DHCP servers to set-up the TCP/IP configuration. These servers then assign, release and renew the IP addresses as there might be a chance that network devices can leave the network and some of them can join back to the network.

Read: DHCP: https://searchnetworking.techtarget.com/definition/DHCP

Read: FTP: https://searchnetworking.techtarget.com/definition/File-Transfer-Protocol-FTP

A **Network Operating System** (NOS) is a computer Operating System (OS) that is designed primarily to support workstations, personal computers and, in some instances, older terminals that are connected on a local area network (LAN).

Watch: Network operating system: https://youtu.be/41FKxGn99HA

Read: Network operating system:
https://searchnetworking.techtarget.com/definition/network-operating-system

Watch: Configuration of network: https://youtu.be/2W_X49G-3qc

3.3.4.3 Self-Assessment

i. Describe the layers of OSI model?
ii. Explain TCP/IP Model
iii. What is HTTP and what port does it use?
iv. What are TCP and UDP?
v. Explain DHCP briefly?
vi. Expand DHCP and describe how it works?
vii. Network Layer is in OSI's:
   A. 7th layer
   B. 4th Layer
   C. 1st layer
   D. 3rd Layer
viii. What does UDP provide in OSI model?
   A. It provide data segmentation
   B. It secure the data
   C. It is connection less protocol
   D. It is a layer 3 protocol
ix. You are IT support engineer, your IT manager wants you to Telnet R7 which is in LA, Which is the highest layer used to get access to LA's router from Telnet?

A. Layer 7
B. Layer 1
C. Layer 4
D. Layer 5

x. The physical layer translates logical communication requests from the _____ into hardware-specific operations.
   A. Data link layer
   B. Network layer
   C. Transport layer
   D. Application layer

xi. Which software troubleshooting tool could you use to determine which protocol Is Configured with the wrong address?

xii. Which TCP/IP utility is most often used to test whether an IP host is up and functional?

xiii. What protocol can be applied when you want to transfer files between different platforms, such between Unix systems and windows servers?

3.3.4.4 Tools, Equipment, Supplies and Materials

TeemIP: Easy IP Address Management, Node-RED: Wiring Nodes to Solve Anything, Speedtest.net/pingtest.net, Subnet and IP Calculator, PuTTY/Tera Term, Netstat, Nslookup, Ipconfig/ifconfig, Tracert/traceroute, Ping

3.3.4.5 References

- https://www.webopedia.com/TERM/H/HTTP.html
- https://study-ccna.com/http-https/
- https://www.w3schools.com/whatis/whatis_http.asp
- The TCP/IP Guide: A Comprehensive, Illustrated Internet Protocols Reference, authored by Charles M. Kozierok, published by No Starch Press; 1st edition
- Elements of Network Protocol Design, authored by Mohamed G. Gouda published by Wiley-Interscience; 1st edition

3.3.5 Learning Outcome 4: Network testing

3.3.5.1 Learning Activities

The following are the performance criteria:

- Network components are tested to determine the performance.
- Testing of connectivity medium between components is done as per the manual instructions.
- Network testing is done, and report generated.

Trainees to demonstrate knowledge in relation to:

- Outline network test plan
- Network testing tools: Clamp meter, Voltmeter, Cable tester, Signal tester
- Test network components
- Test the network
- Test report

3.3.5.2 Information Sheet

A test plan is a detailed document that outlines the test strategy, Testing objectives, resources (manpower, software, hardware) required for testing, test schedule, Test Estimation and test deliverables. **A clamp meter** is an electrical test tool that combines a basic digital millimeter with a current sensor.

Source: https://www.flukenetworks.com

Figure 51: Clamp meter

A voltmeter is an instrument used for measuring electrical potential difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter.

A cable tester is an electronic device used to verify the electrical connections in a signal cable or other wired assembly.

Watch: How to network cable tester work: https://youtu.be/sQ5V3cHlISk

The Signal Tester will provide a summary of all networks found and their absolute and relative strengths. The information is shown directly on the LCD screen.

Source: https://www.4grouter.co.uk

Figure 52: Signal tester

A network performance test is any process that is used to quantitatively or qualitatively measures the performance of a computer network. It tests for and records certain behaviors and processes of networks that, when combined, define the network performance and/or quality of service.

Testing the network include:

- Identify the testing environment
- Identify performance metrics
- Plan and design performance tests
- Configure the test environment
- Implement test design
- Execute tests
- Analyze, report, retest

Watch: Testing Network: https://youtu.be/i5cGw6vokW8

3.3.5.3 Self-Assessment

i. What is cable tester?
ii. How to measure your network signal?
iii. What is the role of clamp meter?
iv. Differentiate clamp meter and voltmeter?
v. Which device we use to test network signal?
   A. Clamp meter

B. Voltmeter
C. Signal Tester
D. None of them

v. Voltmeter measures?
A. Electrical current
B. Network speed
C. Signal
D. None above all

vi. How fast is 10baseT?
A. 100Mbps
B. 30Mbps
C. 10Mbps
D. 2Mbps
E. 1000Mbps

vii. How fast can data travel over Cat3 UTP?
A. 200Mbps
B. 100Mbps
C. 10Mbps
D. 2Mbps
E. 1.5Mbps

3.3.5.4 Tools, Equipment, Supplies and Materials

Cable test, Voltmeter, Clamp meter, Signal tester

3.3.5.5 References

- https://www.techopedia.com/definition/29991/network-performance-test
- The Art of Testing Network Systems, authored by Robert W. Buchanan published by Wiley; 1 edition 1996
- Enterprise Network Testing: Testing Throughout the Network Lifecycle to Maximize Availability and Performance Networking Technology, authored by Tom Kunath, Andy Sholom, published by Cisco Press; 1 edition 2011

3.3.6 Learning Outcome 5: Configuration of Network types

3.3.6.1 Learning Activities

The following are the performance criteria:

- Network types are identified as per the
- Network design Network types are configured as per the type of connection
- Network testing of network types is done

Trainees to demonstrate knowledge in relation to:

- Determine appropriate Network type
- Types of Network types
- Assemble prerequisite components and medium
- Network Components Configuration procedures
- Network protocols Configuration procedures

3.3.6.2 Information Sheet

Network configuration is the process of setting a network's controls, flow and operation to support the network communication of an organization and/or network owner. This broad term incorporates multiple configuration and setup processes on network hardware, software and other supporting devices and components.

Watch: Network Component configuration: https://youtu.be/gVrXLq5E-CQ

Network configurations procedures take place along with the installation of the operating system software. At that time, certain IP configuration parameters must be stored in appropriate files so they can be read at boot time.

The procedure is a matter of creating or editing the network configuration files. How configuration information is made available to a machine's kernel depends on whether these files are stored locally (local files mode) or acquired from the network configuration server (network client mode).

Parameters supplied during network configuration are:

- IP address of each network interface on every machine
- Host names of each machine on the network. You can type the host name in a local file or a name service database.
- NIS, NIS+, or DNS domain name in which the machine resides, if applicable
- Default router addresses. You supply this only if you have a simple network topology with only one router attached to each network, or your routers don't run routing protocols such as the Router Discovery Server Protocol (RDISC) or the Router Information Protocol (RIP).
- Subnet mask (required only for networks with subnets)

3.3.6.3 Self-Assessment

i. Define network configuration
ii. Which parameter used during network configuration?
iii. Conduct performance test in your lab.
iv. **Case situation:** You are asked to visit a near-by high school and test their ICT lab. They are facing lot of challenges with their computer lab. What are the steps you will consider for diagnosis of their challenges?
v. _____ is the process of setting a network control.
   A. Network configuration
   B. Network management
   C. Network styling
   D. Network wiring

3.3.6.4 Tools, Equipment, Supplies and Materials

Computer, cables, switch, hubs, router

3.3.6.5 References

- https://youtu.be/gVrXLq5E-CQ
- https://www.techopedia.com/definition/25766/network-configuration
- Computer Networking: Top-Down authored by Kurose, Ross, published by Pearson 2013

3.3.7 Learning Outcome 6: Perform network security

3.3.7.1 Learning Activities

The following are the performance criteria:

- Identification and implementation of network security policy is done as per the Organization ICT policy.
- Network security measures are identified according to the threats defined.
- Network security measures are enforced in line with the Network security policy.

Trainees to demonstrate knowledge in relation to:

- Definition of network security
- Network threats: Internal and External
- Prevention measures: Firewalls, User accounts control, Security policies, Anti-viruses, Encryption
- Enforce network security measures
- Network Security Policy

3.3.7.2 Information Sheet

Network Security is the process of taking physical and software preventative measures to protect the underlying networking infrastructure from unauthorized access, misuse, malfunction, modification, destruction, or improper disclosure, thereby creating a secure

platform for computers, users and programs to perform their permitted critical functions within a secure environment.

Internal Threat a threat originating inside a company, government agency, or institution, and typically an exploit by a disgruntled employee denied promotion or informed of employment termination.

External threats are malicious campaigns and threat actors that attempt to exploit security exposures in your attack surface that exist outside the firewall. All organizations with a digital presence are exposed to external threats by attackers who attempt to impersonate your brand and official communications channels on the internet, social media, and through mobile apps.

A firewall is software used to maintain the security of a private network. Firewalls block unauthorized access to or from private networks and are often employed to prevent unauthorized Web users or illicit software from gaining access to private networks connected to the Internet. A firewall may be implemented using hardware, software, or a combination of both.

Watch: How Firewall work: https://youtu.be/KZc1KaE1OKU

User Account Control or UAC for short is a security feature of Windows which helps prevent unauthorized changes to the operating system. Applications, users, viruses or other forms of malware can initiate these changes.

Security policy is a definition of what it means to be secure for a system, organization or other entity. For an organization, it addresses the constraints on behavior of its members as well as constraints imposed on adversaries by mechanisms such as doors, locks, keys and walls.

Antivirus software, or **anti-virus** software (abbreviated to AV software), also known as **anti**-malware, is a computer program used to prevent, detect, and remove malware.

Encryption is the process of encoding a message or information in such a way that only authorized parties can access it and those who are not authorized cannot.

A **network security policy**, or NSP, is a generic document that outlines rules for computer **network** access, determines how **policies** are enforced and lays out some of the basic architecture of the company **security**/ **network security** environment.

3.3.7.3 Self-Assessment

i. Define antivirus?
ii. What is the difference between antivirus and firewall?
iii. What is firewall?

iv. Differentiate internal threads and external threads?
v. What is Network Security?
vi. Which way to prevent unauthorized user to change the operating system?
   A. Firewall
   B. User account control
   C. Encryption
vii. **Case situation:** You have been hired by a pharmaceutical office. The manager of the sales team has asked you to ensure that none of the computers have access to any social media or entertainment sites on the Internet. What will be your approach to address the manager's request?
viii. Review the different anti-viruses available and make a table on advantages and disadvantages.
ix. **Case situation:** You are visiting a Cyber Café and you see that the anti-virus package is pirated. What will you consider doing?

3.3.7.4 Tools, Equipment, Supplies and Materials

Antivirus software, Computer

3.3.7.5 References

- https://www.riskiq.com/products/external-threats/
- Network Security authored by Jan L. Harrington, published by Elsevier Science & Technology

3.3.8 Learning Outcome 7: Monitor Network connectivity and performance

3.3.8.1 Learning Activities

The following are the performance criteria:

- Monitoring tools are identified
- Deployment of monitoring tools is done as per the network connection type.
- Network status is determined as per the monitoring report.

Trainees to demonstrate knowledge in relation to:

- Monitoring tools and software: Ping, Tracert, NSLookup, Ipconfig, Speed test

3.3.8.2 Information Sheet

Monitoring software observes and tracks the operations and activities of users, applications and network services on a computer or enterprise systems. This type of software provides a way to supervise the overall processes that are performed on a computing system, and provides reporting services to the system or network administrator.

Ping is a computer network administration software utility used to test the reachability of a host on an Internet Protocol network. It is available for virtually all operating systems that have networking capability, including most embedded network administration software.

Read: Introduction to ping: https://techterms.com/definition/ping

Watch: How to ping: https://youtu.be/A2nkwZh8hws

Traceroute (or **tracert** on Microsoft Windows systems) displays information about each "hop" a packet takes from your computer to the remote host. It is often a good way to pinpoint possible ISP connection issues or network bottlenecks.

Watch: How traceroute work: https://youtu.be/x_3dWSQkHB8

The **nslookup** command will look up the IP addresses associated with a domain name.

Watch: How nslookup work: https://youtu.be/mx8RP-XsEKw

An **internet speed** test is a website or web application that measures a user's internet connection speed. It reports on: Upload speed and download speed.

3.3.8.3 Self-Assessment

i. What is ping command and what are its uses?
ii. Why is it necessary to test the speed of your Internet?
iii. Explain briefly computer monitoring?
iv. What are ipconfig and ifconfig?
v. Differentiate between ping and tracert.
vi. You need to troubleshoot your network IP connectivity. Which of the following commands would you use to find the IP address on your Ethernet 0 interface?
   A. Ping
   B. IPConfig
   C. traceroute
   D. Show interface Ethernet 0
vii. We can use ping program to find, if a host is:
   A. Alive
   B. Dead
   C. Responding
   D. Both A and C
viii. _____ command is used to manipulate TCP/IP routing table.
   A. route
   B. Ipconfig
   C. Ifconfig
   D. Traceroute
ix. Ping can:

A. Measure round-trip time
B. Report packet loss
C. Report latency
D. All of the mentioned

3.3.8.4 Tools, Equipment, Supplies and Materials

Speed test, Computer, GUI, Software

3.3.8.5 References

- https://techterms.com/definition/ping
- https://youtu.be/mx8RP-XsEKw
- https://youtu.be/x_3dWSQkHB8
- Computer Networking: Top-Down authored by Kurose, Ross, published by Pearson 2013

3.3.9 Learning Outcome 8: Maintain Network

3.3.9.1 Learning Activities

The following are the performance criteria:

- Optimization between the network components and medium is done
- Network security is applied according to vulnerability of the network
- Maintenance schedule is performed
- User training is done according to the instruction manual

Trainees to demonstrate knowledge in relation to:

- Maintenance schedule plan
- Maintenance tools: Console, Wireshark, Nmap
- Corrective/preventive measures

3.3.9.2 Information Sheet

Maintenance planning and scheduling includes planning decisions related to what, how and time estimate for a job.

There are different types of maintenance tools for network. **Console** is the combination of display monitor and keyboard (or other device that allows input). Another term for console is terminal. The term console usually refers to a terminal attached to a minicomputer or mainframe and used to monitor the status of the system.

Read: Introduction to console: https://www.webopedia.com/TERM/C/console.html

Wireshark is a free and open-source packet analyzer. It is used for network troubleshooting, analysis, software and communications protocol development, and education. Originally named Ethereal, the project was later renamed to Wireshark.

Read: About Wireshark: https://en.wikipedia.org/wiki/Wireshark

Watch: How to analyze IP using wireshark: https://youtu.be/S92h5Q4svds

Network Mapper (Nmap) is a free and open-source network scanner created by Gordon Lyon (also known by his pseudonym Fyodor Vaskovich). **Nmap** is used to discover hosts and services on a computer network by sending packets and analyzing the responses.

Read: Introduction and use of Namp in networks:
https://www.networkworld.com/article/3296740/what-is-nmap-why-you-need-this-network-mapper.html

3.3.9.3 Self-Assessment

i. What is Nmap?
ii. Explain wireshark.
iii. What is console?
iv. In the virtual LAN of your lab, how many hosts are running? Please list their IP addresses. You should consider the router in all this and following questions, remember the router has different interfaces on different subnets.
   A. If a computer is up, which services (TCP and UDP) are open on it?
   B. Can you determine the Operating system and its possible version that is running on each alive computer?
   C. All the answers should be included in a file named /tmp/nmap,
v. Nmap was originally a command-line application for Unix, but a Windows version has been available since
   A. 2005
   B. 2008
   C. 2019
   D. 2000
vi. Wireshark is free_____ Analyzer?
   A. Console
   B. Network
   C. Parket
   D. B and C

3.3.9.4 Tools, Equipment, Supplies and Materials

Computer, software, Graphic user interface (GUI)

3.3.9.5 References

- https://www.networkworld.com/article/3296740/what-is-nmap-why-you-need-this-network-mapper.html
- Computer Networking: Top-Down authored by Kurose, Ross, published by Pearson 2013

CHAPTER 4: SOFTWARE INSTALLATION

4.1 Introduction

This unit describes the competencies required in installing computer software. It involves identification of software to be installed, installation of the software, configuration of the software, software testing, user training and software maintenance.

4.2 Performance Standard

- Classified the software according to the functionality, resource requirement and use
- Established software acquisition methods as per the functionality
- Configured software as per the installation manual provided
- Performed software testing
- Prepared user-training manuals according to software functionality

4.3 Learning Outcome

4.3.1 List of the Learning Outcomes

These are the key learning outcomes, which make up workplace function:
- Identify software to be installed
- Install the software
- Configure the software
- Test software functionality
- Perform user training
- Perform Software Maintenance

4.3.2 Learning Outcome 1: Identify software to be installed

4.3.2.1 Learning Activities

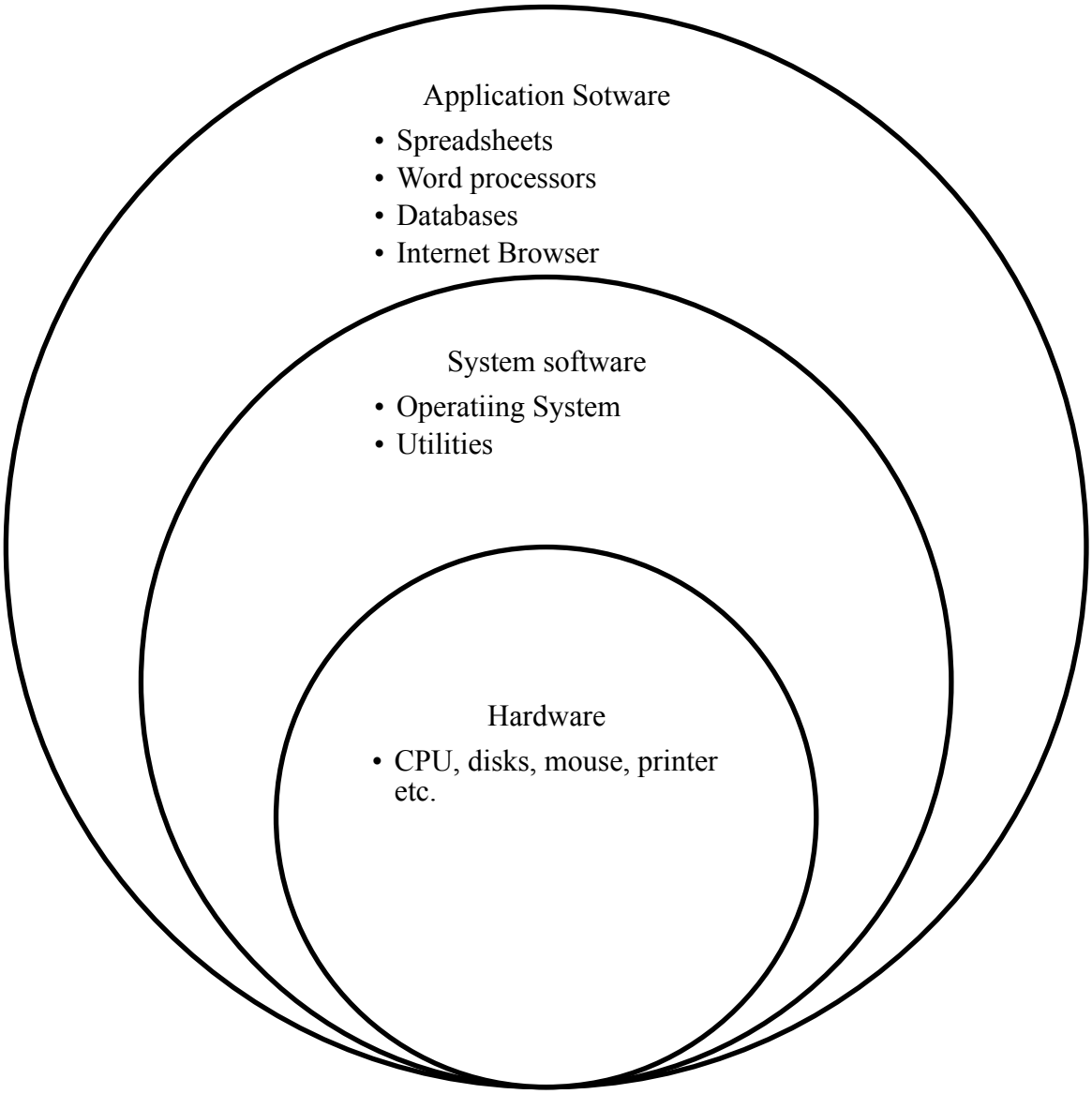
The following are the performance criteria:
- Software are classified according to the functionality, resource requirement and use.
- Criteria for selection of software is identified based on user requirements and functionality
- Appropriate software acquisition methods are established as per the functionality.

Trainees to demonstrate knowledge in relation to:
- Definition of software
- Classification of software: System and Application
- Criteria for selection
- Operating systems
- Types of operating systems: Single and multi-user, Single and multitasking, Real time, Distributed, Batch

- Functions of operating systems: Device management, Memory management, Storage management, Process control, Security Management
- Types of operating system interfaces: Menu driven and Graphical user Interface

4.3.2.2 Information Sheet

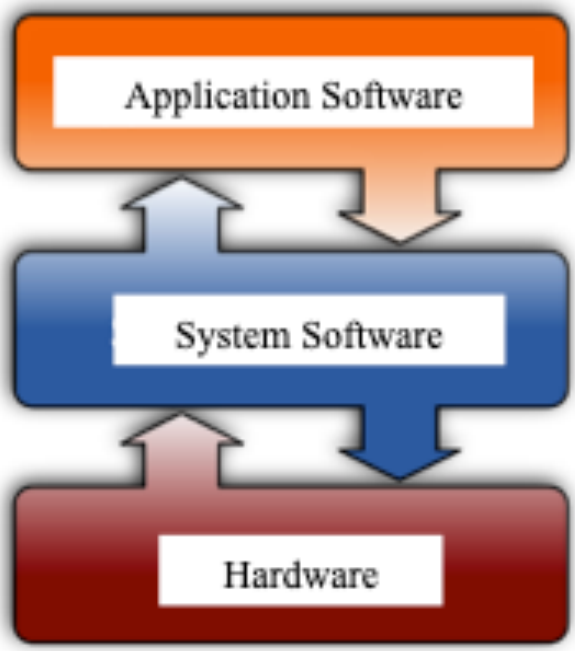
Software, in its most general sense, is a set of instructions or programs instructing a computer to do specific tasks. Software is a generic term used to describe computer programs. Scripts, applications, programs and a set of instructions are all terms often used to describe software.



Source: https://courses.cs.vt.edu

Figure 53: Overview of software

System software manages and controls the internal operations of a computer system. It is a group of programs, which is responsible for using computer resources efficiently and effectively. For example, an operating system is **system software**, which controls the hardware, manages memory and multitasking functions, and acts as an interface between application programs and the computer. System software is designed to provide platform for other software.



Source: https://en.wikibooks.org

Figure 54: Interface of application software, system software and hardware

Application software is the general designation of computer programs for performing tasks. Application software may be general purpose (word processing, web browsers, etc.)

Watch: Introduction to operating system: https://youtu.be/0ZjkUMKy6x0

Table 10: Difference between System software and Application software

System Software	Application Software
• System software is used for operating computer hardware.	• Application software is used by user to perform specific task.
• System softwares are installed on the computer when operating system is installed.	• Application softwares are installed according to user's requirements.
• In general, the user does not interact with system software because it works in the background.	• In general, the user interacts with application software.
• System software can run independently. It provides platform for running	• Application software can't run independently. They can't run without

application softwares.	the presence of system software.
• Some examples of system softwares are compiler, assembler, debugger, driver, etc.	• Some examples of application softwares are word processor, web browser, media player, etc.

An Operating System (OS) is a program that acts as an interface between the software and the computer hardware.

The main difference between **single user and multiuser operating system** is that in a single user operating system, only one user can access the computer system at a time while in a multiuser operating system, multiple users can access the computer system at a time.

An operating system that allows a single user to perform two or more functions at once is a **single-user or multitasking operating system**. Early versions of both Microsoft Windows and the Macintosh operating systems were examples of this category.

Read: Categories of operating systems:
https://www.tankonyvtar.hu/en/tartalom/tamop412A/2011_0009_Herdon_Miklos-Agroinformatics/ch03s09.html

Watch: Introduction of single or multitasking: https://youtu.be/glGlGtxwfQ4

A real-time operating system (RTOS) is a very fast and relatively small OS. Often embedded, meaning it is built into the circuitry of a device and not normally loaded from a disk drive, a real-time operating system runs real-time applications. It may support multiple simultaneous tasks or it may only support single tasking.

A distributed operating system manages a group of distinct computers and makes them appear to be a single computer. The development of networked computers that could be linked and communicate with each other gave rise to distributed computing. Distributed computations are carried out on more than one machine. When computers in a group work in cooperation, they form a distributed system.

Batch processing is a technique in which an Operating System collects the programs and data together in a batch before processing starts. An operating system does the following activities related to batch processing. The OS defines a job, which has predefined sequence of commands, programs and data as a single unit.

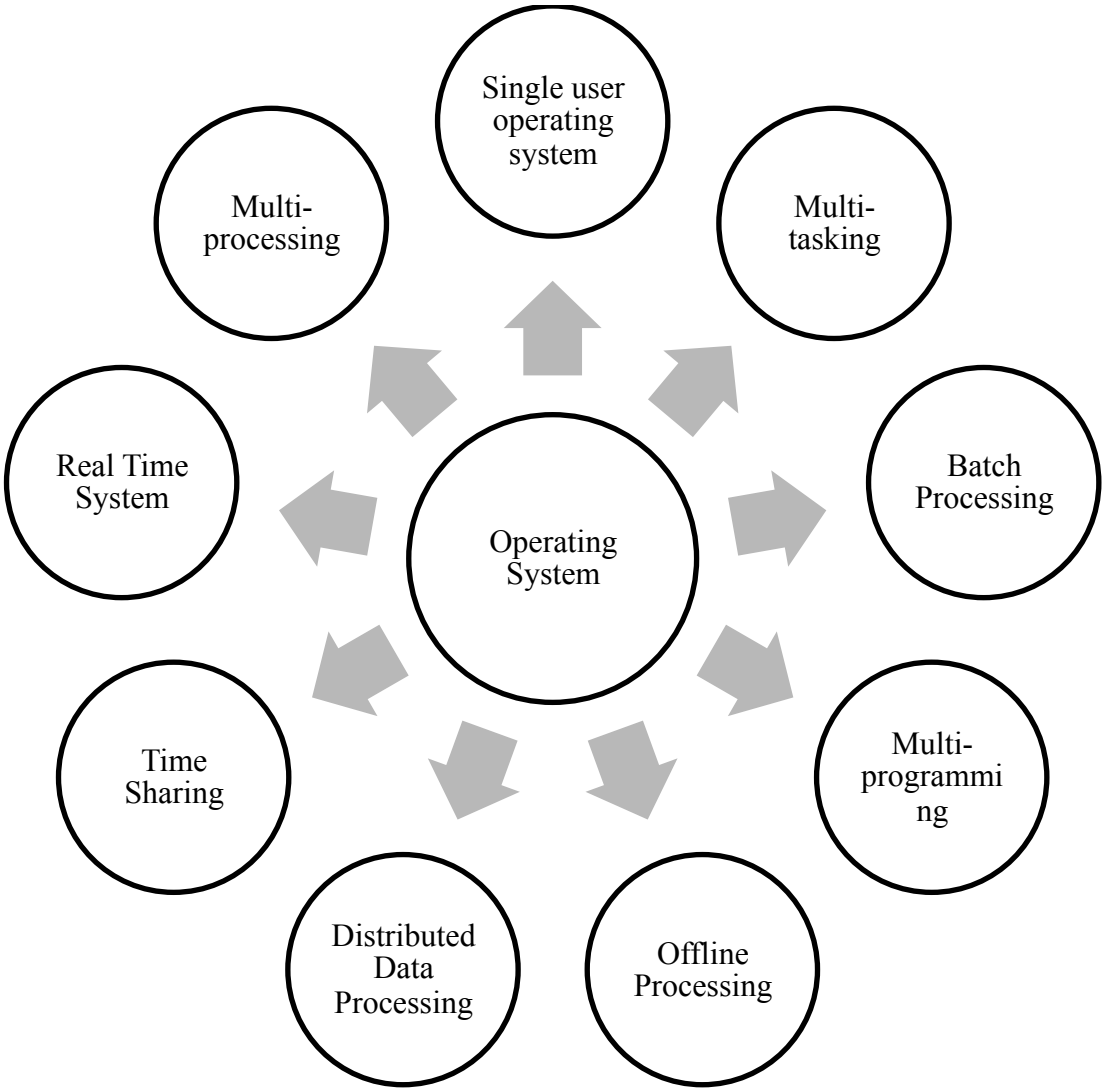


Figure 55: Activities of operating system

An Operating System manages device communication via their respective drivers. It does the following activities for **device management**:

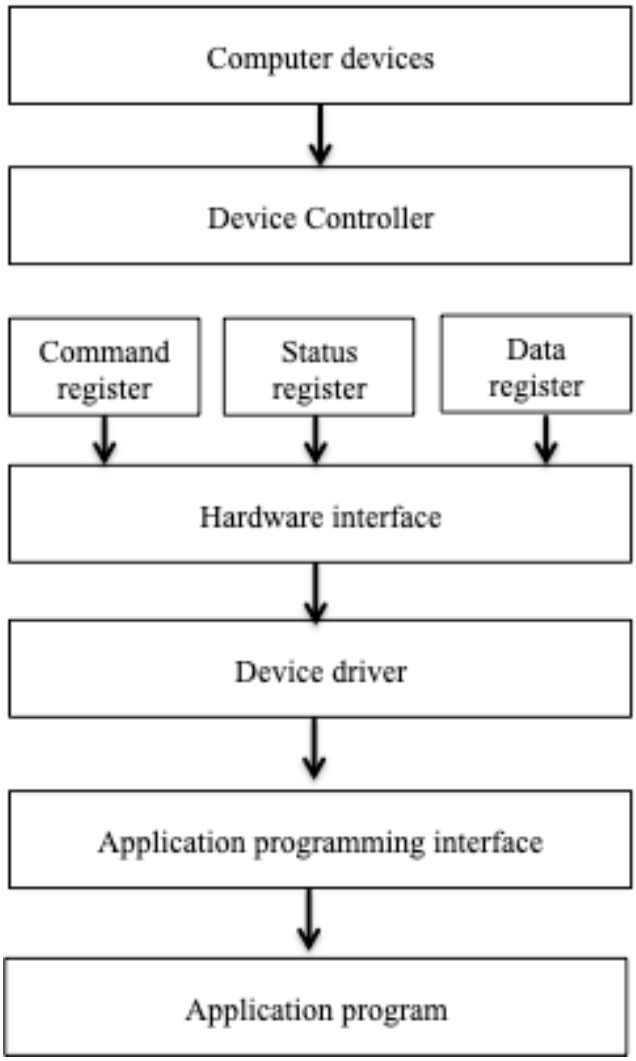
- Keeps tracks of all devices. Program responsible for this task is known as the I/O controller.
- Decides which process gets the device when and for how much time.
- Allocates the device in the efficient way.
- De-allocates devices.

Memory management refers to management of **Primary Memory** or **Main Memory**. Main memory is a large array of words or bytes where each word or byte has its own address. Main memory provides a fast storage that can be accessed directly by the CPU. For a program to be executed, it must in the main memory. An Operating System does the following activities for memory management:

- Keeps tracks of primary memory, i.e., what part of it are in use by whom, what parts are not in use?
- In multiprogramming, the OS decides which process will get memory when and how much.
- Allocates the memory when a process requests it to do so.
- De-allocates the memory when a process no longer needs it or has been terminated.

Since main memory is usually too small to accommodate all the data and programs permanently, the computer system must provide **secondary storage** to back up main memory. **Process Control** is a data structure in the operating system kernel containing the information needed to manage the scheduling of a particular process.

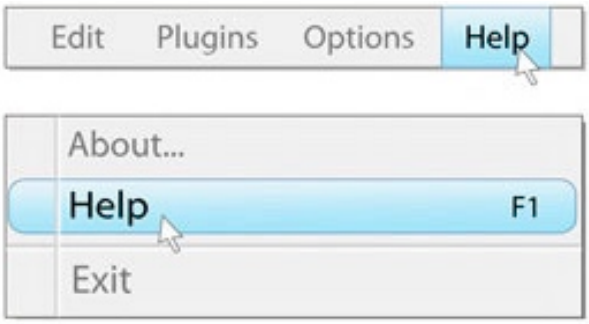
Operating system security refers to specified steps or measures used to protect the OS from threats, viruses, worms, malware or remote hacker intrusions. OS security encompasses all preventive-control techniques, which safeguard any computer assets capable of being stolen, edited or deleted if OS security is compromised.



Source: https://www.includehelp.com

Figure 56: Operating System interfaces

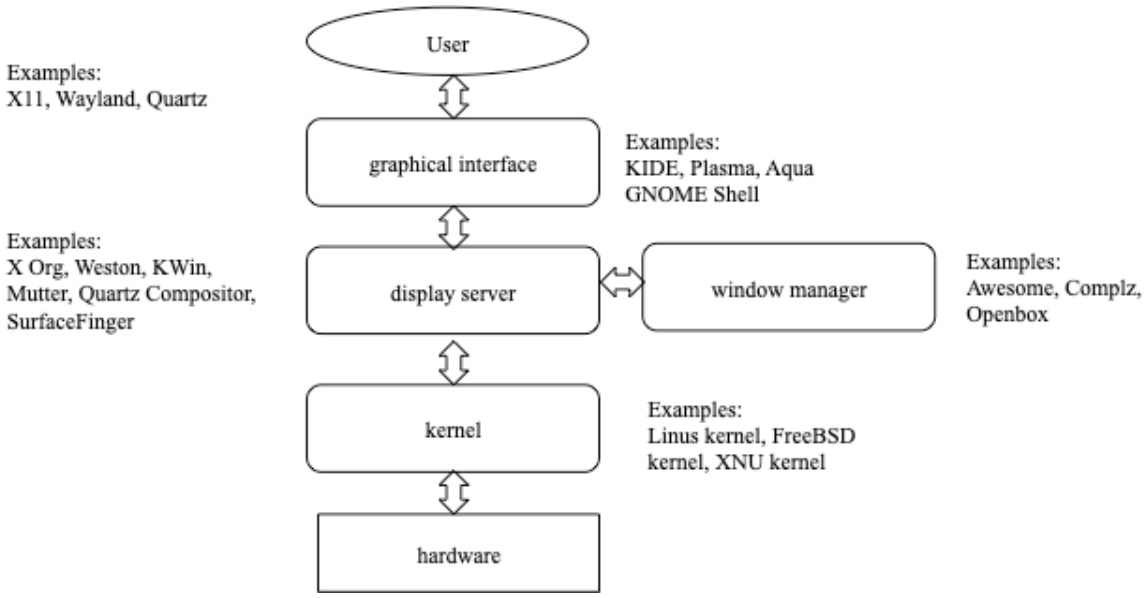
Menu-driven is used to describe a software program that is operated using file menus instead of using commands. Below is an example of how a user may quit a menu-driven program, as opposed to a non menu-driven program.



Source: https://www.computerhope.com

Figure 57: Menu

Graphical User Interface (GUI) is an interface that uses icons or other visual indicators to interact with electronic devices, rather than only text via a command line. For example, all versions of Microsoft Windows are a GUI, whereas MS-DOS is a command line.



Source: https://en.wikipedia.org

Figure 58: Approach for Graphical User Interface (GUI)

4.3.2.3 Self-Assessment

i. What are real-time systems?
ii. Describe the objective of multitasking?
iii. What is menu-driven? Give examples
iv. What is multitasking?
v. State differences: real-time operating system vs. distributed operating system
vi. What is GUI?
    A. A type of virus

B. Good universal indicator
C. There is no such a thing
D. Graphical user interface

v. **Case situation:** A user is running Windows 8 and wants to upgrade to Windows 10. Is this possible? If yes, how? If no, why?

vi. Identify the difference between: Ubuntu and VLC player

vii. _____ is an example of menu driven software.

viii. _____ is an example of GUI software program.

ix. Identify the application software from the image below:

Source: https://brainly.in

x. Types of software programs are
A. Application programs
B. Replicate programs
C. Logical programs
D. Both A and B

xi. Examples of system programs includes
A. Operating system of computer
B. Trace program
C. Compiler
D. All of above

4.3.2.4 Tools, Equipment, Supplies and Materials

Computer, Operating system, Utility program, external hard disk, Deploy master

4.3.2.5 References

- https://www.techopedia.com/definition/4356/software
- http://ecomputernotes.com/software-engineering/characteristics-and-classification-of-software

- https://www.tankonyvtar.hu/en/tartalom/tamop412A/2011_0009_Herdon_Miklos-Agroinformatics/ch03s09.html
- https://www.tutorialspoint.com/operating_system/os_overview.htm
- https://study.com/academy/lesson/what-is-a-graphical-user-interface-gui-definition-components-examples.html
- Software Engineering authored by Sumit Prakash Tayal, Bharat Bhushan Agarwal, published by Firewall 2009
- Principles of Operating Systems: Design and Applications authored by Brian Stuart published by Cengage Learning 2008

4.3.3 Learning Outcome 2: Install the software

4.3.3.1 Learning Activities

The following are the performance criteria:

- Software specifications and computer resource requirements are identified
- Source of software installation files is determined
- Existing data is backed up
- User vendor agreements are identified according to the installation manual
- Software installation is done as per the installation manual provided

Trainees to demonstrate knowledge in relation to:

- Define software installation
- Acquisition of software
- Installation media
- Software installation legal requirements
- Existing data protection
- Types of software installation: Attended, Unattended, Headless, Schedule/Automated, Clean/Updating, Network
- Software and installation and registration
- Software configuration
- Importance of registration

4.3.3.2 Information Sheet

Software installation is the process of making hardware and/or software ready for use. Obviously, different systems require different types of installations. While certain installations are simple and straightforward and can be performed by non-professionals, others are more complex and time-consuming and may require the involvement of specialists.

The **software acquisition** is a computer-aided system that supports the improvement of an organization's **software acquisition** process capability and performance.

Software installation legal requirements : Software can be provided as a single user and

multi-user user license:

- **Single user(s):** Software can be activated on single PCs and notebooks.
- **Multi-user network license:** Software can be activated over a network for multiple users.

Data Protection controls how your personal information is used by organizations, businesses or the government.

Read: Data protection policy: https://www.gov.uk/data-protection

Attended installation goes through the following setup stages:

- **Setup Program (text mode):** prepares the hard drive for the subsequent stages of installation and copies the files required for running the Setup Wizard. Requires reboot. (Clean installations only.)
- **Setup Wizard (graphical mode):** prompts for additional information such as product key, names, passwords, regional settings, etc.
- **Install Windows Networking:** detects adapter cards, installs networking components (Client for MS Networks, File & Printer Sharing for MS Networks), and installs TCP/IP protocol by default (other protocols can be installed later). You can choose to join a workgroup or domain at this stage. You must be connected to network and provide appropriate credentials to join a domain. After all choices have been made, components are configured, additional files are copied, and the system is rebooted.
- **Post installation:** create user accounts and activate retail versions software. This stage is sometimes referred to as the "Out of Box Experience" (OOBE).

Read: Attended installation: https://www.sqa.org.uk/e-learning/ClientOS01CD/page_01.htm

Unattended installation is a procedure for installing software without user intervention.

Read: Unattended installation: http://www.thenetworkencyclopedia.com/entry/unattended-installation/

Headless software (e.g. "headless java" or "headless Linux") is software capable of working on a device without a graphical user interface. Such software receives inputs and provides output through other interfaces like network or serial port and is common on servers and embedded devices.

A **clean install** is a software installation in which any previous version is eradicated. The alternative to a clean install is an **upgrade,** in which elements of a previous version remain.

Software license registration tools and services provide the means for presenting a software

developer's software licenses (also known as an End-User License Agreement, or EULA) to an end user as well as facilitating the transfer of required registration information and consent to the license. Successfully registering a software application often activates the software for legal use by the end user or enterprise.

Read: Software licenses: https://www.webopedia.com/TERM/L/license_registration.html

In software engineering, **software configuration management** (SCM or S/W CM) is the task of tracking and controlling changes in the software, part of the larger cross-disciplinary field of configuration management. SCM practices include revision control and the establishment of baselines.

4.3.3.3 Self-Assessment

i. What is the importance of registering software?
ii. Differentiate attended installation and unattended installation.
iii. What is Software Acquisition?
iv. Explain headless software.
v. **Case situation:** Your computer application software prompts you to upgrade it and you do not have registration keys how will fix the issue?
vi. Identify and install software for office application.
vii. Identify and install software for doing creative design.
viii. Hardness software is software capable of working on a device without a graphical user interface
   A. True
   B. False
viii. _____is the process of making hardware and/or software ready for use?
   A. Hardness software
   B. Software installation
   C. Clean install
ix. _____ software can be activated on single PCs and laptops?
   A. Single user
   B. Attended
   C. Multi user
x. Attended installation goes through the following setup stages:
   A. Setup Program text mode
   B. Setup Wizard graphical mode
   C. Install Windows Networking
   D. Post installation

4.3.3.4 Tools, Equipment, Supplies and Materials

Computer, external hard disk, deploy master, install ware

4.3.3.5 References

- https://resources.sei.cmu.edu/library/asset-view.cfm?assetid=13031
- http://www.thenetworkencyclopedia.com/entry/unattended-installation/
- https://www.sqa.org.uk/e-learning/ClientOS01CD/page_04.htm
- Software Engineering authored by Sumit Prakash Tayal, Bharat Bhushan Agarwal, published by Firewall, 2009
- Principles of Operating Systems: Design and Applications authored by Brian Stuart published by Cengage Learning, 2008

4.3.4 Learning Outcome 3: Configure the software

4.3.4.1 Learning Activities

The following are the performance criteria:

- Software configuration is done as per the installation manual provided
- Required software parameters are set as per the software manual
- Software configuration is done as per the set parameters

Trainees to demonstrate knowledge in relation to:

- Software configuration components: Software Configuration Identification, Software Configuration Control, Software Configuration Status Accounting and Auditing
- Reasons for software configuration: Tracking and Controlling
- Importance of software configuration management: identification and management
- Auditing and accounting

4.3.4.2 Information Sheet

Identification, control, audit, and status accounting are the four basic requirements for a **software configuration** management system. These requirements must be satisfied regardless of the amount of automation within the SCM process. All four may be satisfied by an SCM tool, a tool set, or a combination of automated and manual procedures.

Configuration identification is the process of identifying the attributes that define every aspect of a configuration item. A configuration item is a product (hardware and/or software) that has an end-user purpose.

The recording and reporting of information needed for configuration management including the status of configuration items proposed changes and the implementation status of approved changes. Status accounting provides the means by which the current state of the development can be judged and the history of the development life cycle can be traced.

A typical Configuration Status Report might include:

- A list of the configuration items that comprise a baseline
- The date when each version of each configuration item was baselined
- A list of the specifications that describe each configuration item

- The history of baseline changes including rationales for change
- A list of open change requests by configuration item
- Deficiencies identified by configuration audits
- The status of works associated with approved change requests by configuration identifier

Tracking software observes and tracks the operations and activities of users, applications and network services on a computer or enterprise systems. This type of software provides a way to supervise the overall processes that are performed on a computing system, and provides reporting services to the system or network administrator.

Software control is the set of procedures used by organizations to ensure that a software product will meet its quality goals at the best value to the customer, and to continually improve the organization's ability to produce software products in the future.

The purpose of configuration identification is to maintain control of an evolving system by:

- Uniquely identifying the system, revisions of the system and the component parts of each revision
- Understanding the status of configuration items as they progress through the development process.

4.3.4.3 Self-Assessment

i. What are the requirements of software installation?
ii. Why identification configuration is important?
iii. What is software tracking?
iv. What is software controlling?
v. Prepare a configuration status report.
vi. **Case situation**: Download different tracking software and prepare a detailed report on the software used.
vii. **Case situation:** You are asked to visit a high school hostel to check their ICT lab set up. There key challenge has been high Internet consumption. What will be your approach of addressing their challenges?
viii. _____ is the set of procedures used by organizations to ensure that a software product will meet its quality goals at the best value to the customer?
   A. Microsoft
   B. Operating system
   C. Software control
ix. _____Software observes and tracks the operations and activities of users, applications and network services on a computer or enterprise systems.
   A. Sniffing
   B. Tracking
   C. Hacking
   D. Penetration

4.3.4.4 Tools, Equipment, Supplies and Materials

Computer, external hard disk, Deploy master, utility program

4.3.4.5 References

- https://www.techopedia.com/definition/4313/monitoring-software
- http://www.chambers.com.au/glossary/configuration_status_accounting.php
- Software Engineering authored by Sumit Prakash Tayal, Bharat Bhushan Agarwal, published by Firewall 2009

4.3.5 Learning Outcome 4: Test software functionality

4.3.5.1 Learning Activities

The following are the performance criteria:

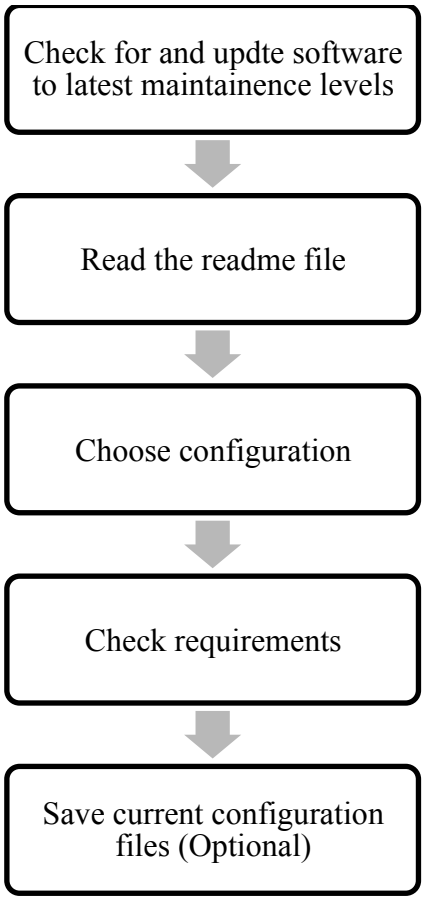
- Software test is performed
- Software functionality is determined according to the test performed
- Test report is generated
- Corrective measures are taken based on the test report

Trainees to demonstrate knowledge in relation to:

- Define software installation testing
- Installation checklist
- Functional Testing: Mainline functions, Basic Usability, Accessibility , Error Conditions

4.3.5.2 Information Sheet

Installation testing is performed to check if the software has been correctly installed with all the inherent features and that the product is working as per expectations. Also known as implementation testing, it is done in the last phase of testing before the end user has his/her first interaction with the product.



Source: https://www.ibm.com

Figure 59: Basic program installation steps

Installation checklist: Following is the checklist for installation

- Determine the root path
- Attach the hardware keys
- Install the Software on the server
- Install the Software at every workstation
- Configure the root path at each workstation.
- Test your installation

Functional Testing is defined as a type of testing which verifies that each function of the software application operates in conformance with the requirement specification. This testing mainly involves black box testing and it is not concerned about the source code of the application.

- **Mainline functions**: Testing the main functions of an application
- **Basic Usability**: It involves basic usability testing of the system. It checks whether a user can freely navigate through the screens without any difficulties.
- **Accessibility**: Checks the accessibility of the system for the user
- **Error Conditions**: Usage of testing techniques to check for error conditions. It checks whether suitable error messages are displayed.

Watch: How to resolve problems while installing software in Windows 10: https://youtu.be/rKKatwf6dSM

Watch: How to install software and resolve issues: https://youtu.be/3D4CkPNDUf8

4.3.5.3 Self-Assessment

i. What are mainline functions?
ii. Define installation testing.
iii. Differentiate between accessibility and error conditions
iv. In which activity of the Fundamental Test Process is the test environment set up?
   A. Test implementation and execution
   B. Test planning and control
   C. Test analysis and design
   D. Evaluating exist criteria and reporting
v. Identify a productivity software and install it in a Windows computer.
vi. Identify an entertainment software and install it in a Windows laptop.
vii. _____checks the accessibility of the system for the user
   A. Accessibility
   B. Usability
   C. Durability
   D. None of above
viii. _____ test the main functions of an application
   A. Basic usability
   B. Mainline functions
   C. Accessibility

4.3.5.4 Tools, Equipment, Supplies and Materials

Computer, diagnostic tools

4.3.5.5 References

- http://www.professionalqa.com/installation-testing
- https://www.guru99.com/functional-testing.html
- Software Engineering authored by Sumit Prakash Tayal, Bharat Bhushan Agarwal, published by Firewall 2009

4.3.6 Learning Outcome 5: Perform user training

4.3.6.1 Learning Activities

The following are the performance criteria:

- Determine user skill set as per the instructions manual
- User training manuals are prepared according to software functionality
- User training is conducted according to system functionality

Trainees to demonstrate knowledge in relation to:

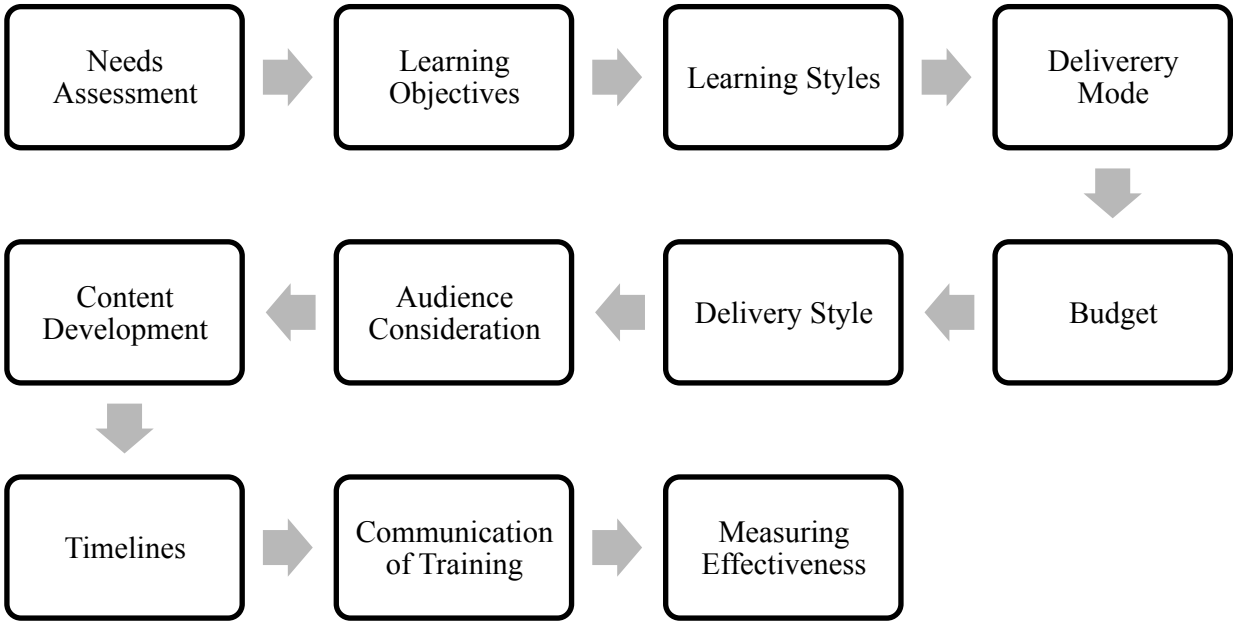
- Keys to Developing an End User Training Plan: Determine user skill set, Creating a training program, Setting training goals, Training delivery methods, Assessing end-user needs
- Training feedback

4.3.6.2 Information Sheet

Determine set skill your training program scalable a scalable training program is flexible enough to accommodate both small numbers of users (for example, when new employees join the company and need to be trained on the software) and large numbers (as is necessary in an organization-wide rollout of a new product).

Creating a training program: End-user training is more effective and memorable if you tailor it to your own organization's use of the software, rather than generic lessons.

Setting training goals: Your first objective in providing software training for end-users is minimizing any productivity losses associated with the software transition. This means you have to, as quickly as possible, get them up to the skill level required to do their jobs at least as quickly and accurately as they were doing with the old software.



Source: https://saylordotorg.github.io

Figure 60: Training module development and delivery steps

Training delivery methods

- Individual hands-on instructor
- Hands-on classroom style instructor-led training
- Seminar style group demonstration
- Computer Based Training (CBT)
- Book-based self-paced training

Assessing end-user needs An important element in creating your training plan is to evaluate the technical skill level(s) of those who will actually use the software on a daily basis.

Overall Considerations

Before considering specific training techniques, ask yourself these questions:

- What are your training goals for this session?
  - New skills
  - New techniques for old skills
  - Better workplace behavior
  - A safer workplace
  - A fair and equal workplace free of discrimination and harassment
- Who is being trained?
  - New employees
  - Seasoned employees
  - Upper management
- What is your training budget?
- How much time has been allocated for training within your organization?
- What training resources and materials do you have at your disposal?

A training feedback form is a tool used by training managers and human resource professionals to collect feedback from trainers and trainees. It is used to identify skill gaps and problems to help improve training programs and the overall experience these programs provide.

4.3.6.3 Self-Assessment

i. Determine user-training needs?

ii. Explain training delivery methods for software training.

iii. **Case situation:** Prepare a checklist for assessing training requirements of a women's Sacco group for using social media for enhancing their business opportunities.

iv. **Case situation:** Prepare a basic introduction to computer course for a community group who has never used computers.

v. **Case-situation:** You are asked to prepare and submit a proposal for conducting ICT training for using various office packages that promotes productivity in a legal firm. What will be the key training outcomes that you will focus on?

vi. End-user training is more effective and memorable if you tailor it to your own organization's use of the software, rather than generic lessons.
   A. True
   B. False

vii. Blended approach is best for non-native computer users.
   A. True
   B. False

viii. Blended training approach means:
   A. Self-paced training
   B. Instructor driven training
   C. Both
   D. None of the above

4.3.6.4 Tools, Equipment, Supplies and Materials

Computer, Diagnostic tools, Application software

4.3.6.5 References

- https://www.sunviewsoftware.com/blog/learn/blog/5-keys-to-end-user-training
- End-User Training (Technological Innovation And Human Resources) authored by Urs E. Gattiker published by D Gattiker

4.3.7 Learning Outcome 6: Perform Software Maintenance

4.3.7.1 Learning Activities

The following are the performance criteria:

- Software maintenance schedule is established
- Software upgrades and modules patches are applied.
- Software revisions are performed to correspond with functionality changes.

Trainees to demonstrate knowledge in relation to:

- Develop software maintenance schedule
- Evaluate the software
- Perform maintenance procedures
- Software maintenance report generated

4.3.7.2 Information Sheet

Software maintenance in software engineering is the modification of a software product after delivery to correct faults, to improve performance or other attributes.

The **software evaluation** is done through reviewing non-systematic checklists at regular intervals with different users and evaluation of overall performance efficiency.

Maintenance procedures are important. This process requires detailed knowledge of maintenance requirements and the resources that are required in order to perform maintenance. The resources required include labour, parts, materials, and tool costs.

Maintenance Reporting: The software developer normally generates a maintenance request form (MRF), sometimes called software problem report that is completed by the user who desires a maintenance activity.

4.3.7.3 Self-Assessment

i. What is software maintenance?

ii. What is maintenance evaluation?

iii. Software Maintenance includes:

A. Error corrections

B. Enhancements of capabilities

C. Deletion of obsolete capabilities

D. All of the mentioned

iv. Maintenance is classified into how many categories?

A. Two

B. three

C. four

D. five

v. **Case situation**: You are software developer and you have developed software for one of your client but you didn't mention to him that the software needs maintenance to work perfectly. What are the steps you will consider taking to ensure that client pays additionally for software maintenance?

vii. _____ in software engineering is the modification of a software product after delivery to correct faults, to improve performance or other attributes.

A. Software maintenance

B. Maintenance procedure

C. Maintenance reporting

Tools, Equipment, Supplies and Materials

Diagnostic tool, computer, processor and memory optimizers

4.3.7.5 References

- https://www.igi-global.com/dictionary/software-evaluation/27677
- http://swebokwiki.org/Chapter_5:_Software_Maintenance
- https://www.tutorialspoint.com/software_engineering/software_maintenance_overview.htm
- Software Engineering authored by Sumit Prakash Tayal, Bharat Bhushan Agarwal, published by Firewall, 2009

CHAPTER 5: ICT SECURITY THREATS

5.1 Introduction

This unit covers the competencies required to provide ICT security. They include identification of security threats, installation of security control measures, implementation of security measures, testing of system vulnerability and monitoring of the security system.

5.1 Performance Standard

- Identified and classified security threats
- Identified and categorized security control measures
- Implemented ICT security policy
- Developed a schedule system testing plan

5.3 Learning Outcome

5.3.1 List of the Learning Outcomes

These are the key learning outcomes, which make up workplace function:
- Identify security threats
- Establish and Install security measures
- Deploy security measures
- Test system vulnerability
- Monitor security system

5.3.2 Learning Outcome 1: Identify security threats

5.3.2.1 Learning Activities

The following are the performance criteria:
- Security threats are identified based on the vulnerability of the system.
- Security threats are categorized according to the risk impact
- Appropriate security measures are selected as per the security threats

Trainees to demonstrate knowledge in relation to:
- Definition of security threats
- Categories of security threats: Internal and External
- Importance of Computer Security to an Organization
- Identification of Common threats: Fraud and theft, Employee sabotage, Loss of physical and infrastructure support, Malicious hackers and code, Industrial espionage, Threats to personal privacy, Natural Calamities, Cyber crime
- Constraints to computer security: Cost, User responsibility, Integration challenges, Inadequate Assessment

5.3.2.2 Information Sheet

A threat, in the context of **computer security,** refers to anything that has the potential to cause serious harm to a computer system. A threat is something that may or may not happen, but has the potential to cause serious damage. Threats can lead to attacks on computer systems, networks and more.

An **internal threat** originating inside a company, government agency, or institution, and typically an exploit by a disgruntled employee denied promotion or informed of employment termination. An attacker who has sought temporary employment with a target and uses social engineering skills to get on the inside also can launch such exploits.

External threat, originate outside a company, government agency, or institution. In contrast, an internal threat is one originating inside the organization typically by an employee or "insider."

Importance of computer security to an organization:
To protect company's assets: This can be considered as the primary goal of securing the computers and computer networks. The assets mean the information that is stored in the computer networks, which are as crucial and valuable as the tangible assets of the company. The computer and network security is concerned with the integrity, protection and safe access of the confidential information. It also involves the accessibility of information in a meaningful manner.

To comply with regulatory requirements and ethical responsibilities: It is the responsibility of every organization to develop procedures and policies addressing the security requirements of every organization. These policies work for the safety and security of any organization and are compulsory for any organization working on computers. Protection of company's assets would mean that it is protected from liability addressing to the ethical responsibilities of an organization.

For competitive advantage: Developing an effective security system for networks will give the organization a competitive edge. In the arena of Internet financial services and e-commerce, network security assumes prime importance. The customers would avail the services of Internet banking only if the networks are secured.

Fraud and theft have a lot in common. Both are criminal acts, and both are forcibly taking something from others without asking permission. Both are all about stealing and both are bad things.

Read: Difference between fraud and theft:
http://www.differencebetween.net/miscellaneous/difference-between-fraud-and-theft/#ixzz5qRVXtQ00

Identification of common threats: It is important to identify and appropriately manage common threats to an organization.

- **Employee sabotage:** Employees are most familiar with their employer's computers and applications, this include knowing what actions might cause the most damage, mischief, or sabotage.
- **The loss of supporting infrastructure** includes power failures (outages, spikes, and brownouts), loss of communications, water outages and leaks, sewer problems, lack of transportation services, fire, flood, civil unrest, and strikes.
- **The term malicious hackers,** sometimes called crackers, refer to those who break into computers without authorization. They can include both outsiders and insiders. Much of the rise of hacker activity is often attributed to increases in connectivity in both government and industry.
- **Malicious code** refers to viruses, worms, Trojan horses, logic bombs, and other "uninvited" software. Sometimes mistakenly associated only with personal computers, malicious code can attack other platforms.
- **Industrial espionage** is the act of gathering proprietary data from private companies or the government for the purpose of aiding another company(ies). Industrial espionage can be perpetrated either by companies seeking to improve their competitive advantage or by governments seeking to aid their domestic industries.

Threats to personal privacy

- The accumulation of vast amounts of electronic information about individuals by governments, credit bureaus, and private companies, combined with the ability of computers to monitor, process, and aggregate large amounts of information about individuals have created a threat to individual privacy.
- **Natural calamities**, such as earthquakes, floods and hurricanes, can damage computer. Fires, extreme temperatures and lightning strikes can cause major physical damage and lead to loss of data.

Cybercrime, or computer-oriented crime, is a crime that involves a computer and a network. The computer may have been used in the commission of a crime, or it may be the target.

User responsibility

- Use computer and information systems in an ethical and legal manner.
- Agree not to duplicate or use copyrighted or proprietary software without proper authorization.

The challenge of integration between physical and cyber security creates a number of challenges. First, no single system exists to confirm a person's identity because each functional security department controls its own identity database. Second, the lack of integration increases the potential for theft.

Case studies - Cyber Crime around the world

Wanna Cry virus hits the NHS, 2017

The most widespread cyber attack ever, hackers managed to gain access to the NHS' computer system in mid-2017, causes chaos among the UK's medical system. The same hacking tools were used to attack worldwide freight company FedEx and infected computers in 150 countries. Ransomware affectionately named "WannaCry" was delivered via email in the form of an attachment. Once a user clicked on the attachment, the virus was spread through their computer, locking up all of their files and demanding money before they could be accessed again. As many as 300,000 computers were infected with the virus.

It was only stopped when a 22-year-old security researcher from Devon managed to find the kill switch, after the NHS had been down for a number of days.

JP and Morgan Chase & Co target of giant hacking conglomerate, 2015

Late in 2015, three men were charged with stealing data from millions of people around the world, as part of a hacking conglomerate that spanned the best part of a decade. The group stole information from more than 83 million customers from JP Morgan alone, and are thought to have made hundred of millions of dollars in illegal profits. Along with personal data, the hacking group also stole information related to company performance and news, which allowed them to manipulate stock prices and make enormous financial gain.

Sony Pictures crippled by GOP hackers, 2014

In late 2014, major entertainment company Sony Pictures were hit with a crippling virus. Cyber crime group Guardians of Peace (GOP) were behind the apparent blackmail attempt, which saw around 100 terabytes of sensitive data stolen from the company.

One billion user accounts stolen from Yahoo, 2013

In one of the largest cases of data theft in history, Yahoo had information from more than one billion user accounts stolen in 2013. Personal information including names, phone numbers, passwords and email addresses were taken from the Internet giant.

Source: https://www.nation.co.ke

Figure 61: Cyber crime in Kenya

5.3.2.3 Self-Assessment

i. What is the difference between fraud and theft?

ii. Differentiate internal and external threads?

iii. What is hacking?

iv. What is malicious?

v. Differentiate hacking and cybercrime?

vi. **Case situation:** One of your friend's social media accounts has been hacked. What will you do to help him?

viii. Review various risks associated with computer security and make a detail report on how to address them.

ix. What are the training contents you will consider for helping community understand the security treats related to cyber security?

x. **Case situation:** You at working as a consultant to the Financial Auditing firm. They want you to evaluate their employee contract and ensure that there are strict rules against cyber crime. What will be your suggestions? They also want you to improvise their security. They are a financial audit firm and they need to ensure security of all their client data.

xi. Which of the following are forms of malicious attack?

A. Theft of information
B. Modification of data
C. Wiping of information
D. All of the mentioned

E.

xii. What are common security threats?
   A. File Shredding
   B. File sharing and permission
   C. File corrupting
   D. File integrity

xiii. What is not a good practice for user administration ?
   A. Isolating a system after a compromise
   B. Perform random auditing procedures
   C. Granting privileges on a per host basis
   D. Using telnet and FTP for remote access.

xiv. Why would a hacker use a proxy server?
   A. To create a stronger connection with the target.
   B. To create a ghost server on the network.
   C. To obtain a remote access connection.
   D. To hide malicious activity on the network.

xvi. Conduct secondary analysis and share in group discussion regarding challenges of data hacking on social media site.

5.3.2.4 Tools, Equipment, Supplies and Materials

Hardware security, Data encryption, Cybersecurity education, LastPass Enterprise, Password

5.3.2.5 References

- https://www.avalan.com/blog/bid/385189/Importance-Of-Network-Security-For-Business-Organization
- https://www.yourdictionary.com/external-threat
- https://www.coursehero.com/file/11659891/Employee-sabotage/
- http://www.differencebetween.net/miscellaneous/difference-between-fraud-and-theft/#ixzz5qRVXtQ00
- Cyber Security, authored by John G. Voeller published by Wiley, 2014

5.3.3 Learning Outcome 2: Establish and install security measures

5.3.3.1 Learning Activities

The following are the performance criteria:

- ICT Security policy is implemented as per the Kenya Security Act 2018
- Security control measures are identified and categorized as per the laws governing security in ICT.
- Evaluation of Security control measures is done as per the ICT Security policy
- Installation of Security control measures is done as per the ICT Security policy

Trainees to demonstrate knowledge in relation to:

- Definition of security risk management
- Benefits of Risk management
- Risk management procedures: Risk assessment, Risk mitigation Uncertainty analysis, Interdependencies, Cost considerations
- Benefits of security measures
- Types of Security measures: Firewalls, User accounts control, Security policies, Antivirus, Encryption, Secure Socket Layer protocol (SSL), Multi-factor authentication, Malware detection, Site monitoring, Daily or weekly backups
- Application of security measures

5.3.3.2 Information Sheet

Risk is the possibility of something adverse happening. **Risk management** is the process of assessing risk, taking steps to reduce risk to an acceptable level and maintaining that level of risk. Though perhaps not always aware of it, individuals manage risks every day. Actions as routine as buckling a car safety belt, carrying an umbrella when rain is forecast, or writing down a list of things to do rather than trusting to memory fall into the purview of risk management. People recognize various threats to their best interests and take precautions to guard against them or to minimize their effects.

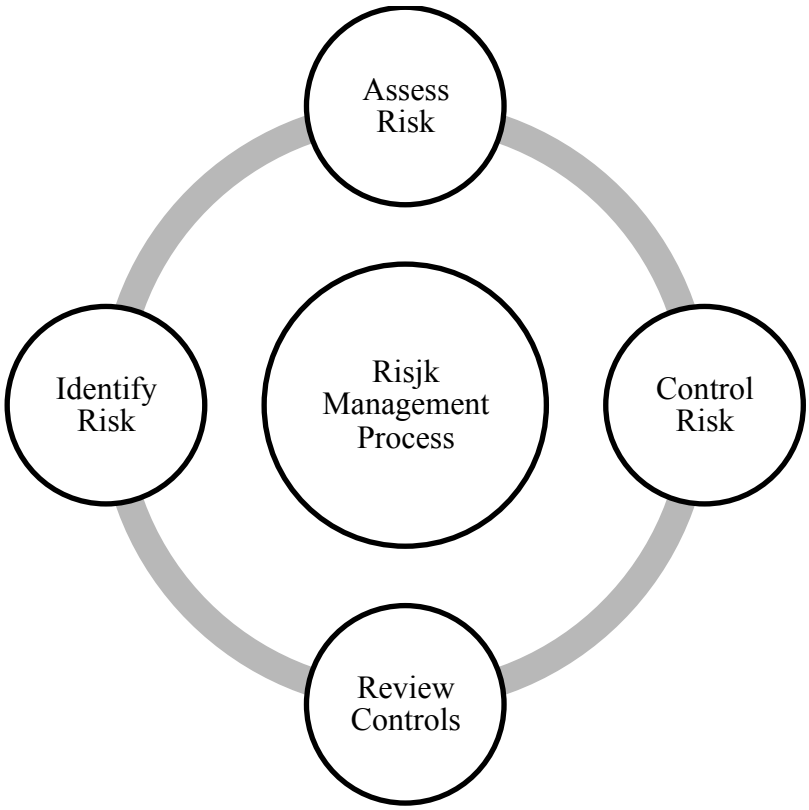
Risk assessment often produces an important side benefit in depth knowledge about system and an organization as risk analyst tries to figure out how system and functions are interrelated. **Risk assessment,** the process of analyzing and interpreting risk, is comprised of three basic activities:

- Determining the assessment's scope and methodology;
- Collecting and analyzing data; and
- Interpreting the risk analysis results

Read: Introduction to computer security:
http://www.davidsalomon.name/CompSec/auxiliary/handbook.pdf

Risk mitigation involves the selection and implementation of security controls to reduce risk

to a level acceptable to management, within applicable constraints.



Source: www.123rf.com

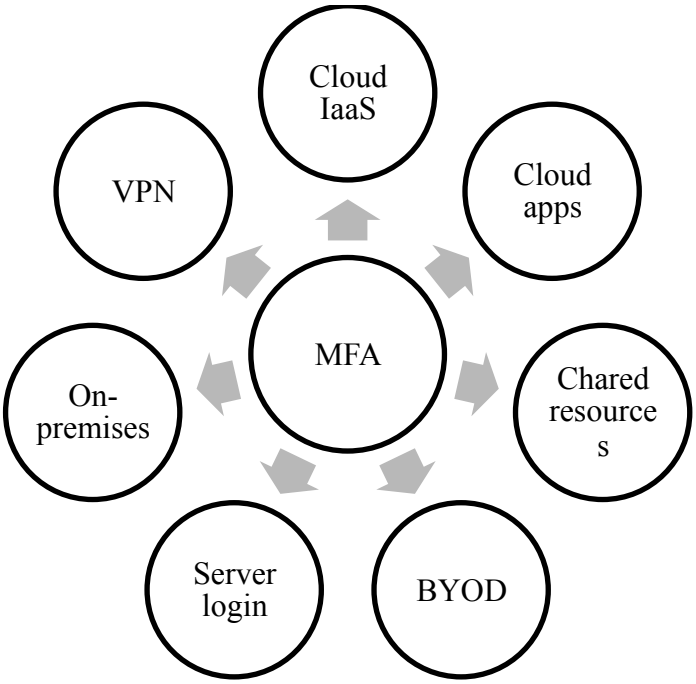
Figure 62: Risk Management Process

Interdependencies: Risk management touches on every control it is, however, most closely related to life cycle management and the security planning process. The requirement to perform risk management is often discussed in organizational policy and is an issue for organizational oversight.

The cost of different methodologies can be significant. A "back-of-the-envelope" analysis or high-medium-low ranking can often provide all the information needed. However, especially for the selection of expensive safeguards or the analysis of systems with unknown consequences, more in-depth analysis may be warranted.

Secure Sockets Layer (SSL) is a standard protocol used for the secure transmission of documents over a network. Developed by Netscape, SSL technology creates a secure link between a Web server and browser to ensure private and integral data transmission. SSL uses Transport Control Protocol (TCP) for communication.

Multi-factor authentication is an authentication method in which a computer user is granted access only after successfully presenting two or more pieces of evidence to an authentication mechanism: knowledge, possession, and inherence. Two-factor authentication is a type, or subset, of multi-factor authentication.



Source: www.centrify.com

Figure 63: Multi-factor authentication (MFA)

Watch: Introduction to multi-factor authentication: https://youtu.be/tFv101qURKE

Malware detection focuses on detecting intrusions by monitoring the activity of systems and classifying it as normal or anomalous.

Malware Infection Symptoms

- Strange emails
- Files wont open
- Programs acting weird
- Pop-up

Source: thelatesttechnews.com

Figure 64: Malware infection symptoms

Watch: Prevention and detection of malware: https://youtu.be/Ces7UeMQ7ic

Site monitoring is the process of testing and verifying that end-users can interact with a website or web application as expected. Website monitoring is often used by businesses to ensure website uptime, performance, and functionality is as expected.

Some common **backup frequencies** you'll see offered include continuous, once per minute, every x minutes (e.g. every 15 minutes), hourly, daily, weekly, monthly, and manually. Continuous backup means that the software is constantly backing up data.

Application security encompasses measures taken to improve the security of an application often by finding, fixing and preventing security vulnerabilities.

Watch: Introduction to site monitoring: https://youtu.be/Ufw6iuwm1rU

5.3.3.3 Self-Assessment

i. What is meant by risk assessment of an organization's ICT department?

ii. What is SSL?
   A. Source socket layer
   B. Secure socket lay
   C. Socket secure layer
   D. Secure socket layer

iii. What is Multi-factor authentication?

iv. What is site monitoring?

v. Evaluation of security control measures is done as per the ICT Security policy in the lab

vi. Installation of Security control measures is done as per the ICT Security policy in the lab.

vii. **Case situation:** How can you help an organization to set multi-factor authentication when making any changes on their system administration settings?

viii. _____ is an authentication method in which a computer user is granted access only after successfully presenting two or more pieces of evidence to support credibility.
   A. Multi-factor authentication
   B. Cost
   C. Monitoring

5.3.3.4 Tools, Equipment, Supplies and Materials

Computer, anti-virus, maintenance tools, anti-spyware, password management software, Internet

5.3.3.5 References

- http://www.davidsalomon.name/CompSec/auxiliary/handbook.pdf
- https://www.keycdn.com/blog/website-monitoring-tools
- Cyber Security, authored by John G. Voeller published by Wiley 2014

5.3.4 Learning Outcome 3: Deploy security measures

5.3.4.1 Learning Activities

The following are the performance criteria:

- Physical control measures are implemented according to the ICT security policy
- Logical security control measures are implemented according to the ICT security policy
- ICT Security policy is implemented according to the Kenya security Act 2018

Trainees to demonstrate knowledge in relation to:

- Implement security measures contained in the ICT security policy
- Apply physical and logical risk mitigation measures
- Take corrective action
- Security audit to identify security gaps
- Generate system audit report

5.3.4.2 Information Sheet

Implement security measures contained in the ICT security policy:

- Identify your risks
- Learn from others
- Make sure the policy conforms to legal requirements
- Level of security equals to the level of risk
- Include staff in policy development
- Train your employees
- Get it in writing
- Set clear penalties and enforce them
- Update your staff
- Install the tools you need

Read: Successful ICT policy: https://www.computerworld.com/article/2572970/10-steps-to-a-successful-security-policy.html

Read: Kenya's ICT policy: http://icta.go.ke/national-ict-policy/

A logical mitigation strategy ties assets to threats to vulnerabilities to identify risks. Solutions for the identified risks typically enhance three facets of security: Policies, Procedures and Training; Physical/Electronic Security Systems; and Security Personnel.

Corrective action is a process of communicating with the employee to improve attendance, unacceptable behavior or performance. You may take corrective action when other methods such as coaching and performance management have not been successful.

The network security audit is a process that many managed security service providers

(MSSPs) offer to their customers. In this process, the MSSP investigates the customer's cyber security policies and the assets on the network to identify any deficiencies that put the customer at risk of a security breach.

5.3.4.3 Self-Assessment

i. What is corrective action?
ii. Define network security audit?
iii. Review the computer lab and prepare a report if it conforms to the ICT Security Act 2018.
iv. Security levels should be _____ to risks involved.
   A. Equal
   B. Great
   C. Appoximate
v. National security of Kenya is govern by _____ .
   A. ICT Authority
   B. Police
   C. Network of ICT

5.3.4.4 Tools, Equipment, Supplies and Materials

Firewall, Malware Protection, Software Updates, Audit and Accountability

5.3.4.5 References

- https://www.computerworld.com/article/2572970/10-steps-to-a-successful-security-policy.html
- https://www.nyu.edu/about/policies-guidelines-compliance/policies-and-guidelines/data-and-system-security-measures.html
- Cyber Security, authored by John G. Voeller published by Wiley 2014

5.3.5 Learning Outcome 4: Test system vulnerability

5.3.5.1 Learning Activities

The following are the performance criteria:

- Schedule system testing plan is developed
- Vulnerable levels of the system are identified
- Security ethical penetration is done as per the ICT security policy
- Report on system vulnerability is generated
- Corrective action is taken based on the System Vulnerability report

Trainees to demonstrate knowledge in relation to:

- Definition of vulnerability
- System testing schedule
- Levels of system vulnerability
- Ethical penetration

- System vulnerability test report

5.3.5.2 Information Sheet

Computer vulnerability is a cyber security term that refers to a defect in a system that can leave it open to attack. This vulnerability could also refer to any type of weakness present in a computer itself, in a set of procedures, or in anything that allows information security to be exposed to a threat.

A System test schedule includes the testing steps or tasks, the target start and end dates, and responsibilities. It should also describe how the test will be reviewed, tracked, and approved.

Level of system vulnerability
Critical, High, Medium, Low

Read: types of vulnerability:
https://www.atlassian.com/trust/security/security-severity-levels

Ethical penetration is a broader term that includes all hacking methods, and other related cyber attack methods. The goal of ethical hacking is still to identify vulnerabilities and fix them before criminals can exploit them, but the approach is much wider in scope than simple testing. In other words, ethical hacking is more of an umbrella term, while penetration testing represents one subset of all ethical hacking techniques.

Watch: Ethical penetration: https://youtu.be/BEdaiUzUsgM

A vulnerability report is the process of identifying, quantifying, and prioritizing (or ranking) the vulnerabilities in a system.

5.3.5.3 Self-Assessment

i. What is ethical penetration?
ii. Define computer vulnerability.
iii. Explain level system vulnerability.
iv. Identify the vulnerability levels of a system. Prepare a case study using an example.
v. Prepare report at a worksite on the security system on their computers and network.
vi. _____ is a broader term that includes all hacking methods, and other related cyber attack methods.
   A. Vulnerability
   B. Ethical penetration
   C. A System test schedule
vii. When is it better to perform a vulnerability assessment versus a penetration test?
   A. It is necessary to perform them together
   B. When you seek a larger overview of the environment, versus a smaller view
   C. Penetration tests are full of false positives and should not be used

D. Penetration tests are potentially damaging to devices and should not be used

viii. _____ is a weakness that can be exploited by attackers.

A. System with virus
B. System without firewall
C. System with vulnerabilities
D. System with strong password

5.3.5.4 Tools, Equipment, Supplies and Materials

Wireshark, Nmap, Metasploit, sqlmap

5.3.5.5 References

- https://www.hudsoncourses.com/ethical-hacker-vs-penetration-tester/
- https://www.atlassian.com/trust/security/security-severity-levels
- Cyber Security, authored by John G. Voeller published by Wiley 2014

5.3.6 Learning Outcome 5: Monitor security system

5.3.6.1 Learning Activities

The following are the performance criteria:

- Performance of the security systems is evaluated
- Reports on security system are generated
- Security systems are updated or overhauled based on the security system report

Trainees to demonstrate knowledge in relation to:

- Define monitoring criteria
- Evaluation of system security performance based on defined criteria
- Updating and overhauling of security systems
- Generate monitoring report

3.3.6.2 Information Sheet

Given the ubiquitous, unavoidable nature of security risks, quick response time is essential to maintaining system security and automated, continuous security monitoring is the key to quick threat detection and response. **Monitoring criteria** should be for hackers and malware, to disgruntled or careless employees, to outdated or otherwise vulnerable devices and operating systems, to mobile and public cloud computing, to third-party service providers.

The evaluation criteria developed include the following objectives:

- **Measurement:** Provides a metric for assessing comparative levels of trust between different computer systems.
- **Guidance:** Identifies standard security requirements that vendors must build into systems to achieve a given trust level.

- **Acquisition:** Provides customers a standard for specifying acquisition requirements and identifying systems that meet those requirements.
- **Security policy:** The rules and procedures by which a trusted system operates.
- **Discretionary access control (DAC):** Owners of objects are able to assign permissions to other subjects.
- **Mandatory access control (MAC):** Permissions to objects are managed centrally by an administrator.
- **Object reuse:** Protects confidentiality of objects that are reassigned after initial use. For example, a deleted file still exists on storage media; only the file allocation table (FAT) and first character of the file have been modified. Thus residual data may be restored, which describes the problem of data remanence. Object-reuse requirements define procedures for actually erasing the data.
- **Labels:** Sensitivity labels are required in MAC-based systems.
- **Assurance:** Guarantees that a security policy is correctly implemented.
- **System integrity:** Hardware and firmware operate properly and are tested to verify proper operation.
- **Updating and overhauling of Security systems :** When a company needs new data security practices, an external viewpoint can prove invaluable. Remember, a data security auditor has experience helping many different kinds of companies find what they need to change, and that experience can prove invaluable in creating the *right* kind of overhaul plan. Third party intervention provided broader view of the problem at hand for an organization.

Read: Planning security overhauling: https://www.infiniwiz.com/planning-a-security-overhaul-here-are-key-tips-on-how-to-start/

5.3.6.3 Self-Assessment

i. Define monitoring criteria?

ii. Explain evaluation of system security?

iii. What is overhauling of security?

iv. _____ identifies standard security requirements that vendors must build into systems to achieve a given trust level.

A. System integrity
B. Assurance
C. Guidance
D. Acquisition

v. _____Hardware and firmware operate properly and are tested to verify proper operation.

A. System integrity
B. System architecture
C. Covert channel analysis

vi. _____ provides a metric for assessing comparative levels of trust between different computer systems.

A. Guidance

B. Measurement
C. Security policy
D. Monitoring criteria

vii. You are a Network security administrator and your company. Your company has been attacked by hackers, how will you identify what sort of information have been hacked?

viii. You are an ICT manager of a hotel. The General Manager of your hotel called you this afternoon, since he is having difficulty in accessing past customer details. The files are randomly opening and there is gibberish. What are the possibilities that customer data have been hack? What are your suggestion actions?

5.3.6.4 Tools, Equipment, Supplies and Materials

Network Performance Monitor, Nmap, Computer

5.3.6.5 References

- https://www.dummies.com/programming/certification/evaluation-criteria-systems-security-controls/
- https://www.infiniwiz.com/planning-a-security-overhaul-here-are-key-tips-on-how-to-start/
- https://pdfs.semanticscholar.org/45a2/775770d870b8675fb1301919224c9bcb7361.pdf
- Cyber Security, authored by John G. Voeller published by Wiley 2014

CHAPTER 6: ICT SYSTEM SUPPORT

6.1 Introduction

This unit describes the competencies required to perform ICT infrastructure support. It involves identification and documentation of ICT infrastructure, evaluation of the state of performance and possible causes of failure, diagnosing and fixing of the problems, testing of performance and user training.

6.2 Performance Standard

- Performed audit on existing ICT Components and Infrastructure
- Identified and used appropriate Tools for ICT infrastructural support
- Performed troubleshooting on the ICT infrastructure and components
- Identified and applied Safety and precautions measures as per the internal ICT policy

6.3 Learning Outcome

6.3.1 List of the Learning Outcomes

These are the key learning outcomes, which make up workplace function:
- Identify and document ICT infrastructure
- Evaluate the state of performance and possible causes of failures
- Diagnose and fix problems
- Test component performance
- Perform User training

6.3.2 Learning Outcome 1: Identify and Document ICT infrastructure

6.3.2.1 Learning Activities

The following are the performance criteria:
- Perform audit on existing ICT Components and Infrastructure as per the manufacturers manual
- Perform ICT Components and Infrastructure documentation as per the manufacturers manual
- Classification of ICT infrastructural components is done as per the manufacturers manual
- Specifications of ICT infrastructure is established based on manufacturer's manual
- Tools for ICT infrastructural support are identified as per the audit report
- Safety and precautions measures are identified as per the internal ICT policy
- Maintain the ICT Infrastructure and components asset register to date

Trainees to demonstrate knowledge in relation to:
- Definition of ICT infrastructure
- Components of ICT infrastructure
- ICT infrastructure specifications

- Types of ICT infrastructure: Computer hardware platforms, Operating system platforms, Enterprise and other software applications, Data management and storage, Networking and Telecommunications platforms, Internet platforms, End users
- Safety precautions of ICT Infrastructure
- Documentation of Infrastructure assets and their operational and service status

6.3.2.2 Information Sheet

The ICT Infrastructure that is currently used in the business constitutes all the information and communications technology and other systems infrastructure reasonably necessary to carry on the business, including having sufficient capacity and maintenance and support requirements to satisfy the requirements of the business with regard to information and communications technology, data processing and communications.

Typically, a **standard ICT infrastructure consists of the following components:**

- **Hardware:** Servers, computers, data centers, switches, hubs and routers, and other equipment
- **Software:** Enterprise resource planning (ERP), customer relationship management (CRM), productivity applications and more
- **Network:** Network enablement, internet connectivity, firewall and security
- **Meatware:** Human users, such as network administrators (NA), developers, designers and end users with access to any IT appliance or service are also part of an IT infrastructure, specifically with the advent of user-centric IT service development.

A **computer platform** is a system that consists of a hardware device and an operating system that an application, program or process runs upon. An example of a computer platform is a desktop computer with Microsoft Windows installed on it. A desktop is a hardware device and Windows is an operating system.

In the same way generally an **operating system** acts as an interface between hardware and the user in IT, a **platform** is any hardware or software used to host an application or service.

An application platform, for example, consists of hardware, an operating system and coordinating programs that use the instruction set for a particular processor or microprocessor.

Enterprise software, also known as enterprise application software (EAS), is computer software used to satisfy the needs of an organization rather than individual users. Such organizations include businesses, schools, interest-based user groups, clubs, charities, and governments.

Data management is a critical component of any business strategy as companies of all sizes and types struggle with data growth, **data storage** costs, data protection (through replication,

snapshots or backups) and long-term data storage capacity to meet growing business demands.

Telecommunications/telephone services companies that offer voice and data connectivity, wide area networking, and Internet access typically provide telecommunications platforms.

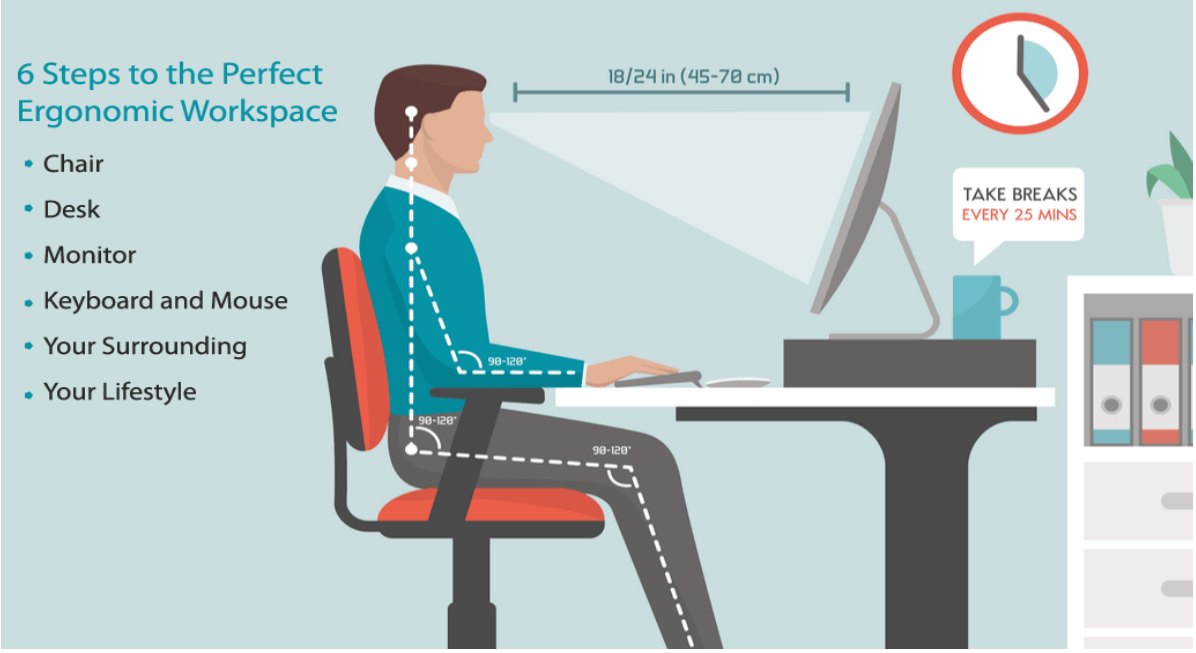
Internet is a big network, which is formed by connecting multiple small networks. It is a platform for all the users that are connected to it. Internet acts as platform in different fields. Such as: Internet as a collaboration platform, Internet as a news and event platform.

An end user is the person that a software program or hardware device is designed for. The term is based on the idea that the "end goal" of a software or hardware product is to be useful to the consumer. The end user can be contrasted with the developers or programmers of the product. End users are also in a separate group from the installers or administrators of the product.

Negative impacts of ICT tools:

- Eye irritation and eye fatigue, lower back pain, wrist pain, cold and flu
- Mobile phone and our health: It is believed that mobile phones can affect the health of people who use them. Research from Finland suggests that mobile phone radiation causes changes in the brain and even low-level emissions from headsets are still damaging.
- Some of the long-term health effects are: Headaches and tiredness, Creates joint pain, Mobile phone battery explosion.

It is important to educate users regarding the negative impacts of using computers for long duration and the harmful effects of sedentary lifestyle. A lot of time users forget to appropriately use ICT tools. These can be easily addressed through ergonomics (workplace furniture and set up) and lifestyle changes.



Source: http://ergonomictrends.com

Figure 65: Sitting ergonomic

Infrastructure asset management is the integrated, multidisciplinary set of strategies in sustaining public infrastructure assets such as water treatment facilities, sewer lines, roads, utility grids, bridges, and railways. Generally, the process focuses on the later stages of a facility's life cycle specifically maintenance, rehabilitation, and replacement. Asset management specifically uses software tools to organize and implement these strategies with the fundamental goal to preserve and extend the service life of long-term infrastructure assets, which are vital underlying components in maintaining the quality of life in society and efficiency in the economy.

6.3.2.3 Self-Assessment

i. What is ICT Infrastructure?
ii. Differentiate between operating system and platform.
iii. Who are end-users?
iv. What is Internet platform?
v. What is enterprise software?
vi. **Case situation:** You are School Network Administrator currently your network device support 50 students, by next year, the total number of student will be 200. What type of network infrastructure will you suggest? Prepare a budget plan for full network solution and seamless ICT education for all students.
vii. Prepare an awareness-training program for proper use of ICT devices for your institution or company.
viii. How do you sit ergonomically on your computer desk?
   A. Bending your back
   B. Your head closer enough to your screen
   C. Your legs on the desk

D. Sitting ergonomically

ix. _____ is a big network, which is formed by connecting multiple small networks.

A. Internet
B. Computer
C. Telephone

x. _____ acts as an interface between hardware and the user.

A. Operating system
B. Platform
C. Network
D. Computer

6.3.2.4 Tools, Equipment, Supplies and Materials

Public Address System, Radio, Mobile Phone, Computer, paper, pen, presentation

6.3.2.5 References

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6.3.3 Learning Outcome 2: Evaluate the state of performance and possible causes of failures

6.3.3.1 Learning Activities

The following are the performance criteria:

- Perform troubleshooting of failed components as per as per the manufacturers manual
- Determine Possible causes of failure as per the manufacturers manual
- Carry out repair or replacement of failed components according to Manufacturer manual
- Test the repaired or replaced component
- Adopt component failure Prevention measures as per the manufacturers manual
- Generate report as per the manufacturers manual

Trainees to demonstrate knowledge in relation to:

- Define troubleshooting
- Possible causes of failure: Unstable power, Malfunctioning, Mechanical faults
- Environmental factors: Natural disasters, Dust, Ventilation
- User factors: Malicious damage, Accidents, Lack of maintenance

6.3.3.2 Information Sheet

Troubleshooting is a systematic approach to problem solving that is often used to find and correct issues with complex machines, electronics, computers and software systems.

There are many different things that could cause a problem with your computer. No matter what's causing the issue, troubleshooting will always be a process of trial and error—in some cases, you may need to use several different approaches before you can find a solution; other problems may be easy to fix. We recommend starting by using the following tips.

- **Write down your steps:** Once you start troubleshooting, you may want to write down each step you take. This way, you'll be able to remember exactly what you've done and can avoid repeating the same mistakes. If you end up asking other people for help, it will be much easier if they know exactly what you've tried already.
- **Take notes about error messages:** If your computer gives you an error message, be sure to write down as much information as possible. You may be able to use this information later to find out if other people are having the same error.
- **Always check the cables:** If you're having trouble with a specific piece of computer hardware, such as your monitor or keyboard, an easy first step is to check all related cables to make sure they're properly connected.
- **Restart the computer:** When all else fails, restarting the computer is a good thing to try. This can solve a lot of basic issues you may experience with your computer.

Read: Quick tips for troubleshooting:
https://edu.gcfglobal.org/en/computerbasics/basic-troubleshooting-techniques/1/

Tips for addressing client troubleshoot

Step 1: What exactly ***is*** the problem?
Getting to the bottom of a computer issue can be tricky, so it's crucial to ask the right questions first if you want to discover the root problem quickly.

- If you're talking to someone or emailing with them, listen or read carefully and take notes (mental or otherwise). When they're done, proceed with questions that either have a yes/no answer or can be answered quantifiably (e.g., "How many times did this happen?"). This approach can move things along and cut down on ambiguous responses.
- What should you ask? The key is to find out the **"who, what, and when"** of the problem. Does the issue affect just one person or many people? Did it occur right after a significant event on the computer or the network? There are specific questions you can ask to drill down beneath general statements like "I can't send email." Are they using a PC or mobile device? Is the PC power on? Are they able to open their e-mail client? Can they send or receive email, or both?
- Once you've got a grasp on the issue, try repeating your understanding of the problem so that you're both on the same page as to what's wrong. It's a good idea to use some the same language they used and avoid using complex tech terminology. Ideally, this will help remove potential confusion related to the issue.

Now that you have a basic understanding of what the issue is all about, you can look into technical details that could point you toward to a solution.

Step 2: Gather more details, eliminate variables

In many instances, what was reported as a general issue (e.g., the Internet is down) is actually something very particular, such as a specific website being offline. Best way to find out? Ask those pertinent questions and then dig up more info from various sources such as:

- **Error messages:** If the user reports one or you're present to check for one, they can point you in the right direction as to why a failure occurred. For example, Windows blue screens of death provide a relevant error code that'll give you a good sense of what caused a failure.
- **Events logs:** Do they exist, and if so, what exactly do they say? In addition to error messages, logs often provide a timestamp so you can answer the question of when exactly events happened. Checking the Windows event viewer can be a first step in pointing you towards any relevant logs.
- Can the user provide screenshots, video, or other supporting information that can help assist in the troubleshooting process?
- **Diagnostics results:** Have you run system utilities to get even more information? For example: ping can help you remotely check if a server or website in question is reachable. Additionally, the Windows memory diagnostic can check for faulty memory, the resource monitor or performance monitor can check for unusually high CPU or memory usage, and a disk check can examine your hard drives for errors.
- **Monitoring:** Do you have any 3rd party tools that can offer more clues or predict issues before they occur? A network monitoring solution like company provides preemptive alerts and warnings about servers at risk of going down. And a network inventory application can provide vital statistics on dozens or hundreds of systems such as disk space, available memory, OS installed, and software running on the devices in question.

Step 3: Reproduce the problem, develop hypothesis of root cause

Now that you've gathered basic background info, it's time to get hands-on with the problem.

- Reproducing an issue simply means verifying you can recreate the same error the user reported. You can do this at the physical site of the problem, or through a remote desktop/ remote control application. Neither of those options available? You might be able to approximate the same conditions on a similar computer.
- Once you encounter the same error(s), you can more easily develop theories as to the root cause based on what you observe, then start taking steps to fix the issue. Sometimes you'll find it is pretty quick. Other times, it'll take longer and you may have to dig into knowledge bases, comb through data, or Google the problem for others who have faced the same issue.
- At this phase, a deep understanding of how computers work will prove… useful. For example, in computer networking, if you understand 7 layer OSI model for networks (a problem can exist in any one of them), you have a framework for systematically working your way through the potential causes of a networking problem. For a connectivity issue, an Ethernet cable could be damaged or unplugged (Layer 1 issue), network requests might not be going through (Layer 3), or an application might not be properly coded (Layer 6).

Step 4: Attempt a fix based on findings
The evidence you've already gathered should have narrowed down possible root causes and positioned you to fix the issue. You can try tweaking changing settings related to the problem, swapping out faulty parts, repairing corrupted files, updating drivers and software, etc. until you solve the problem (or at least get closer).

While every issue is like a unique, a significant number of issues can be resolved through common troubleshooting steps like rebooting the problematic machine, checking for DNS and DHCP issues, checking the device manager for driver issues, cleaning up a machine, or checking firewall or proxy settings, etc.

For issues that are tougher, if your own experimentation and Google searches don't result in a satisfactory result, browsing discussions online IT forums can be extremely helpful for fixing PC issues.

Problem Solved? Prepare for future issues. No matter what the underlying tech problems are (networks issues, driver conflicts, disk problems, etc.), the process outlined above works well for gathering info, identifying possible causes of the issue, and getting to a solution no matter what issue you're dealing with. But you'll still have to make judgment calls depending on each unique case.

With this sort of system in place, and knowledge learned working through previous computer problems, you'll be able to knock out computer problems more efficiently as you gain more experience. And to be proactive in avoiding future crises, perhaps you can document issues so they can be referred to by anyone who encounters similar challenges down the line.

Unstable power sources are a common challenge for devices in remote and extreme environments. This can severely affect solid-state drive (SSD) operation. Instability during start-up and shutdown can cause system crashes and restarting issues.

Malfunctioning is a failure to operate or function in the normal or correct manner.

Machine fault diagnosis is a field of mechanical engineering concerned with finding faults arising in machines. A particularly well-developed part of it applies specifically to rotating machinery, one of the most common types encountered.

A **natural disaster** is a major adverse event resulting from natural processes of the Earth; examples are floods, hurricanes, tornadoes, volcanic eruptions, earthquakes, tsunamis, and other geologic processes.

Dust in a computer can cause a variety of heat-related issues. Dust that collects on

components, such as memory modules, insulates them, preventing the air from the computer's fans from drawing the heat away.

Ventilation is the intentional introduction of outdoor air into a space and is mainly used to control indoor air quality by diluting and displacing indoor pollutants; it can also be used for purposes of thermal comfort or dehumidification.

Malicious damage the crime of intentionally causing damage to property.

An accident, also known as an unintentional act, is an undesirable, incidental, and an unplanned event that could have been prevented had circumstances leading up to the accident been recognized, and acted upon, prior to its occurrence.

Lack of Maintenance Processes is maintenance operations are the backbone of every heavy industry company. Almost every major industrial disaster can be tracked back to a root cause of a clear lack of maintenance protocol or adherence to maintenance practices.

6.3.3.3 Self-Assessment

i. Define malicious damage.
ii. What is natural disaster?
iii. What is troubleshooting?
iv. How does dust affect your computer performance?
v. **Case situation:** You are IT technician, a user save file on desktop after some minutes file become shortcuts how will you resolve the problem?.
vi. Identify the steps to solve problems for a client over a call. What are the options you have to sort the problem without travelling to your client location? Tips! Use online tools to have a deeper look.
vii. A technician arrives and asks a customer, "Can you describe the problem?" The customer replies, "All email messages that I send have the wrong date. I have restarted the computer several times, but this does not seem to help." What could be the problem?
   A. The CMOS battery has failed
   B. The hard drive is beginning to fail
   C. The MBR is corrupted
   D. The CPU voltage is set too low
viii. Several times during the last few days, a user has experienced the Blue Screen of Death when plugging an external hard drive into a laptop via USB. What is a possible solution for this problem?
   A. Upgrade the operating system.
   B. Research the boot error beep code to identify the source of the error.
   C. Research the STOP error and the name of the module that produced the error.
   D. Reinstall the operating system
ix. A PC is not able to connect to a wired network. Pinging the loopback address is successful, but the gateway cannot be reached. On the network switch all the interface

lights are on, except for the interface connected to the PC. The LED on the network card is off. What is the most likely cause of this problem?

x. A computer repeatedly locks without any error message. Which two conditions may be the cause of the problem? (Choose two.)
   A. The index service is not running.
   B. The computer has a virus.
   C. An update has corrupted the operating system.
   D. The UAC has been turned off.
   E. The user has breached the user security policy.
   F. The CPU needs to be upgraded

6.3.3.4 Tools, Equipment, Supplies and Materials

Computer, Software

6.3.3.5 References

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- https://www.haploos.com/home/industry-issues/maintenance/
- ICT Infrastructure Management authored Office of Government Commerce
- Failure-Tolerant Computer Design authored by William H. Pierce published Academic Press, 2014

6.3.4 Learning Outcome 3: Diagnose and fix problems

6.3.4.1 Learning Activities

The following are the performance criteria:

- Tools and equipment for diagnosing and fixing the problem are identified
- Troubleshooting activities are carried out to establish causes of problems
- Problems identified are fixed as per the manufacturer guidelines
- Generate a report as per the manufacturers manual

Trainees to demonstrate knowledge in relation to:

- Define diagnostic terms
- Identify diagnostic and repair tools and their functions
- Tools to diagnose and fix the problems
- Hardware related problems
- Software related problems
- Internet/network related problems
- User related problems
- Role of ICT Policies in organizations

6.3.4.2 Information Sheet

Diagnostic terms means identification of a condition, disease, disorder, or problem by systematic analysis of the background or history, examination of the signs or symptoms, evaluation of the research or test results, and investigation of the assumed or probable causes. Effective prognosis is not possible without effective diagnosis.

Tools are available to help you diagnose and solve hardware-related problems.

Power-on self-test (POST), progress codes (checkpoints), error codes, and isolation procedures: The POST checks out the hardware at system initialization. IPL diagnostic functions test some system components and interconnections. The POST generates eight-digit checkpoints to mark the progress of powering up the blade server.

Light path diagnostics: Use the light path diagnostic LEDs on the system board to identify failing hardware. If the system error LED on the system LED panel on the front or rear of the BladeCenter unit is lit, one or more error LEDs on the BladeCenter unit components also might be lit.

Troubleshooting tables: Use the troubleshooting tables to find solutions to problems that have identifiable symptoms.

Dump data collection: In some circumstances, an error might require a dump to show more data. The Integrated Virtualization Manager (IVM) or Hardware Management Console (HMC) sets up a dump area. Specific IVM or HMC information is included as part of the information that can optionally be sent to IBM® support for analysis.

Stand-alone diagnostics: The AIX-based stand-alone diagnostics CD is in the ship package and is also available from the IBM Web site. Boot the diagnostics from a CD drive or from an AIX network installation manager (NIM) server if the blade server cannot boot to an operating system, no matter which operating system is installed.

Functions provided by the stand-alone diagnostics include:

- Analysis of errors reported by platform, such as microprocessor and memory errors
- Testing of resources, such as I/O adapters and devices
- Service aids, such as firmware update, format disk, and Raid Manager

Hardware troubleshooting is the process of reviewing, diagnosing and identifying operational or technical problems within a hardware device or equipment. It aims to resolve physical and/or logical problems and issues within a computing hardware. Hardware or technical support technician does hardware troubleshooting.

Internet connection problems can be frustrating. Ensure you check the physical connections before getting too involved with troubleshooting. Someone could have accidentally kicked

the router or modem's power cable or pulled an Ethernet cable out of a socket, causing the problem.

As the ICT department tries to meet the needs of the workforce, it also needs to develop policies to ensure the acceptable uses of ICTs within the organization. Developing an ICT policy for an organization is as important as having any other policy within the organization.

Read: https://www.liberianobserver.com/columns/technology/develop-an-ict-policy-within-your-organization-a-repeat/

6.3.4.3 Self-Assessment

i. Identify different kinds of diagnostic tools available.
ii. What is hardware troubleshooting?
iii. What is troubleshooting?
iv. How to fix Internet problem?
v. **Case situation:** In a network that contains two servers and twenty workstations, where is the best place to install an anti-virus program?
vi. Prepare an ICT policy for a firm of 20 employees.
vii. A laptop that is running Windows 10 displays "Missing NTLDR" after the POST. What are the two most probable reasons for this problem? (Choose two.)
   A. There is a conflict with a newly installed device.
   B. The index service is not indexing in the correct locations.
   C. Boot.ini is missing or damaged.
   D. The boot order is not set correctly in the BIOS.
   E. BOOTMGR has been corrupted
viii. _____ can help with troubleshooting because it can help you eliminate the simplest possible causes of a computer problem.
   A. The KISS (Keep it simple and straightforward) principle
   B. An owner's manual
   C. A call to tech support
   D. A call to a help desk
ix. John sets up a new Window 10 Professional PC for his client in an insecure, networked environment. What's the first step for making the data safe?
   A. Make sure the user shuts the machine off every night.
   B. Require the user to log in with a password
   C. Require the user to log in with a password composed of alphanumeric characters
   D. Nothing, anybody with a external disk can access the data on the PC
x. Which utility is useful in identifying a program that is hogging the processor?
   A. Task Manager
   B. Device Manager
   C. System Monitor
   D. System Information

6.3.4.4 Tools, Equipment, Supplies and Materials

Protocol analyzer, Toner probe, Punch down tool, Cable tester, SolarWinds Security Event Manager

6.3.4.5 References

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- Troubleshooting and Maintaining Your PC All-in-One For Dummies authored by Dan Gookin published by For Dummies; 2nd edition

6.3.5 Learning Outcome 4: Test component performance

6.3.5.1 Learning Activities

The following are the performance criteria:

- System is powered on and performance analysis is carried out
- Recommendation from performance analysis is done.
- Test performance report is generated as per the manufacturers manual

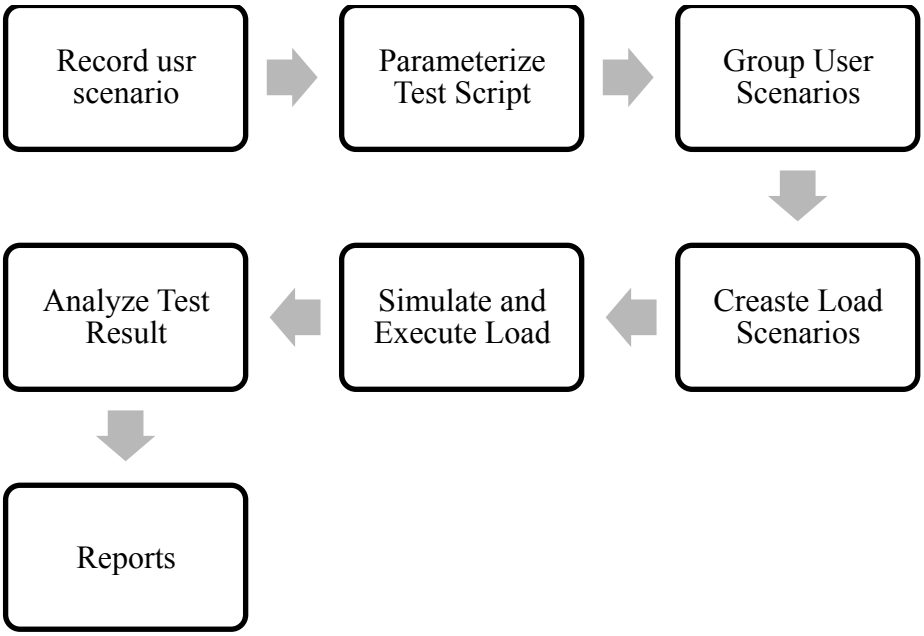
Trainees to demonstrate knowledge in relation to:

- Test Hardware performance, Test Software performance, Test Internet/network performance
- Performance analysis, recommendation from performance analysis, performance test report

6.3.5.2 Information Sheet

Test Hardware performance: check your every hardware performance and quality assurance

In software quality assurance, performance testing is in general a testing practice performed to determine how a system performs in terms of responsiveness and stability under a particular workload.



Source: stackify.com

Figure 66: Performance Testing Process

Test Internet/network performance

The **NDT (Network Diagnostic Tool)** is a bandwidth test that will test your upload and download connection speeds as well as provide additional diagnostics about your network.

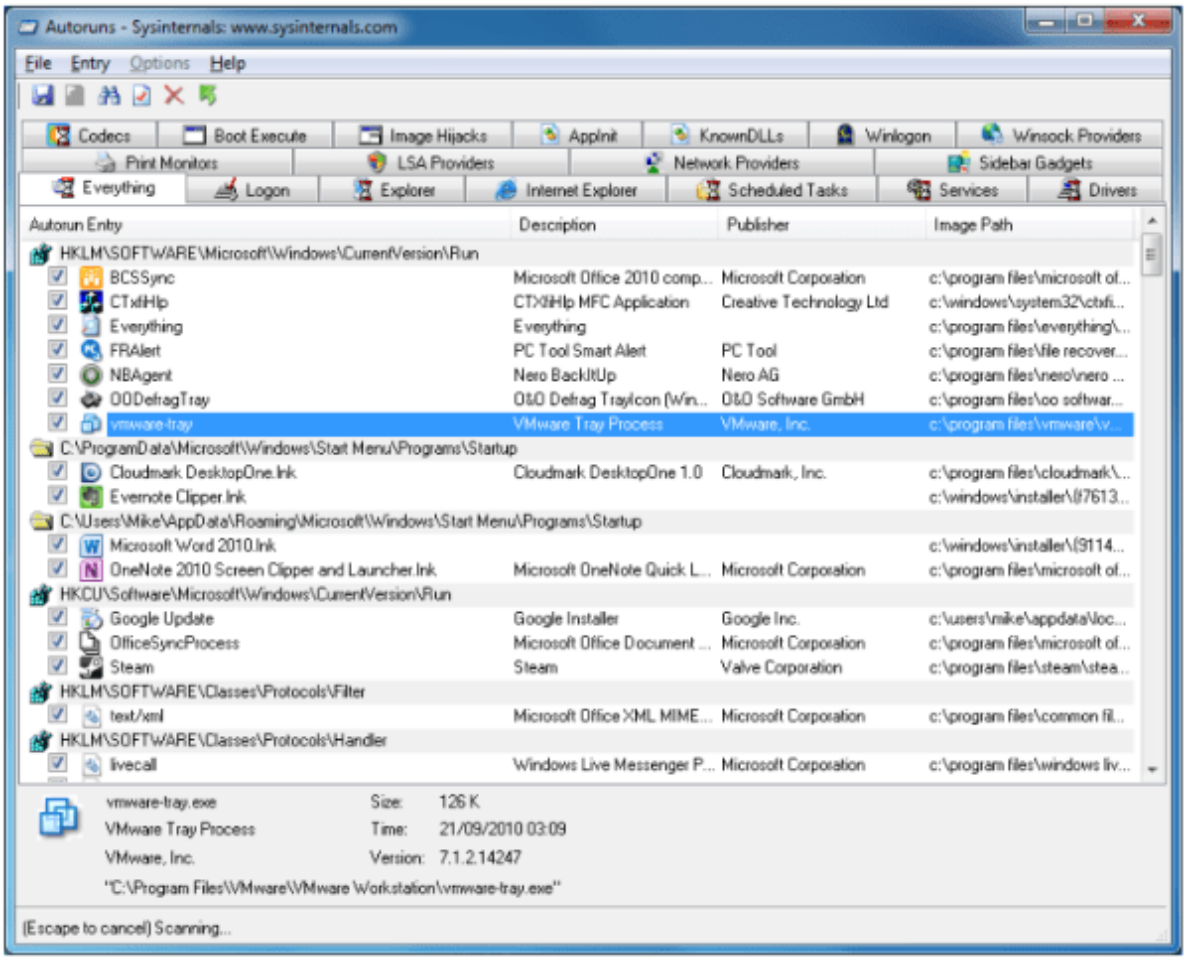
Performance analysis is a measure of the success or failure of a project using various parameters. It helps in developing a positive culture of project management that yields excellent results. A good program performance typically needs: proper management of stakeholders.

Performance analysis of system is based on collaborative filtering and demographics.

Below are some tools, which technicians use to troubleshoot a windows PC. These tools are useful in diagnosing a PC to find out the exact issue.

Process Explorer: Process Explorer is a small utility available for free. It can help to find out the files and directory opened by a program. If you need information that - what file or folder is using a process then this tool is very helpful. It is useful to track the DLL version problems or handle leaks.

Windows Sysinternals Suite: Sysinternals suite is collection of diagnostic and troubleshooting utilities provided by Microsoft for free. So it includes all the utilities, which can help to troubleshoot a PC. Process explorer and other useful tools like Autoruns, PsTools, desktops etc. are bundled with this.



Source: www.downloadcrew.com

Figure 67: Windows Systeminternals suite

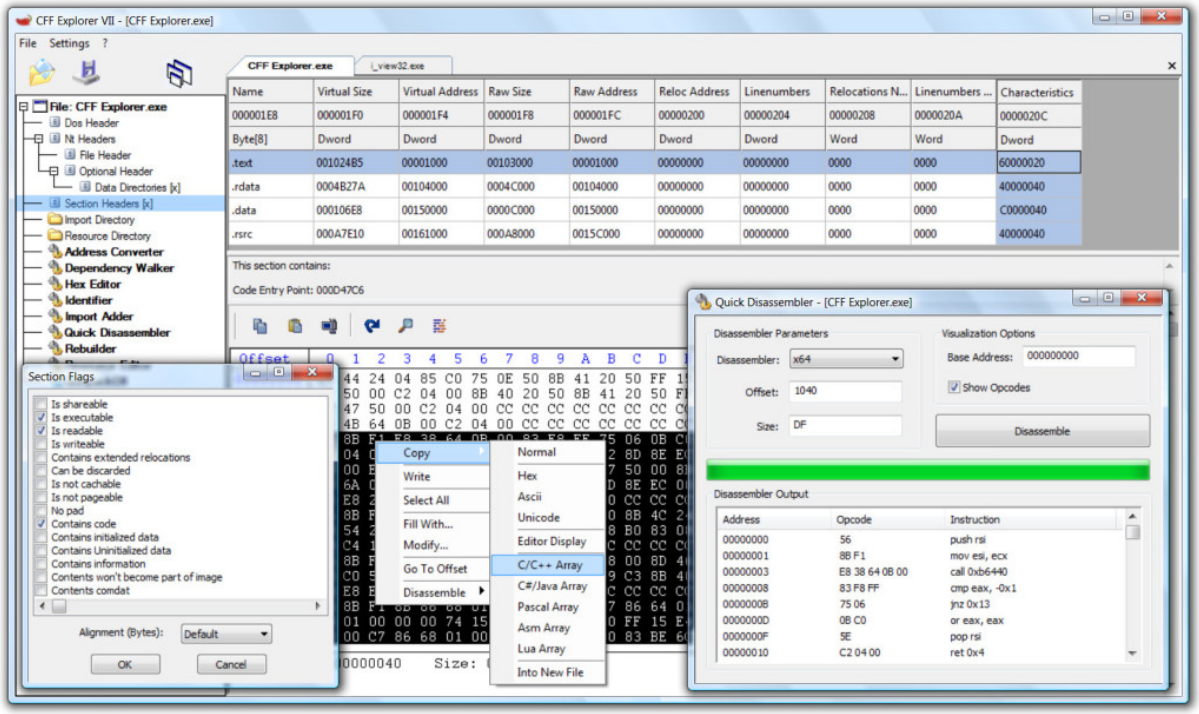
HWiNFO: Popular and award winning hwinfo is a free software utility for hardware monitoring and reporting with detailed analysis. It can generate reports and log files in XML, CSV and HTML Formats. It alerts about the system health by real time monitoring. Customized tables and graphs option.

Speccy is a hardware information tool by Piriform. It gives detailed information about motherboard, graphics card, CPU, RAM etc. It is a free utility. There are some more advanced features are available in its Pro version.

Hddscan It is a disk drive diagnostic tool. HDDScan is available free to download. It can check storage devices including USB drive for bad sectors.

File database can help to find out the suspicious files, system resources detailed graphs, WMI browser and more.

System Explorer: It is also a free software tool to get the detailed system information. It is an award winning software, which can explore the internal system and processes running in the computer such as - get details about tasks, processes services, drivers and opened files.



Source: http://www.rohitab.com

Figure 68: System explorer

6.3.5.3 Self-Assessment

i. How to perform software test?

ii. Explain performance analysis?

iii. Which of the following is NOT a static testing technique?

A. Error guessing

B. Walkthrough

C. Data flow analysis

D. Inspections

vi. Identify tech support tools for system diagnosis. Prepare a list and mention their benefits.

v. _____ is a disk drive diagnostic tool.

A. Hddscan

B. Flash disk

C. CD-ROM

vi. _____ is a small utility available for free. It can help to find out the files and directory opened by a program.

A. Mozilla firefox

B. Process Explorer

C. Internet

vii. What is NDT?

A. Network Diagram Tools

B. Network Diagnostic Tool

C. Network Data test

6.3.5.4 Tools, Equipment, Supplies and Materials

Ranorex, TestComplete, Tosca Testsuite, TestingWhiz, Windows Sysinternals Suite, System Explorer.

6.3.5.5 References

- https://www.techsupportall.com/10-best-computer-diagnostic-tools-technicians/
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6.3.6 Learning Outcome 5: Perform user training

6.3.6.1 Learning Activities

The following are the performance criteria:

- User training needs are identified
- User skill set is determined based on the user training needs report
- User training is conducted based on the user training needs report

Trainees to demonstrate knowledge in relation to:

- Meaning of user training
- Importance of user training
- Implement end user training plan

6.3.6.2 Information Sheet

User Training is a term business executives hear quite often when they are in the process of implementing a new software system, however, more often than not, many choose to opt out of receiving this training for their staff. **Training of the end users** is one of the most important steps for a successful system implementation.

The creation of a training plan is one element within the training process of a software organisation. The model has four components:

- (E) entry criteria : Management support, Training policy and objectives, Resources, Organizational context
- (T) tasks: Conducting training needs analysis, Create training plan, Design curriculum, Create training products, Pilot and deliver training, Evaluate training
- (V) validation tasks or criteria: Training plan approved, course development and delivery processes followed, Quality standards me, Training results analyzed and reported
- (X) exit criteria: Needed training delivered, Training objective met

Importance of **Training and Support After Software is implemented.** When adopting or creating new software, training helps users adapt to changes in their be it roles, new team members, or vendors, while support helps end-users address issues they experience.

6.3.6.3 Self-Assessment

i. Why is user training important?

ii. What are the approaches for training end-users?

iii. What is importance of support after software installation? What are the kinds of support provided by some of the key software companies?

iv. **Case situation:** Prepare a software-training plan for an organization for using basics of Microsoft Excel for documenting research data.

v. _____ end-user training is more effective and memorable if you tailor it to your own organization's use of the software, rather than generic lessons.

   A. Creating a training program
   B. Setting training
   C. All are true

vi. Determine set skill is training program scalable a scalable training program is flexible enough to accommodate both small numbers of users

   A. True
   B. False

vii. Now-a-days there is a number of online application for bodaboda drivers. The bodaboda drivers are new users of technology for transportation logistics. Mobile application companies are training the bodaboda drivers on using the app effectively. Is it an example of user-training?

   A. Yes
   B. No
   C. I don't know

6.3.6.4 Tools, Equipment, Supplies and Materials

Test training materials for accuracy, Test training database, training & support material

6.3.6.5 References

- https://www.princeton.edu/~pshrsys/Implementation%20Plan/Strategies/EndUserTraining.html
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CHAPTER 7: WEBSITE DESIGN

7.1 Introduction

This unit specifies competencies required Design a Website. It involves gathering data required, determining website design tool, developing functional website, host website developed and perform website routine maintenance.

7.2 Performance Standard

- Obtained and analysed website requirements
- Designed Website based on the obtained requirements.
- Identified the Appropriate website authoring software suite
- Linked the website with the database
- Implemented Website security measures
- Performed website maintenance

7.3 Learning Outcome

7.3.1 List of the Learning Outcomes

These are the key learning outcomes, which make up workplace function:
- Gather data required
- Determine Website design tool
- Develop functional website
- Host Website developed
- Perform Website Routine Maintenance

7.3.2 Learning Outcome 1: Gather data required

7.3.2.1 Learning Activities

The following are the performance criteria:
- Website requirements are obtained and analysed as per website type to be developed
- Website design is done based on the obtained requirements.
- Website design is done as per the data gathered

Trainees to demonstrate knowledge in relation to:
- Meaning of web terms
- Importance of website
- Types of websites
- Website requirements
- Web Programming languages

7.3.2.2 Information Sheet

The Web is the common name for the World Wide Web, a subset of the Internet consisting of the pages that can be accessed by a Web browser. Many people assume that the Web is the same as the Internet, and use these terms interchangeably. However, the term Internet actually refers to the global network of servers that makes the information sharing that happens over the Web possible. So, although the Web does make up a large portion of the Internet, but they are not one and same.

Read: About Web and Internet: https://www.lifewire.com/difference-between-the-internet-and-the-web-2483335

A website or web site is a collection of related network web resources, such as web pages, multimedia content, which are typically identified with a common domain name, and published on at least one web server. Notable examples are wikipedia.org, google.com, and amazon.com.

Websites can be accessed via a public Internet Protocol (IP) network, such as the Internet, or a private local area network (LAN), by a uniform resource locator (URL) that identifies the site.

Websites can have many functions and can be used in various fashions; a website can be a personal website, a corporate website for a company, a government website, an organization website, etc. Websites are typically dedicated to a particular topic or purpose, ranging from entertainment and social networking to providing news and education. All publicly accessible websites collectively constitute the World Wide Web, while private websites, such as a company's website for its employees, are typically part of an intranet.

Web pages, which are the building blocks of websites, are documents, typically composed in plain text interspersed with formatting instructions of Hypertext Markup Language (HTML, XHTML). They may incorporate elements from other websites with suitable markup anchors. Web pages are accessed and transported with the Hypertext Transfer Protocol (HTTP), which may optionally employ encryption (HTTP Secure, HTTPS) to provide security and privacy for the user. The user's application, often a web browser, renders the page content according to its HTML markup instructions onto a display terminal.

Hyperlinking between web pages conveys to the reader the site structure and guides the navigation of the site, which often starts with a home page containing a directory of the site web content. Some websites require user registration or subscription to access content. Examples of subscription websites include many business sites, news websites, academic journal websites, gaming websites, file-sharing websites, message boards, web-based email, social networking websites, websites providing real-time stock market data, as well as sites providing various other services. End users can access websites on a range of devices, including desktop and laptop computers, tablet computers, smartphones and smart TVs.

Here are the top 10 importance of having a Website:

1. Cost-Effective: Online advertisement is cost-effective compared to print advertisement and enables you to make on-the-fly changes, given that you are using a CMS.
2. Wider Demographic Reach: Unlike having a local brick and mortar establishment, a business Website transmits your business profile around the world, permitting for enhanced exposure and sales, due to a wider demographic reach.
3. Business Credibility: If you have a professional looking and user-friendly Website, consumers will likely have a greater chance of considering your business credible over companies who either do not have a Web presence, or have a poor Website presence.
4. Around-The-Clock Availability: Having a Website provides your consumers with around-the-clock availability in terms of access to products, information etc. This type of 24 hours a day, seven days a week service definitely generates more profits than that of a traditional storefront.
5. Consumer Convenience: In branching off from the above noted benefit, being available to meet the needs of consumers at any time day or night provides added convenience, giving them access to products and information whenever they need.
6. Increased Sales: When owning a business exposure is key to attracting customers. An effective Website with great content increases the probability for increased sales.
7. Fosters Customer Rapport: An online presence helps in terms of building and fostering a rapport among your customers. Providing special offers to loyal customers on your Website lets them know you appreciate their business.
8. Competitive Opportunity: Chances are your competitors have a Website and they're using it to their fullest advantage. In order to keep up or surpass the competition, having a Website is a must.
9. Build Customer Base: Consumer communication via your Website can help you build your customer base. Populating a list of consumer contacts is gold to any company.
10. **Targeted Marketing**: A strategically planned Website can effectively attract the targeted audience you seek. Now that you have known why having a website is important to your business, contact an expert.

Types of websites: There are many varieties of websites, each specializing in a particular type of content or use, and they may be arbitrarily classified in any number of ways. A few such classifications might include:

- Classified
- Community site
- Corporate website
- Government website
- Personal website
- eCommerce
- Social media

Some websites may be included in one or more of these categories. For example, a business website may promote the business's products, but may also host informative documents, such as white papers.

A **static website** is one that has web pages stored on the server in the format that is sent to a client web browser. It is primarily coded in Hypertext Markup Language (HTML); Cascading Style Sheets (CSS) are used to control appearance beyond basic HTML. Images are commonly used to effect the desired appearance and as part of the main content. Audio or video might also be considered "static" content if it plays automatically or is generally non-interactive. This type of website usually displays the same information to all visitors. Similar to handing out a printed brochure to customers or clients, a static website will generally provide consistent, standard information for an extended period of time. Although the website owner may make updates periodically, it is a manual process to edit the text, photos and other content and may require basic website design skills and software. Simple forms or marketing examples of websites, such as classic website, a five-page website or a brochure website are often static websites, because they present pre-defined, static information to the user. This may include information about a company and its products and services through text, photos, animations, audio/video, and navigation menus.

A **dynamic website** is one that changes or customizes itself frequently and automatically. Server-side dynamic pages are generated "on the fly" by computer code that produces the HTML (CSS are responsible for appearance and thus, are static files). There are a wide range of software systems, such as CGI, Java Servlets and Java Server Pages (JSP), Active Server Pages and ColdFusion (CFML) that are available to generate dynamic web systems and dynamic sites. Various web application frameworks and web template systems are available for general-use programming languages like Perl, PHP, Python and Ruby to make it faster and easier to create complex dynamic websites.

A site can display the current state of a dialogue between users, monitor a changing situation, or provide information in some way personalized to the requirements of the individual user. For example, when the front page of a news site is requested, the code running on the web server might combine stored HTML fragments with news stories retrieved from a database or another website via RSS to produce a page that includes the latest information. Dynamic sites can be interactive by using HTML forms, storing and reading back browser cookies, or by creating a series of pages that reflect the previous history of clicks. Another example of dynamic content is when a retail website with a database of media products allows a user to input a search request, e.g. for the keyword Beatles. In response, the content of the web page will spontaneously change the way it looked before, and will then display a list of Beatles products like CDs, DVDs and books. Dynamic HTML uses JavaScript code to instruct the web browser how to interactively modify the page contents. One-way to simulate a certain type of dynamic website while avoiding the performance loss of initiating the dynamic engine on a per-user or per-connection basis, is to periodically automatically regenerate a large series of static pages.

Early websites had only text, and soon after, images. Web browser plug ins were then used to add audio, video, and interactivity (such as for a rich Internet application that mirrors the complexity of a desktop application like a word processor). Examples of such plug-ins are Microsoft Silverlight, Adobe Flash, Adobe Shockwave, and applets written in Java. HTML 5 includes provisions for audio and video without plugins. JavaScript is also built into most modern web browsers, and allows for website creators to send code to the web browser that instructs it how to interactively modify page content and communicate with the web server if needed. The browser's internal representation of the content is known as the Document Object Model (DOM) and the technique is known as Dynamic HTML.

WebGL (Web Graphics Library) is a modern JavaScript API for rendering interactive 3D graphics without the use of plug-ins. It allows interactive content such as 3D animations, visualizations and video explainers to presented users in the most intuitive way.

A 2010-era trend in websites called "responsive design" has given the best of viewing experience as it provides with a device based layout for users. These websites change their layout according to the device or mobile platform thus giving a rich user experience.

Read: Find more about website type:
https://www.expertmarket.co.uk/web-design/different-types-of-websites

Watch: Different type of website: https://youtu.be/M6j7RLeEkNI

9 Things You Need To Start a Website

Domain Name
Business Email Address
Website Building Software
Website Hosting
Website Template Design
Logo Design
High-Quality Images for Website
Image Editors
Google Analytics

Web programming refers to the writing, markup and coding involved in Web development, which includes Web content, Web client and server scripting and network security. The most common languages used for Web programming are XML, HTML, JavaScript, Perl 5 and PHP. Web programming is different from just programming, which requires interdisciplinary knowledge on the application area, client and server scripting, and database technology.

7.3.2.3 Self-Assessment

i. Define website?
ii. What is web programming?
iii. Explain briefly importance of website?
iv. What are requirements of website?
v. What are types of website?
vi. **Case situation:** You are asked by a women SACCO to prepare their website. What information do you need from your client? How you will help them share the details with you?
vii. Which one of the following is an example of a web browser?
   A. Google
   B. Frontpage
   C. Internet Explorer
viii. What is a CMS in web design?
   A. Content Management System
   B. Creative Management System
   C. Content Mixing System
   D. Creatives Managerial System
ix. To make your website mobile friendly, you can make your website
   A. Responsive
   B. Reactive
   C. Fast Loading
   D. Light
x. What does CSS stand for?
   A. Current Style Sheets
   B. Current Sheets Style
   C. Cascading Style Sheets
   D. Cascading Sheets Style

7.3.2.4 Tools, Equipment, Supplies and Materials

Text editor, Computer, PHP compiler like xampp, wamp, Mobirise Website Builder, Browser

7.3.2.5 References

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- The Principles of Beautiful Web Design Second Edition (2nd edition), authored by Jason Beaird published by SitePoint

7.3.3 Learning Outcome 2: Determine website design tool

7.3.3.1 Learning Activities

The following are the performance criteria:

- Identify and consider appropriate website authoring software suite
- Installation and configuration of adopted web authoring software or desired scripting language is done

Trainees to demonstrate knowledge in relation to:

- Types of website authoring tools
- Criteria of choosing website authoring tools
- Installation and configuration of website authoring tools
- Use of website authoring tools

7.3.3.2 Information Sheet

Web authoring tools are used to create web content, and cover a wide range of software programs you can download to your computer or access online.

List of website authoring tools include - Word Processors, HTML Editors, Plain Text Editors, Photoshop, Dreamweaver, Firefox developer. Word processors like Microsoft Word, WordPerfect or OpenOffice Writer are some of the most popular web authoring tools available. Users can create a Web page just as they would a printable document and then save it in HTML format, creating a quick and easy web page. Because users are usually familiar with the word processor on their computers, creating HTML pages with the same program represents a low learning curve. These usually present content in a what you see is what you get format, or WYSIWYG, meaning how the page appears on the screen is how it will appear when it's online.

Desktop publishing programs, like Adobe InDesign and Scribus are designed for producing material like newspapers, magazines, books and Web pages. Like word processors, desktop publishing programs provide a WYSIWYG interface. Their advanced Web authoring options, such as page layout and style elements, give users more control over the page's appearance. These programs also support multimedia objects, like images, graphics or audio files. Completed pages can be converted to both HTML and CSS files.

Website hosting sites usually offer their customers many web-authoring tool options to create and maintain their web pages online. Tools can include Web page builders, shopping systems, audio/visual editors and domain options. The builders incorporate many web authoring tools, including word processing, graphic editing, templates and layout schemes. Webpage builders have two main editing options: HTML or a non-HTML interface. Users who have limited HTML knowledge can use the non-HTML interface to drop and drag items to create layouts and use the text option to type in content.

HTML editing programs like Adobe Dreamweaver are some of the most powerful web authoring tools available. They are generally used by professional Web designers to create commercial websites. Most HTML editors are similar to web-page builders in offering users HTML or non-HTML interfaces. The non-HTML interface allows the user to see how the web page will look when it is uploaded to the Internet. HTML editors are used to type raw code, much as one would in a plain text document like a word processor, including HTML, CSS, JavaScript or XML. Most of the work is performed using a built-in text editor. HTML editors feature HTML validation checkers that will run through a webpage and check for markup errors and accessibility validation issues.

Basic text editors like Notepad are also a useful Web authoring tool for those familiar with the code. Unlike word processors or desktop publishing programs, plain text editors do not apply additional code to what appears in the document. Plain text editors are also useful for quickly making edits to completed pages that require updates.

Criteria of choosing website authoring tools:

- User-Friendly Interface
- Support Services
- Online Multimedia Assets
- Responsive Design Features
- Price

Web authoring is the practice of creating web documents using modern web authoring software and tools. Web authoring software is a type of desktop publishing tool that allows users to navigate the tricky environment of HTML and webcoding by offering a different kind of graphical user interface.

Case study: Developing an e-commerce webpage

There are many ecommerce tools and technologies required to build an e-commerce store and operate a successful online business. Both software and hardware technologies must be included in the e-business plan.

Web Server: A web server is used to host an e-commerce website. All the Html, JavaScript, PHP files, databases, media files that make up the entire website are stored on this server. The web server runs on Windows or Linux operating system. Managing a web server is a very specific job. The website development companies host the site on their own web server or pay a hosting company to provide space on a secure web server.

Server Software: When a user visits any website on a web browser, the web server knows the client is requesting some specific information. So it processes that request and serves the correct files to the client. The web browser then displays these files to the user.

There are many types of server software available including application software, database server, file server software, and cloud computing software. The popular web server software includes Apache and Windows IIS. Server software can either use on a physical server or on a virtual / cloud server.

Web Tools: A web authoring tool is used to create the front end of an e-commerce website. They range from basic HTML text editors (like Notepad++) to more complex graphic authoring tools and CMS (content management system) with built-in frameworks and debugging tools. Html files are created by Dreamweaver along with the CSS (cascading style sheet) which enhance the visual appearance of the site. Another web authoring tool would be Visual Studio .net that can be used to make the sites which have integrated databases in it. Graphic design packages are also web authoring tools which design the skin for a user interface.

Database System: A database is an integral part of an e-commerce website. The database is used to store information about the products and services of the website such as pricing, description, image, details, and sales. In addition to this, the customer details are also stored in the database like what they ordered, their payment details, shipping details, and contact information. It is necessary to program the website to connect securely to the database so that all the orders are processed correctly and your business runs smoothly. Technologies like PHP and MySQL are the communication route between the website and the DBMS (database management system).

Networking: TCP (transfer control protocol) and IP (internet protocol) defines as how computers should connect with each other through the internet and how they share information. Common TCP/IP protocols are HTTPS, HTTP, and FTP. We use these protocols to access the website without even realizing it. FTP (file transfer protocol) used to download files from a browser. HTTPS (where the "S" stands for security) responsible for the secure communication between a server and a browser like an account information or personal information. For an e-commerce website or online store, it is considered essential to provide a secure connection. SSL (secure sockets layer) and TLS (transport layer security) are the protocols associated with trust and security of any e-commerce website.

Browser Compatibility: A web browser is a software application that is used to locate, receive and display content received from the web servers. Popular web browsers include Mozilla Firefox, Google Chrome, Internet Explorer and Safari. Web developers and Web development agencies test the website see how it displays on multiple browsers across multiple devices and screen sizes before launching the website.

The Tip: To analyze website traffics, use tools like Google Analytics to get an idea as what browsers people are using and which one is the most popular.

Ports: Ports allow one device to connect with the other through a different and unique IP address. A device can have more than one port.

Port 25 (SMTP) is usually reserved for email. It is used to transmit data from remote email servers. If that port is blocked no emails can be sent. Some other common port numbers are 80(HTTP), 443 (HTTPS), 21 (FTP), 22 (SSH). Firewalls can often block a port to tighten the security.

Domain Names: Domain names link to a company or a brand. Successful e-commerce companies have recognizable domain names. If you have any smaller business then it is best to select the domain name as per your business name. This would help to rank highly in search engines. If a business becomes successful online, it is important to protect the brand by doing multiple registrations of domain names such as .com, .net, .uk, .org, .co Doing this ensures that no one can steal your business by copying your business model.

Here is a quick recap that will help you put everything into place.

1: **Front End:** HTML, CSS, JavaScript, Ajax, JQuery
2: **Server Side Scripting:** PHP, ASP
3: **CMS:** WordPress + Woo commerce, Magento, OpenCart, PrestaShop
4: **Database:** MySQL, MSSQL

7.3.3.3 Self-Assessment

i. What is web authoring?
ii. Shortlist website authoring tools for preparing a webpage.
iii. Which of the following software is used for web designing?
   A. MS Word
   B. Frontpage
   C. Powerpoint
iv. What is the Homepage called in FrontPage when you design a website?
   A. Content.htm
   B. Index.htm
   C. Glossary.htm

7.3.3.4 Tools, Equipment, Supplies and Materials

Computer, text editor, graphics editor, web browsers,version control system, An FTP program

7.3.3.5 References

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- https://www.arpatech.com/blog/technologies-required-for-ecommerce-store/

7.3.4 Learning Outcome 3: Develop functional website

7.3.4.1 Learning Activities

The following are the performance criteria:

- Development of web pages is done as per user requirements
- Adding interactivity to the website is done as per the user requirements.
- Website testing is done to check Interactivity of the website.
- Linkage of website to the database is done based on the user requirements.

Trainees to demonstrate knowledge in relation to:

- HTML coding: Formatting Tags, Hyperlinks Tag, Tables Tags, Frames Tags, Forms Tags, List Tags
- Scripting: Functions Of Scripting Languages, Types Of Scripting Languages
- Java scripting: JS Statements, JS Variables, JS Operators, JS Data Types, JS Functions, JS Objects, JS Events, JS Strings, JS Numbers, JS Arrays
- PHP: Importance Of PHP, PHP Syntax, PHP Variables, PHP Data Types, PHP Operators, PHP control structures, PHP Functions, PHP Arrays, PHP Forms
- Database creation
- Database Linkage

7.3.4.2 Information Sheet

Hypertext Markup Language, a standardized system for tagging text files to achieve font, colour, graphic, and hyperlink effects on World Wide Web pages.

HTML Formatting is a process of formatting text for better look and feel. HTML provides us ability to format text without using CSS. There are many formatting tags in HTML. These tags are used to make text bold Bold Text, italicized Italic Text , or underlined <u>Underline Text</u>,.

The <a> tag defines a hyperlink, which is used to link from one page to another. The most important attribute of the <a> element is the href attribute, which indicates the link's destination. By default, links will appear as follows in all browsers: An unvisited link is underlined and blue.

A table is defined using the <table> element, and contains a number of table cells (<td>, for "table data") which are organized into table rows (<tr>).

<**Frame**> **Tag**. HTML Frames are used to divide the web browser window into multiple sections where each section can be loaded separately. A frameset tag is the collection of frames in the browser window.

Creating Frames: Instead of using body tag, use frameset tag in HTML to use frames in web browser.

The HTML <form> tag is used for creating a form for user input.

An unordered **list** is a collection of related items that have no special order or sequence. Using HTML <ul> tag creates this list. Each item in the **list** is marked with a bullet.

A **scripting** or **script language** is a programming language for a special run-time environment that automates the execution of tasks; the tasks could alternatively be executed one-by-one by a human operator. Scripting languages are often interpreted (rather than compiled). **Script language examples:** AppleScript, awk, JCL, Lua., m4.Perl., Unix Shell scripts (ksh, csh, bash, sh and others), VBScript

JavaScript statements are composed of: Values, Operators, Expressions, Keywords, and Comments. **JavaScript variables** are loosely typed which means it does not require a data type to be declared. You can assign any type of literal values to a **variable** e.g. string, integer, float, Boolean etc.

JavaScript operators are used to assign values, compare values, perform arithmetic operations, and more.

In **JavaScript (JS)** there are two different kinds of **data**: primitives, and objects. A primitive is simply a **data type** that is not an object, and has no methods. In **JS**, there are six primitive **data types**: Boolean, Number, String, Null, Undefined, Symbol.

A **JavaScript function** is a block of code designed to perform a particular task. A JavaScript function is executed when "something" invokes it (calls it) **JavaScript** is designed on a simple **object**-based paradigm. An **object** is a collection of properties, and a property is an association between a name (or key) and a value.

Often, when **events** happen, you may want to do something. **JavaScript** lets you execute code when **events** are detected. HTML allows **event** handler attributes, with **JavaScript** code, to be added to HTML elements.

The **String**() function converts the value of an object to a **string**. Note: The **String**() function returns the same value as to String() of the individual objects.

JavaScript Numbers are always 64-bit floating point. Unlike many other programming languages, **JavaScript** does not **define** different types of **numbers**, like integers, short, long, floating-point etc. The **Array in JavaScript** is a global object, which contains a list of items.

PHP Programming the Languages mostly commonly used for Website and Web Application Development. **PHP** is a general purpose, server-side scripting language run a web server that's designed to make dynamic pages and applications.

The **PHP syntax** and semantics are the format and the related meanings of the text and

symbols in the PHP programming language. They form a set of rules that define how a PHP program can be written and interpreted.

Variables are used to store data, like string of text, numbers, etc. Variable values can change over the course of a script. Here're some important things to know about variables:

- In PHP, a variable does not need to be declared before adding a value to it. PHP automatically converts the variable to the correct data type, depending on its value.
- After declaring a variable it can be reused throughout the code.
- The assignment operator (=) used to assign value to a variable.

In PHP variable can be declared as: $var_name = value,

```
1  <?php
2  $str_isset = "";
3  $bol_isset = isset($str_isset);
4
5  If ($bol_isset){
6     echo "The variable is set";
7  }
8  else {
9      echo "The variable is not set";
10 }
11 ?>
12
```

Source: www.jquery-az.com

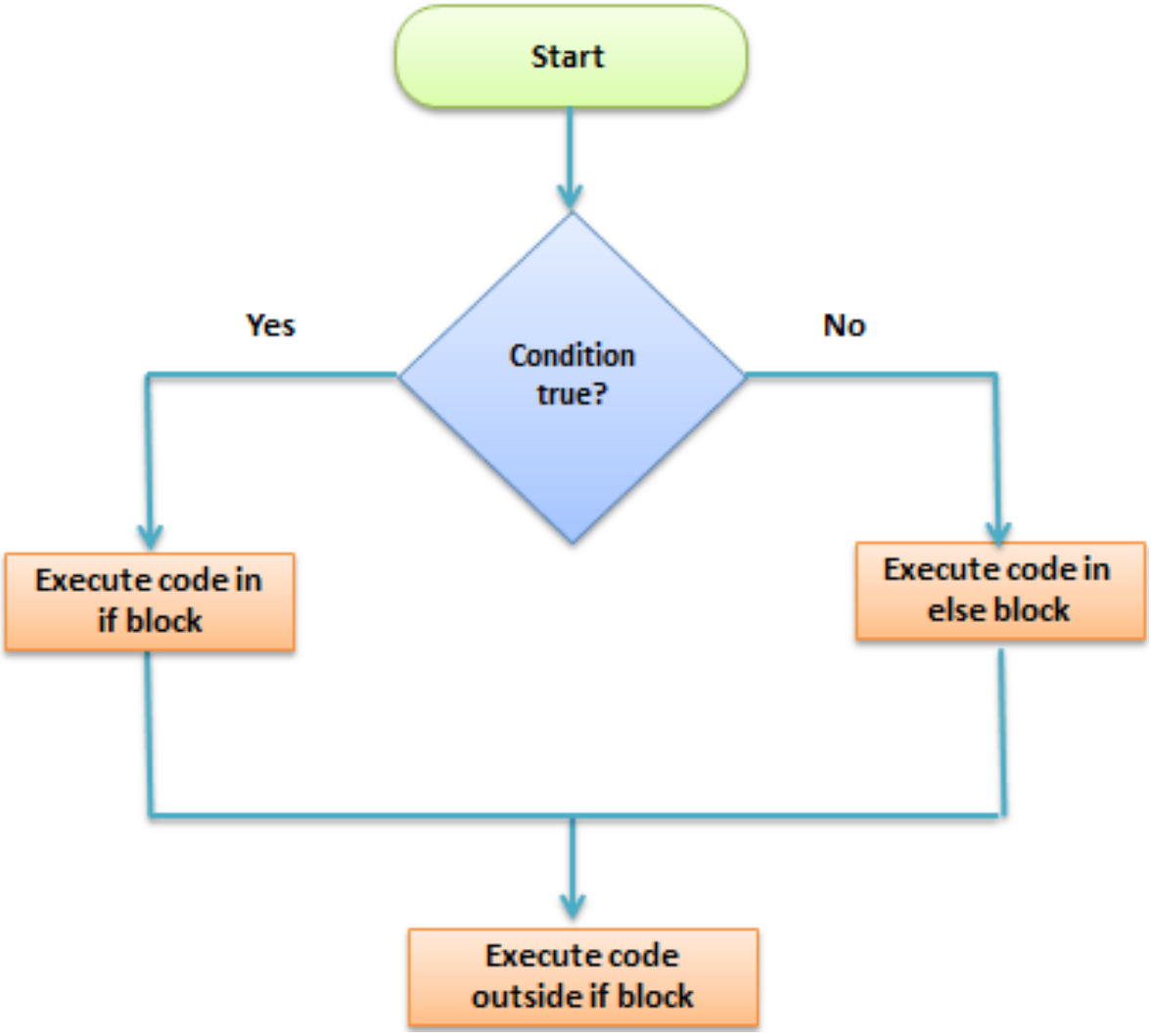
Figure 69: PHP variable code

Data Types defines the type of data a variable can store. **PHP** allows eight different types of **data types**. These include - String, Integer, Float (floating point numbers - also called double), Boolean, Array, Object, Null, Resource

Operators are used to perform operations on variables and values.

PHP divides the operators in the following groups:
Arithmetic operators, Assignment operators, Comparison operators, Increment/Decrement operators, Logical operators, String operators, Array operators

A **control structure** is a block of code that decides the execution path of a program depending on the value of the set condition. Let's now look at some of the **control structures** that **PHP** supports.



Source: www.guru99.com

Figure 70: Control structure

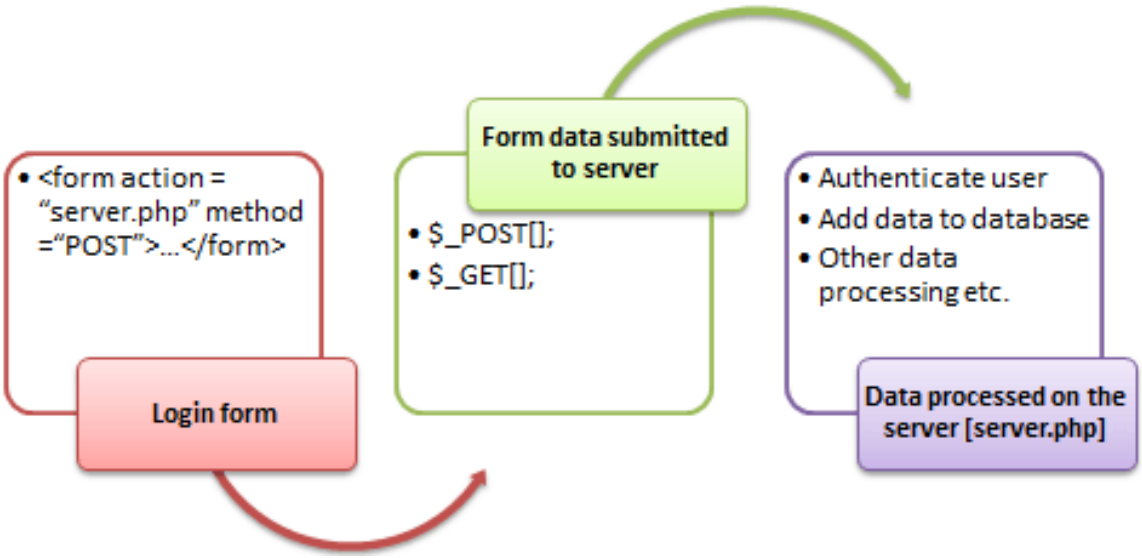
What is a **Function**?

A **function** is a reusable piece or block of code that performs a specific action. **Functions** can either return values when called or can simply perform an operation without returning any value. **PHP** has over 700 **functions** built in that perform different tasks.

The **array**() function is used to create an **array**. In **PHP**, there are three types of **arrays**: Indexed **arrays** - **Arrays** with numeric index. Associative **arrays** - **Arrays** with named keys.

When you login into a website or into your mailbox, you are interacting with a form.
Forms are used to get input from the user and submit it to the web server for processing.

The diagram below illustrates the form handling process.



Source: www.guru99.com

Figure 71: HTML handling process

A form, is an HTML tag that contains graphical user interface items such as - input box, check boxes radio buttons etc. The form is defined using the <form>...</form> tags and GUI items are defined using form elements such as input.

With database management systems, many tasks can be done either via programmatically or a user interface. Creating databases is no exception. Example of creating database in SQL CREATE DATABASE *databasename*;

Watch: How to create database: https://youtu.be/FAXhXI2Gxdc

Database Linking is available for researchers and data repositories as one method to ensure that data can be easily discovered and accessed, this is done by creating bidirectional links between data repositories and online articles such as - Science Direct. Readers on Science Direct have one-click access to relevant, trusted data that may help to validate research or drive further investigations.

Watch: Table linking: https://youtu.be/s4knkwJ6NZw

Watch: Creating simple shopping cart: https://youtu.be/0wYSviHeRbs

7.3.4.3 Self-Assessment

i. HTML is a
   A. Programming Language
   B. Database software
   C. Markup Language with Tags
   D. Operating system

ii. What is the file extension used for HTML files
   A. .htm or .html

B. ppt
C. .exe
D. .jpg

iii. What are tags?
iv. What is formatting in HTML? How to create a hyperlink in HTML?
v. What is the use of an iframe tag?
vi. How do you execute a PHP script from the command line?
vii. How can PHP and HTML interact?
viii. What are some of the common lists that can be used when designing a page?
ix. Write an HTML table tag sequence that outputs the following:
A. 50 pcs 100 500
B.10 pcs 5 50
x. What Javascript numbering?
xi. Explain how can you set an image as a background on web pages
xii. Create a simple webpage-using HTML.
a) Use frames to include images and videos.
b) Add a Cascading Style sheet for designing the web page
c) Design a dynamic web page with validation using JavaScript
d) Design a catalogue in ASP
e) Simple application to demonstrate servlets
f) Design a simple online test web page in PHP.
xiii. Discuss the relationship between HTML 4.01, XHTML 1.0, SGML and XML. (max. 200 words)
xiv. Choose the correct HTML tag for the largest heading
A. the H6 tag
B. The h1 tag
C. The h4 tag
D. The largest tag
xv. Which is the correct HTML code for a vertical frameset with 3 frames:
A. The tag - frameset cols= “500,250,250"
B. The tag - frames = “50%, 25%, 25%”
C. The tag - frameset cols=50%,25%,25%
D. The tag - frameset rows="50%,25%,25%"

7.3.4.4 Tools, Equipment, Supplies and Materials

Text editor, Web browser, Xampp or wamp, Computer, Graphical editor, Hosting Server

7.3.4.5 References

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7.3.5 Learning Outcome 4: Host website developed

7.3.5.1 Learning Activities

The following are the performance criteria:

- Legal and regulatory requirements are determined based on the existing ICT laws
- Assigning of the domain name is done based on the existing laws
- Website security measures are implemented as per the existing ICT laws

Trainees to demonstrate knowledge in relation to:

- Website hosting process, Factors to consider when selecting a host, Legal and regulatory requirements, Domain name, Uploading web site, Security measures

7.3.5.2 Information Sheet

Web hosts are companies that rent out their services and technologies to host websites on the Internet. Once the hosting company hosts your website, users can access it by typing in your web address (domain name) in their web browser. When they do this, their computer connects to the server your website is hosted on.

At the same time, you should note that different hosting service providers are differently suited to host varied types of sites. However, there are some common yet highly essential factors you must consider before committing to a service provider.

Here are eight:

- Server reliability, uptime scores and security
- Customer service
- Availability of site backups
- Registration and maintenance costs
- Ability to add domains
- Account limitations
- E-commerce and email options

Regulatory compliance is an organization's adherence to laws, regulations, guidelines and specifications relevant to its business processes. Violations of **regulatory compliance regulation**s often result in legal punishment including fines.

Domain name is simply a human readable form of an IP address. In function it is the destination that you type into a web browser in order to visit a website, such a www.google.com

Uploading website files is one of the very first steps users have to take in order to publish their creation on the Internet.

In short, to upload a website you can follow these 6 simple steps:
Step 1: Pick a reliable website host
Step 2: Choose your website upload method
Step 3: Upload the site archive and extract it
Step 4: Make sure all files are in public_html
Step 5: Import the MySQL database
Step 6: Check if the website works

Watch: Uploading website: https://youtu.be/LcJzBG9l1fA

Here are eight essential things that you can do to safeguard your website right now.

- Keep your software up-to-date.
- Enforce a strong password policy
- Encrypt your login pages
- Use a **secure** host
- Backup your data
- Scan your **website** for vulnerabilities

7.3.5.3 Self-Assessment

i. What is domain name?
ii. How to secure your website?
iii. Name essential factor you must consider to commit service provider?
iv. Define web hosts?
v. The website for a company is hosted on a:
   A. Web client
   B. Web server
   C. Web infrastructure
   D. Web page
vi. A URL specifies the following:
   A. Protocol Used
   B. Domain Name Of Server Hosting Web Page
   C. Name Of Folder With Required Information
   D. Name Of Document Formatted Using Html
   E. The Name Of Isp
vii. A search engine is a program to search
   A. For information
   B. Web pages

C. Web pages for specified index terms
D. Web pages for information using specified search terms

viii. Desirable properties of a website are
A. A meaningful address
B. Help and search facilities
C. Links to related sites
D. Features to allow users to give feedback
E. Hosting on a mainframe

7.3.5.4 Tools, Equipment, Supplies and Materials

Hosting server, Computer

7.3.5.5 References

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7.3.6 Learning Outcome 5: Perform website routine maintenance

7.3.6.1 Learning Activities

The following are the performance criteria:

- Links of the website are tested, and corrections are done
- Website pages are tested according to the user requirements and necessary changes are done
- Verification of output data is done to ensure it conforms to the user requirements
- Website version is upgraded to meet the current standards
- Continuous creation, update and archiving of content is done
- Generate maintenance report as per the internal policy

Trainees to demonstrate knowledge in relation to:

- Importance of website testing
- Components of the website functionalities
- Creation, update and archiving of contents
- Generate maintenance report as per internal policy

7.3.6.2 Information Sheet

Website usability refers to the ease with which the average person can interact with any given website. One of the main reasons website usability testing is so important is because of the amount of websites offering the same services and products.

Components of the website functionalities

- Reliable Web Hosting Service
- A Content Management System (CMS)
- SEO Basics
- Analytics Tools
- Inventory Management
- Mobile friendly template and theme
- Sections that visitors expect
- Media
- Social Media Links and integration
- Shopping Cart and Payment Tools

There are several reasons why website maintenance is considered so important for the growth of your business. For one, it helps with the updating of codes/software of your website which keeps the site's data as well as your visitors' info safe and secure.

Updating the site also helps with eliminating the chances of any broken links or links that redirect to any unrelated pages. This, in turn, keeps customers engrossed and prevent them from getting frustrated and switching over to the competition with their better-maintained websites. Outdated content that is no longer being maintained, but which needs to be available to the public for reference or to provide historic context should be archived

7.3.6.3 Self-Assessment

i. Define importance of web testing?
ii. Explain components of the website functionality?
iii. **Case situation:** One of you clients sells jewelry online. She wants you to help her with her website maintenance. What are your suggestions?
iv. **Case situation:** A clients want to update their website. What are the steps will you consider for updating their website. List out your suggestion and approach.
v. Identify various SEO tools that are useful for helping website have new visitors?
vi. Prepare a mobile friendly website for selling paintings for a local artist.
vii. Maintenance consist of the following action(s)
    A. Replace of component
    B. Repair of component
    C. Service of component
    D. All of the above
viii. Total website productive maintenance aims at
    A. Less idle time

B. Increase in productivity
C. Zero down time
D. None of the above

ix. A portable chunk of code that can be embedded in Web pages to give extra functionality is known as a
A. Folksonomy
B. Widget
C. Curator
D. Wiki
E. Listserv

7.3.6.4 Tools, Equipment, Supplies and Materials

Computer, Server

7.3.6.5 References

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- Web Design For Dummies. authored by Lisa Lopuck, published by Wiley; 3rd edition
- The Principles of Beautiful Web Design Second Edition, authored by Jason Beaird published by SitePoint; Second edition
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CHAPTER 8: COMPUTER REPAIR AND MAINTENANCE

8.1 Introduction

This unit specifies competencies required to perform computer repair and maintenance. It involves performing troubleshooting, disassembling of faulty components, repairing/replacing faulty components, testing of component functionality up gradation and testing of hardware and software.

8.2 Performance Standard

- Performed Component Troubleshooting
- Assembled appropriate computer maintenance tools
- Identified different maintenance techniques
- Identified and disassembled Faulty components
- Performed specific component test

8.3 Learning Outcome

8.3.1 List of the Learning Outcomes

These are the key learning outcomes, which make up workplace function:
- Perform troubleshooting
- Disassemble faulty components
- Repair/Replace and reassemble faulty components
- Test computer functionality
- Upgrade computer software/hardware

8.3.2 Learning Outcome 1: Perform troubleshooting

8.3.2.1 Learning Activities

The following are the performance criteria:
- Identification of computer parts is done as per the manufacturer's manual
- Assembling of appropriate computer maintenance tools and maintenance techniques is done as per the manufacturer's manual
- Theory of probable cause is established
- Testing of the theory to determine cause is done
- Identification of the problem is established
- Appropriate solution to the problem is performed

Trainees to demonstrate knowledge in relation to:
- Computer parts
- Assembling and disassembling process
- Theory of probable cause

- Test of theory of probable cause
- Problem identification
- Appropriate solutions
- Occupational safety and health standards

8.3.2.2 Information Sheet

Disassembling the computer system

Detach the power cable: The disassembling of the computer system starts with externally connected device detachment. Make sure the computer system is turned off, if not then successfully shut down the system and then start detaching the external devices from the computer system. It includes removing the power cable from electricity switchboard, then remove the cable from SMPS (switch mode power supply) from the back of the CPU Cabinet. Do not start the disassembling without detaching the power cable from the computer system. Now remove the remaining external devices like keyboard, mouse, monitor, printer or scanner from the back of CPU cabinet.

Remove the Cover: The standard way of removing tower cases used to be to undo the screws on the back of the case, slide the cover back about an inch and lift it off. The screwdrivers as per the type of screw are required to do the task.

Remove the adapter cards: Make sure if the card has any cables or wires that might be attached and decide if it would be easier to remove them before or after you remove the card. Remove the screw if any, which holds the card in place. Grab the card by its edges, front and back, and gently rock it lengthwise to release it.

Remove the drives: Removing drives is easier. There can be possibly three types of drives present in your computer system, Hard disk drive, CD/DVD/Blue-ray drives. They usually have a power connector and a data cable attached from the device to a controller card or a connector on the motherboard. CD/DVD/Blue Ray drive may have an analog cable connected to the sound card for direct audio output.

The power may be attached using one of two connectors, a Molex connector or a Berg connector for the drive. The Molex connector may require to be wiggled slightly from side to side and apply gentle pressure outwards. The Berg connector may just pull out or it may have a small tab, which has to be lifted with a screwdriver.

Now pull data cables off from the drive as well as motherboard connector. The hard disk drive and CD/DVD drives have two types of data cables - IDE and SATA cables. The IDE cables need better care while being removed as it may cause the damage to drive connector pins. Gently wiggle the cable sideways and remove it. The SATA cables can be removed easily by pressing the tab and pulling the connector straight back.

Remove the memory module: Memory modules are mounted on the motherboard as the chips that can be damaged by manual force if applied improperly. Be careful and handle the chip only by the edges. SIMMs and DIMMs are removed in a different way:

- SIMM - gently push back the metal tabs while holding the SIMM chips in the socket. Tilt the SIMM chip away from the tabs until a 45% angle. It will now lift out of the socket. Put SIMM in a safe place.
- DIMM - There are plastic tabs on the end of the DIMM sockets. Press the tabs down and away from the socket. The DIMM will lift slightly. Now grab it by the edges and place it safely. Do not let the chips get dust at all

Remove the power supply: The power supply is attached into tower cabinet at the top back end of the tower. Make sure the power connector is detached from the switchboard. Start removing the power connector connected to motherboard including CPU fan power connector, cabinet fan, the front panel of cabinet power buttons and all the remaining drives if not detached yet. Now remove the screws of SMPS from the back of the cabinet and the SMPS can be detached from the tower cabinet.

Remove the motherboard: Before removing all the connectors from the motherboard, make sure u memorize the connectors for assembling the computer if required, as that may require connecting the connectors at its place. Remove the screws from the back of the motherboard and you will be able to detach it from the cabinet. Now remove the CPU fan from the motherboard. The heat sink will be visible now which can be removed by the pulling the tab upward. Finally, the processor is visible now, which can be removed by the plastic tab which can be pulled back one stretching it side way.

Assembling the computer system: The assembling of the computer system is exactly the opposite of disassembling operation.

Computer Assembly Process

Step 1: Remove Side Panels on Case
Step 2: Insert Motherboard
Step 3: Check Clearances
Step 4: Front Panel Connections
Step 5: Install Power Supply
Step 6: Power Motherboard
Step 7: Installing Optical Drive
Step 8: Installing the Hard Drives
Step 9: Connect Cables
Step 10: Install RAM
Step 11: Install Graphics Card and Expansion Cards
Step 12: Cable Management
Step 13: Final Product

Read: Assembling new PC: https://www.instructables.com/id/Computer-Assembly/

Establish Theory of Probable Cause this is basically a strategic process of elimination by ruling out certain causes, which automatically create problems. You'll learn to determine which components to hone in on, what automatically assessments to make based upon the issue presented and how to conduct an assessment to accurately narrow down the root causes of the problem(s) being experienced.

Read: How to establish probable cause: https://www.cybrary.it/video/establish-theory-probable-cause/

Watch: Assemble and Disassemble a System Unit: https://youtu.be/tQ0YnRntlPA

Test probable cause theory to determine actual **cause**. Once you have established your **theory of probable cause**, you should take a moment to consider whether or not you can troubleshoot the issue on your own, or if escalating it to a higher authority is called for.

Identify and Define the **Problem**. The first step in the problem solving and decision making process is to identify and define the problem. A problem can be regarded as a difference between the actual situation and the desired situation.

8.3.2.3 Self-Assessment

i. What is computer assembling?
ii. Describe computer disassembling?
iii. What is hardware?
iv. What is software?
v. Identify the difference between a desktop and a laptop parts.
vi. Disassemble a desktop.
vii. Disassemble a laptop.
viii. Assemble a desktop
ix. Assemble a laptop
x. One of your friends is complaining that her laptop is heating up. She had recently bought the laptop a secondhand purchase. How can your solve her problem?
xi. Which of the following should be your first choice to remove an application that you no longer need?
   A. Delete the program files
   B. Use the uninstall program that came with the application
   C. Use the Add or Remove Programs Applet
   D. Use the Registry Editor to remove references to the application
xii. Troubleshooting can be best defined as _____.
   A. A systematic way of diagnosing a complex problem
   B. A simple way of diagnosing a complex problem
   C. Checking connections and reviewing error messages
   D. Responding to questions posed by tech support

xiii. Moving from a _____ to a _____ is a basic principle of troubleshooting.

A. Specific Problem, General Problem
B. General Problem, Specific Problem
C. Problem, Symptom
D. Symptom, Problem

8.3.2.4 Tools, Equipment, Supplies and Materials

Wire cutters, Chip extractor, Straight-head screwdriver, large and small, Torx screwdriver, Needle-nosed pliers, Phillips-head screwdriver, large and small.

8.3.2.5 References

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- https://sielearning.tafensw.edu.au/toolboxes/toolbox316/ip/ip_c08.html
- Computer-Managed Maintenance Systems: A Step-by-Step Guide to Effective Management of Maintenance, Labor, and Inventory, 2nd Edition, authored by William W. Cato, R. Keith Mobley published by Butterworth-Heinemann
- Computer Hardware Maintenance authored by Stephen Rood published by Butterworth-Heinemann

8.3.3 Learning Outcome 2: Disassemble faulty components

8.3.4.1 Learning Activities

The following are the performance criteria:

- Tools for disassembling are assembled as per the disassembling procedures
- Faulty components are disassembled
- Disassembling is performed according to provided instruction manuals

Trainees to demonstrate knowledge in relation to:

- Tools for disassembling
- Procedures and techniques for disassembling
- Repair or replace and reassemble components

8.3.4.2 Information Sheet

Using tools properly helps prevent accidents and damage to equipment and people. This section describes and covers the proper use of a variety of hardware, software, and organizational tools specific to working with computers and peripherals.

Hardware Tools: For every job there is the right tool. Make sure that you are familiar with the correct use of each tool and that the correct tool is used for the current task. Skilled use of tools and software makes the job less difficult and ensures that tasks are performed properly and safely.

A toolkit should contain all the tools necessary to complete hardware repairs. As you gain experience, you learn which tools to have available for different types of jobs. Hardware tools are grouped into four categories:

- ESD tools
- Hand tools
- Cleaning tools
- Diagnostic tools

ESD Tools: There are two ESD tools: the antistatic wrist strap and the antistatic mat. The antistatic wrist strap protects computer equipment when grounded to a computer chassis. The antistatic mat protects computer equipment by preventing static electricity from accumulating on the hardware or on the technician.

Hand Tools: Most tools used in the computer assembly process are small hand tools. They are available individually or as part of a computer repair toolkit. Toolkits range widely in size, quality, and price. Some common hand tools and their uses are:

- **Flat-head screwdriver**: Used to tighten or loosen slotted screws.
- **Phillips-head screwdriver**: Used to tighten or loosen cross-headed screws.
- **Torx screwdriver**: Used to tighten or loosen screws that have a star-like depression on the top, a feature that is mainly found on laptops.
- **Hex driver**: Used to tighten or loosen nuts in the same way that a screwdriver tightens or loosens screws (sometimes called a nut driver).
- **Needle-nose pliers**: Used to hold small parts.
- **Wire cutters**: Used to strip and cut wires.
- **Tweezers:** Used to manipulate small parts.
- **Part retriever**: Used to retrieve parts from locations that are too small for your hand to fit.
- **Flashlight**: Used to light up areas that you cannot see well.
- **Wire stripper**: A wire stripper is used to remove the insulation from wire so that it can be twisted to other wires or crimped to connectors to make a cable.
- **Crimper**: Used to attach connectors to wires.
- **Punch-down tool**: Used to terminate wire into termination blocks. Some cable connectors must be connected to cables using a punch down tool.

Cleaning Tools: Having the appropriate cleaning tools is essential when maintaining and repairing computers. Using the appropriate cleaning tools helps ensure that computer components are not damaged during cleaning. Cleaning tools include the following:

- **Soft cloth:** Used to clean different computer components without scratching or leaving debris
- **Compressed air:** Used to blow away dust and debris from different computer parts without touching the components
- **Cable ties:** Used to bundle cables neatly inside and outside of a computer

- **Parts organizer:** Used to hold screws, jumpers, fasteners, and other small parts and prevents them from getting mixed together

Diagnostic Tools: Diagnostic tools are used to test and diagnose equipment. Diagnostic tools include the following:

- A **digital multimeter** is a device that can take many types of measurements. It tests the integrity of circuits and the quality of electricity in computer components. A digital multimeter displays the information on an LCD or LED.

Source: http://electricalacademia.com

Figure 72: Digital multimeter

- A **loopback adapter**, also called a loopback plug, tests the basic functionality of computer ports. The adapter is specific to the port that you want to test.
- The **toner probe**, as shown in Figure 2-4, is a two-part tool. The toner part is connected to a cable at one end using specific adapters, such as an RJ-45, coaxial, or metal clips. The toner generates a tone that travels the length of the cable. The probe part traces the cable. When the probe is in near proximity to the cable to which the toner is attached, the tone can be heard through a speaker in the probe.
- Although an **external hard drive** enclosure is not a diagnostic tool, it is often used when diagnosing and repairing computers. The customer hard drive is placed into the external enclosure for inspection, diagnosis, and repair using a known-working computer. Backups can also be recorded to a drive in an external enclosure to prevent data corruption during a computer repair.

Source: https://www.flukenetworks.com

Figure 73: Toner probe

Software Tools: Like hardware tools, there are a variety of software tools that can be used to help technicians pinpoint and troubleshoot problems. Many of these tools are free and several come with the Windows operating system.

Disk Management Tools: Software tools help diagnose computer and network problems and determine which computer device is not functioning correctly. A technician must be able to use a range of software tools to diagnose problems, maintain hardware, and protect the data stored on a computer.

You must be able to identify which software to use in different situations. Disk management tools help detect and correct disk errors, prepare a disk for data storage, and remove unwanted files.

The following are some disk management tools:

- **FDISK:** A command-line tool that creates and deletes partitions on a hard drive. The FDISK tool is not available in Windows XP, Vista, or 7. It has been replaced with the Disk Management tool.
- **Disk Management Tool:** Initializes disks, creates partitions, and formats partitions.
- **Format:** Prepares a hard drive to store information.
- **ScanDisk or CHKDSK:** Checks the integrity of files and folders on a hard drive by scanning the file system. These tools might also check the disk surface for physical errors.
- **Defrag:** Optimizes space on a hard drive to allow faster access to programs and data.
- **Disk Cleanup:** Clears space on a hard drive by searching for files that can be safely deleted.

- **System File Checker (SFC):** A command-line tool that scans the operating system critical files and replaces files that are corrupted.

Protection Software Tools: Each year, viruses, spyware, and other types of malicious attacks infect millions of computers. These attacks can damage operating systems, applications, and data. Computers that have been infected may even have problems with hardware performance or component failure.

To protect data and the integrity of the operating system and hardware, use software designed to guard against attacks and to remove malicious programs.

Organizational Tools: Keeping accurate records and journals during a busy workday can be challenging. Many organizational tools, such as work-order systems, can help the technician document their work.

Reference Tools: A technician must document all repairs and computer problems. The documentation can then be used as a reference for future problems or for other technicians who may not have encountered the problem before. The documents can be paper based, but electronic forms are preferred because they can be easily searched for specific problems.

It is important that a technician document all services and repairs. These documents need to be stored centrally and made available to all other technicians. The documentation can then be used as reference material for similar problems that are encountered in the future. Good customer service includes providing the customer with a detailed description of the problem and the solution.

Personal Reference Tools: Personal reference tools include troubleshooting guides, manufacturer manuals, quick reference guides, and repair journals. In addition to an invoice, a technician keeps a journal of upgrades and repairs. The documentation in the journal includes descriptions of the problem, possible solutions that have been attempted, and the steps taken to repair the problem. Note any configuration changes made to the equipment and any replacement parts used in the repair. This documentation is valuable when you encounter similar situations in the future.

- **Notes:** Make notes as you go through the troubleshooting and repair process. Refer to these notes to avoid repeating previous steps and to determine what steps to take next.
- **Journal:** Document the upgrades and repairs that you perform. Include descriptions of the problem, possible solutions that have been tried to correct the problem, and the steps taken to repair the problem. Note any configuration changes made to the equipment and any replacement parts used in the repair. Your journal, along with your notes, can be valuable when you encounter similar situations in the future.
- **History of repairs:** Make a detailed list of problems and repairs, including the date, replacement parts, and customer information. The history allows a technician to determine what work has been performed on a specific computer in the past.

Internet Reference Tools: The Internet is an excellent source of information about specific hardware problems and possible solutions:

- Internet search engines
- News groups
- Manufacturer FAQs
- Online computer manuals
- Online forums and chat
- Technical websites

Miscellaneous Tools: With experience, you will discover many additional items to add to the toolkit. Example roll of masking tape can be used to label parts that have been removed from a computer when a parts organizer is not available.

A working computer is also a valuable resource to take with you on computer repairs in the field. A working computer can be used to research information, download tools or drivers, and communicate with other technicians. Make sure that the parts are in good working order before you use them. Using known good components to replace possible bad ones in computers helps you quickly determine which component is not working properly.

Demonstrate Proper Tool Use

Antistatic Wrist Strap: Safety in the workplace is everyone's responsibility. You are much less likely to injure yourself or damage components when using the proper tool for the job.

Before cleaning or repairing equipment, make sure that your tools are in good condition. Clean, repair, or replace items that are not functioning adequately.

An example of ESD is the small shock that you receive when you walk across a carpeted room and touch a doorknob. Although the small shock is harmless to you, the same electrical charge passing from you to a computer can damage its components. Self-grounding or wearing an antistatic wrist strap can prevent ESD damage to computer components.

The purpose of self-grounding or wearing an antistatic wrist strap is to equalize the electrical charge between you and the equipment. Self-grounding is done by touching a bare metal part of a computer case. The antistatic wrist strap is a conductor that connects your body to the equipment that you are working on. When static electricity builds up in your body, the connection made by the wrist strap to the equipment, or ground, channels the electricity through the wire that connects the strap.

Antistatic Mat: You might not always have the option to work on a computer in a properly equipped workspace. If you can control the environment, try to set up your workspace away from carpeted areas. Carpets can cause the buildup of electrostatic charges. If you cannot avoid the carpeting, ground yourself to the unpainted portion of the case of the computer on which you are working before touching any components.

An antistatic mat is slightly conductive. It works by drawing static electricity away from a component and transferring it safely from equipment to a grounding point.

When you are working at a workbench, ground the workbench and the antistatic floor mat. By standing on the mat and wearing the wrist strap, your body has the same charge as the equipment and reduces the probability of ESD. Either connect the table-top mat and the floor mat to each other, or connect both to the electrical earth ground.

Reducing the potential for ESD reduces the likelihood of damage to delicate circuits or components.

NOTE: Always handle components by the edges.

Hand Tools: A technician needs to be able to properly use each tool in the toolkit.

- **Screws:** Match each screw with the proper screwdriver. Place the tip of the screwdriver on the head of the screw. Turn the screwdriver clockwise to tighten the screw and counterclockwise to loosen the screw. Screws can become stripped if you over-tighten them with a screwdriver. A stripped screw, as shown in may get stuck in the screw hole, or it may not tighten firmly. Discard stripped screws.
- **Flat-Head Screwdriver:** Use a flat-head screwdriver when you are working with a slotted screw. Do not use a flat-head screwdriver to remove a Phillips-head screw. Never use a screwdriver as a pry bar. If you cannot remove a component, check to see if there is a clip or latch that is securing the component in place.

  CAUTION: If excessive force is needed to remove or add a component, something is probably wrong. Take a second look to make sure that you have not missed a screw or a locking clip that is holding the component in place. Refer to the device manual or diagram for additional information.

- **Phillips-Head Screwdriver:** Use a Phillips-head screwdriver with crosshead screws. Do not use this type of screwdriver to puncture anything. This will damage the head of the screwdriver.
- **Hex Driver:** Use a hex driver, to loosen and tighten bolts that have a hexagonal (six-sided) head. Hex bolts should not be over-tightened because the threads of the bolts can be stripped. Do not use a hex driver that is too large for the bolt that you are using.

  CAUTION: Some tools are magnetized. When working around electronic devices, be sure that the tools you are using have not been magnetized. Magnetic fields can be harmful to data stored on magnetic media. Test your tool by touching the tool with a screw. If the screw is attracted to the tool, do not use the tool.

- **Component Retrieving Tools:** Needle-nose pliers and tweezers can be used to place and retrieve parts that may be hard to reach with your fingers. There are also tools called part retrievers that are specifically designed for this task. Do not scratch or hit any components when using these tools.

  CAUTION: Pencils should not be used inside the computer to change the setting of switches or to pry off jumpers. The pencil lead can act as a conductor and may damage the computer components.

A computer technician needs proper tools to work safely and prevent damage to the computer equipment. A technician uses many tools to diagnose and repair computer problems:

- Straight-head screwdriver, large and small
- Phillips-head screwdriver, large and small
- Tweezers or part retriever
- Needle-nosed pliers
- Wire cutters
- Chip extractor
- Hex wrench set
- Torx screwdriver
- Nut driver, large and small
- Three-claw component holder
- Wire stripper
- Crimper
- Punch-down tool
- Digital multimeter
- Wrap plugs
- Small mirror
- Small dust brush
- Soft, lint-free cloth
- Cable ties
- Scissors
- Small flashlight
- Electrical tape
- Pencil or pen
- Compressed air

Various specialty tools, such as Torx bits, antistatic bags and gloves, and integrated circuit pullers, can be used to repair and maintain computers. Always avoid magnetized tools, such as screwdrivers with magnetic heads, or tools that use extension magnets to retrieve small metal objects that are out of reach. Using magnetic tools can cause loss of data on hard drives and floppy disks. Magnetic tools can also induce current, which can damage internal

computer components.

Additionally, there are specialized testing devices used to diagnose computer and cable problems:

- **Multimeter:** A device that measures AC/DC voltage, electric current, and other cable and electrical characteristics.
- **Power supply tester:** A device that checks whether the computer power supply is working properly. A simple power supply tester might just have indicator lights, while more advanced versions show the amount of voltage and amperage.
- **Cable tester:** A device that checks for wiring shorts or faults, such as wires connected to the wrong pin.
- **Loopback plug:** A device that connects to a computer, hub, switch, or router port to perform a diagnostic procedure called a loopback test. In a loopback test, a signal is transmitted through a circuit and then returned to the sending device to test the integrity of the data transmission.

Cleaning Materials

Keeping computers clean inside and out is a vital part of a maintenance program. Dirt can cause problems with the physical operation of fans, buttons, and other mechanical components. On electrical components, an excessive buildup of dust acts like an insulator and traps the heat. This insulation impairs the ability of heat sinks and cooling fans to keep components cool, causing chips and circuits to overheat and fail.

NOTE: When using compressed air to clean inside the computer, blow the air around the components with a minimum distance of 4 in. (10 cm) from the nozzle. Clean the power supply and the fan from the back of the case.

CAUTION: Before cleaning any device, turn it off and unplug the device from the power source.

Computer Cases and Monitors: Clean computer cases and the outside of monitors with a mild cleaning solution on a damp, lint-free cloth. Mix one drop of dishwashing liquid with 4 oz (118 ml) of water to create the cleaning solution. If water drips inside the case, allow enough time for the liquid to dry before powering on the computer.

LCD Screens: Do not use ammoniated glass cleaners or any other solution on an LCD screen, unless the cleaner is specifically designed for the purpose. Harsh chemicals damage the coating on the screen. There is no glass protecting these screens, so be gentle when cleaning them and do not press firmly on the screen.

CRT Screens: To clean the screens of CRT monitors, dampen a soft, clean, lint-free cloth with distilled water and wipe the screen from top to bottom. Then use a soft, dry cloth to

wipe the screen and remove streaking.

Components: Clean dusty components with a can of compressed air. Compressed air does not cause electrostatic buildup on components. Make sure that you are in a well-ventilated area before blowing the dust out of the computer. A best practice is to wear a dust mask to make sure that you do not breathe in the dust particles.

Blow out the dust using short bursts from the can. Never tip the can or use the can upside down. Do not allow the fan blades to spin from the force of the compressed air. Hold the fan in place. Fan motors can be ruined from spinning when the motor is not turned on.

Component Contacts: Clean the contacts on components with isopropyl alcohol. Do not use rubbing alcohol. Rubbing alcohol contains impurities that can damage contacts. Make sure that the contacts do not collect lint from the cloth or cotton swab. Before reinstallation, use compressed air to blow lint off the contacts.

Keyboards: Clean a desktop keyboard with compressed air and then use a handheld vacuum cleaner with a brush attachment to remove the loose dust.

CAUTION: Never use a standard vacuum cleaner inside a computer case. The plastic parts of the vacuum cleaner can build up static electricity and discharge to the components. Use only vacuums that are approved for electronic components.

Mice: Use glass cleaner and a soft cloth to clean the outside of the mouse. Do not spray glass cleaner directly on the mouse. If cleaning a ball mouse, you can remove the ball and clean it with glass cleaner and a soft cloth. Wipe the rollers clean inside the mouse with the same cloth. Do not spray any liquids inside the mouse.

Table 11: Computer cleaning materials

Computer case and outside of monitor	Mild cleaning solution and lint-free cloth
LCD screen	LCD cleaning solution or distilled water and lint-free cloth
CRT screen	Distilled water and lint-free cloth
Heat sink	Compressed air
RAM	Isopropyl alcohol and lint-free swab
Keyboard	Handheld vacuum cleaner with a brush attachment
Mouse	Glass cleaner and a soft cloth.

Read: Laptop repair tools: http://www.insidemylaptop.com/laptop-repair-tools/

8.3.5.3 Self-Assessment

i. List the hand tools for dissembling a computer?

ii. List the diagnostic tools for dissembling a computer?

iii. Dissemble a desktop
iv. Clean a CPU
v. Clean a monitor
vi. **Case situation:** You Are Support Technician. One of your customers has just installed a brand new printer for himself. This customer calls you after some time and says that every time he tries to print something, all he gets is some garbled text. However, the printer prints the test page fine. What do you think is the problem here?
vii. _____Used to terminate wire into termination blocks. Some cable connectors must be connected to cables using a punch down tool.
   A. Punch-down tool
   B. Wrap plugs
   C. Small mirror
   D. Small dust brush
viii. _____ A device that checks for wiring shorts or faults, such as wires connected to the wrong pin.
   A. Cable tester
   B. Needle-nosed pliers
   C. Wire cutters
   D. Chip extractor
   E. None of above
ix. _____ A command-line tool that creates and deletes partitions on a hard drive.
   A. Attrib
   B. FDISK
   C. CHKDSK

8.3.5.4 Tools, Equipment, Supplies and Materials

Wire cutters, Chip extractor, Straight-head screwdriver, large and small, Torx screwdriver, Needle-nosed pliers, Phillips-head screwdriver, large and small.

8.3.5.5 References

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- Computer Hardware Maintenance authored by Stephen Rood published by Butterworth-Heinemann; 1st edition

8.3.4 Learning Outcome 3: Repair/Replace and reassemble faulty components

8.3.4.1 Learning Activities

The following are the performance criteria:

- Faulty parts to be repaired or replaced are identified
- Acquisition of new parts is done as per the specifications of the components in the case of replacement and repair is done on faulty components.
- Reassembling of the repaired or replaced components is done

Trainees to demonstrate knowledge in relation to:

- Determine components to replace or repair
- Procedures and Techniques for reassembling
- Component testing
- Repair/replace report

8.3.4.2 Information Sheet

Factors to consider when replacing a component:

With productivity plummeting, your decision will likely be made from an emotional standpoint, rather than solid data to support your decision.

Data Driven Decisions, Analyze the Costs, Consider the Age of Equipment, Consider the Cost of Repairs, Consider Downtime, Consider Safety, Consider Efficiency.

Component testing is defined as a software testing type, in which the testing is performed on each individual component separately without integrating with other components. It's also referred to as Module Testing when it is viewed from an architecture perspective.

8.3.4.3 Self-Assessment

i. Define factors to consider when replacing components?

ii. What is component testing?

iii. **Case situation:** You are asked to maintain a computer lab at an institution. You see that their DVD/ CD drive is not working. What is your suggestion?

iv. **Case situation:** You have received a call from a client saying that their laptop is not starting after it fell down from the bed. You client says that there is no outside damage. What will you tell you client?

v. If you have a PC with an ATX motherboard and case, can you replace it with a BTX motherboard?

   A. Yes
   B. Yes, if you set the jumpers
   C. Yes, if you add more screw holes
   D. Yes, if you remove some ports
   E. No

vi. _____ is defined as a software testing type, in which the testing is performed on each individual component separately without integrating with other components.

A. Component testing
B. RAM
C. Chip extractor
D. Motherboard

8.3.4.4 Tools, Equipment, Supplies and Materials

Wire cutters, chip extractor, straight-head screwdriver, large and small.

8.3.4.5 References

- https://www.micromain.com/asset-repair-or-replace/
- Computer Hardware Maintenance authored by Stephen Rood published by Butterworth-Heinemann; 1st edition

8.3.5 Learning Outcome 4: Test computer functionality

8.3.5.1 Learning Activities

The following are the performance criteria:

- Switch on the computer for POST test
- Perform specific component test as per the manufacturer manual
- Evaluation of the test results is done
- Generation of the component and system report is done
- Develop a component test plan based on the component report

Trainees to demonstrate knowledge in relation to:

- Computer testing tools
- Testing techniques
- Perform computer test functionality
- Status report

8.3.5.2 Information Sheet

Best technicians tools to diagnose a computer are:

- Process Explorer., Process Explorer is a small utility available for free.
- Windows Sysinternals Suite, System Explorer, SIW (System Information for Windows)
- HWiNFO, Speccy,hddscan.

Read: Computer diagnostic tools: https://www.techsupportall.com/10-best-computer-diagnostic-tools-technicians/

Testing techniques

- Test system platform

- I/O signal conditioning
- Benchtop instrumentation
- Data acquisition hardware
- Test sequencing / automation
- Test Steps & application algorithms
- Operator and Engineering User Interface

When conducting functional tests, you typically need to follow a process that looks something like this:

- Use test data to identify inputs
- Determine what the expected outcome should be based on those inputs
- Run the test cases with the proper inputs
- Compare the expected results to the actual results

8.3.5.3 Self-Assessment

i. Explain computer diagnostic?

ii. What is process for functional tests?

iii. What could cause a fixed disk error:

   A. No-CD installed
   B. Bad ram
   C. Slow processor
   D. Incorrect CMOS settings
   E. None of the above

iv. Different components on the motherboard of a PC unit are linked together by sets of parallel electrical conducting lines. What are these lines called?

   A. Conductor's
   B. Buses
   C. Connectors
   D. Consecutively

v. Boot virus affects the _____ of the program of a system.

   A. Boot recorded program
   B. Booting computer
   C. Boot halted
   D. None

vi. Your IT technician and one of office computer is displaying blue screen you shut it on what would you do without format it?

8.3.5.4 Tools, Equipment, Supplies and Materials

Wire cutters, Chip extractor, Straight-head screwdriver, large and small, Torx screwdriver, Needle-nosed pliers, Phillips-head screwdriver, large and small.

8.3.5.5 References

- https://www.techsupportall.com/10-best-computer-diagnostic-tools-technicians/

- Computer Hardware Maintenance, 1st edition, authored by Stephen Rood published by Butterworth-Heinemann;

8.3.6 Learning Outcome 5: Upgrade computer software/hardware

8.3.6.1 Learning Activities

The following are the performance criteria:

- Run diagnostic program according to the manufacturer's manual
- Install update if any according to the manufacturer manual

Trainees to demonstrate knowledge in relation to:

- Determine Reasons of upgrading
- Procedures and techniques for upgrading

8.3.6.2 Information Sheet

Here are the top reasons why you should always be upgrading your software to the latest version.

- Cyber crime is on the rise
- Personal data is at risk
- You might not be updating automatically
- Malware passes like the flu
- New features
- Support might end

Benefits of upgrading hardware

- Enhanced Performance
- Increased Security
- Downtime is Reduced
- Better Communications
- Better Experience for your Employees

Upgrading your release of Identity Manager provides several advantages, including:

- Access to advanced features and functionality
- A more secure environment for your servers
- Continued eligibility for full support and services

Software Upgrade Process:

1. Identify and engage your stakeholders

Remember to include both internal and external stakeholders. End users, trainers, content developers, administrators, support and hosting teams, QA and testing teams, system owners, external suppliers, and service partners. Work out how each group interacts with the system, how an upgrade will affect them, and what level of ongoing engagement they might require.

2. Undertake change control planning
Besides the technical work involved in upgrading your system, effective change control will probably be the biggest challenge surrounding a software upgrade. Keeping the balance between adequate communication and consultation, and overwhelming stakeholders with detail can be difficult.

3. Perform a site review
Performing a site review involves taking a stock of any and all customizations within the site. Identify all bespoke developments and dig out the specifications and other relevant documentation relating to this work.

4. Establish upgrade requirements
Based on your site review, do you need to re-develop customizations and integrations or upgrade bespoke plugins? Do you need to make allowance for historical data from those customizations? Can you upgrade to the latest version of the software from your current version or do you need to upgrade to a more recent version first? Check the technical specifications of the new software—do you need to upgrade, install, or purchase anything as part of the upgrade? Do you also need (or want) to upgrade your theme/design or will it work on the upgraded version?

5. Make an upgrade plan
Who will perform the upgrade? What needs to be upgraded? What needs to be redeveloped? Does anything need to be newly developed? How will the upgrade be performed? Is there any guidance on the upgrade from the software supplier? What time, people, resources, and budget do you need to apply to the upgrade process?

6. Make a roll-out plan
When will the upgrade be performed? Will there be an outage? How long will it be? What sort of message needs to go out to stakeholders? What will be the implementation process? What is your rollback plan?

7. Backup everything
Store that backup somewhere very safe and secure. Backup again, and store that file somewhere else safe and secure.

8. Run a trial upgrade
The best way to know if any issues will crop up during the upgrade is to try upgrading a copy of the live site. It will identify any code and/or database conflicts and where further work will be required.

9. Upgrade a staging site
Once the technical aspect of the upgrade has been completed and any issues resolved, it's time to upgrade a copy of the live site to a staging or testing environment.

10. Perform testing
This includes functional, non-functional and technical testing, quality assurance, data integrity, security, performance, and theme/design testing including browser, and device testing.

11. Undertake configuration
With your freshly upgraded staging site now deployed, tested and issues resolved, site administrators will need some time to ensure any new features and functionality introduced by the updates are configured correctly.

12. Prepare documentation
Preparing help files or user manuals, as well as technical documentation detailing any custom developments or deployment requirements is vital to the success of your current upgrade as well as any future upgrades.

13. Provide training
Training the right people at the right time not only requires adequate training resources but adequate planning. Trainers and the trainees need to be available at the same time, in a suitable space.

14. Prepare your infrastructure
If your upgrade introduces a number of significant changes or you are timing the software upgrade with a re-release of the system, you will need to ensure your hosting setup will be able to cope with an increase in access and usage—if only for a short period of time.

15. Go Live
You have a few options around your go-live including a complete switchover or running the old system and updated system in parallel for a period of time

16. Offer support
There will probably be an initial demand on support resources after an upgrade has been released as users become acquainted with the new system. Changes to ongoing support might be required as a result of new system features and functionality or changes to processes and policies.

17. Perform an upgrade review
It is important to review the upgrade project in retrospect to identify what worked well and where improvements can be made for the next time an upgrade is required.

8.3.6.3 Self-Assessment

i. Describe process of software and hardware upgrading?
ii. Why might a company need to upgrade their hardware? Provide examples to reason.
iii. You have a few options around your _____ including a complete switchover or running the old system and updated system in parallel for a period of time.

A. Go Live
B. Provide Training
C. Backup Everything

iv. Upgrading your release of Identity Manager provides several advantages, including:
A. Access to advanced features and functionality
B. A more secure environment for your servers
C. Continued eligibility for full support and services
D. All are True
E. Only A and B are correct

8.3.6.4 Tools, Equipment, Supplies and Materials

Wire cutters, Straight-head screwdriver, large and small, Torx screwdriver, Needle-nosed pliers, Computer

8.3.6.5 References

- https://correct.com.au/15-great-reasons-upgrade-systems/
- https://www.ophtek.com/what-are-the-benefits-of-upgrading-your-hardware/
- Software Technology, authored by Mike Hinchey published by John Wiley & Sons Inc 2018

CHAPTER 9: DATABASE MANAGEMENT SYSTEM

9.1 Introduction

This unit specifies competencies required to manage database system. They include identification of database management systems, designing of database, Creation and manipulation of database, database testing e.g. using dummy data, implementation of the designed database, establishing transaction and concurrency mechanism and managing database security

9.2 Performance Report

- Established Database requirements
- Identified database components
- Adopted a Suitable database system
- Performed Database operations
- Applied Appropriate Data Attributes
- Extracted data from database using SQL
- Performed test data and validated the results
- Identified transaction and concurrency mechanisms
- Established restrictions to the database

9.3 Learning Outcome

9.3.1 List of the Learning Outcomes

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

- Identify database management system
- Design database
- Create and manipulate database
- Perform database testing
- Implement designed database
- Establish transaction and concurrency mechanism
- Manage database security

9.3.2 Learning Outcome 1: Identify database management system

9.3.2.1 Learning Activities

The following are the performance criteria:

- Database requirements are established based on user needs.
- Main features in databases are identified according to expected output.
- Database components are identified
- Classification and categories of databases is done
- Functionality of databases is identified as per the requirements
- Suitable database system is adopted as per user requirements

Trainees to demonstrate knowledge in relation to:

- Define database management system, components and terminologies
- Classification of databases
- Understand various database management system

9.3.2.2 Information Sheet

A **database management system (DBMS)** is a software package designed to define, manipulate, retrieve and manage data in a database. A DBMS generally manipulates the data itself, the data format, field names, record structure and file structure. It also defines rules to validate and manipulate this data. A DBMS relieves users of framing programs for data maintenance. Fourth-generation query languages, such as SQL, are used along with the DBMS package to interact with a database.

Some other DBMS examples include: MySQL, SQL Server, Oracle, dBASE, FoxPro

Classification based on Data Model: The most popular data model in use today is the relational data model. Well-known DBMSs like Oracle, MS SQL Server, DB2 and MySQL support this model.

- **Centralized database system: the** DBMS and database are stored at a single site that is used by several other systems.
- **Distributed database system**: the actual database and the DBMS software are distributed from various sites that are connected by a computer network
- **Heterogeneous distributed database system:** different sites might use different DBMS software, but there is additional common software to support data exchange between these sites
- **Homogeneous distributed database systems:** use the same DBMS software at multiple sites
- **Multiuser database system:** a database management system, which supports multiple users concurrently
- **Object-oriented data model:** a database management system in which information is

represented in the form of objects as used in object-oriented programming

- **Single-user database system:** a database management system which supports one user at a time
- **Traditional models:** data models that preceded the relational model

Read: Classification of databases: https://opentextbc.ca/dbdesign01/chapter/chapter-6-classification-of-database-systems/

9.3.2.3 Self-Assessment

i. What is database management?
ii. Explain database classification?
iii. What is the difference between centralized and distributed database systems?
iv. What is the difference between homogenous distributed database systems and heterogeneous distributed database systems?
v. Provide three examples of the most popular relational databases used.
vi. DBMS is software.
   A. True
   B. False
vii. DBMS manages the interaction between _____ and database.
   A. Users
   B. Clients
   C. End Users
   D. Stake Holders
viii. Database is generally _____
   A. System-centered
   B. User-centered
   C. Company-centered
   D. Data-centered
ix. Which of the following is not involved in DBMS?
   A. End Users
   B. Data
   C. Application Request
   D. HTML
x. As database administrator how will you explain the primitive operations common to all record management System?

9.3.2.4 Tools, Equipment, Supplies and Materials

MySQL, SQL Server, Oracle, dBASE, computer

9.3.2.5 References

- https://www.techopedia.com/definition/24361/database-management-systems-dbms
- https://opentextbc.ca/dbdesign01/chapter/chapter-6-classification-of-database-systems/

- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 12 edition 2016

9.3.3 Learning Outcome 2: Design database

9.3.3.1 Learning Activities

The following are the performance criteria:

- Appropriate database structures are determined
- Database design is implemented based on requirements.
- Database modeling is done as per the design implemented
- Database operations are performed

Trainees to demonstrate knowledge in relation to:

- Define data abstraction, instances and schemas
- Types of Database structures
- Database operations: INSERT, SELECT, UPDATE, DELETE
- Data models : ER- Models, Relational Models, Hierarchical models, Network Models

9.3.3.2 Information Sheet

Data abstraction is the reduction of a particular body of data to a simplified representation of the whole. Abstraction, in general, is the process of taking away or removing characteristics from something in order to reduce it to a set of essential characteristics.

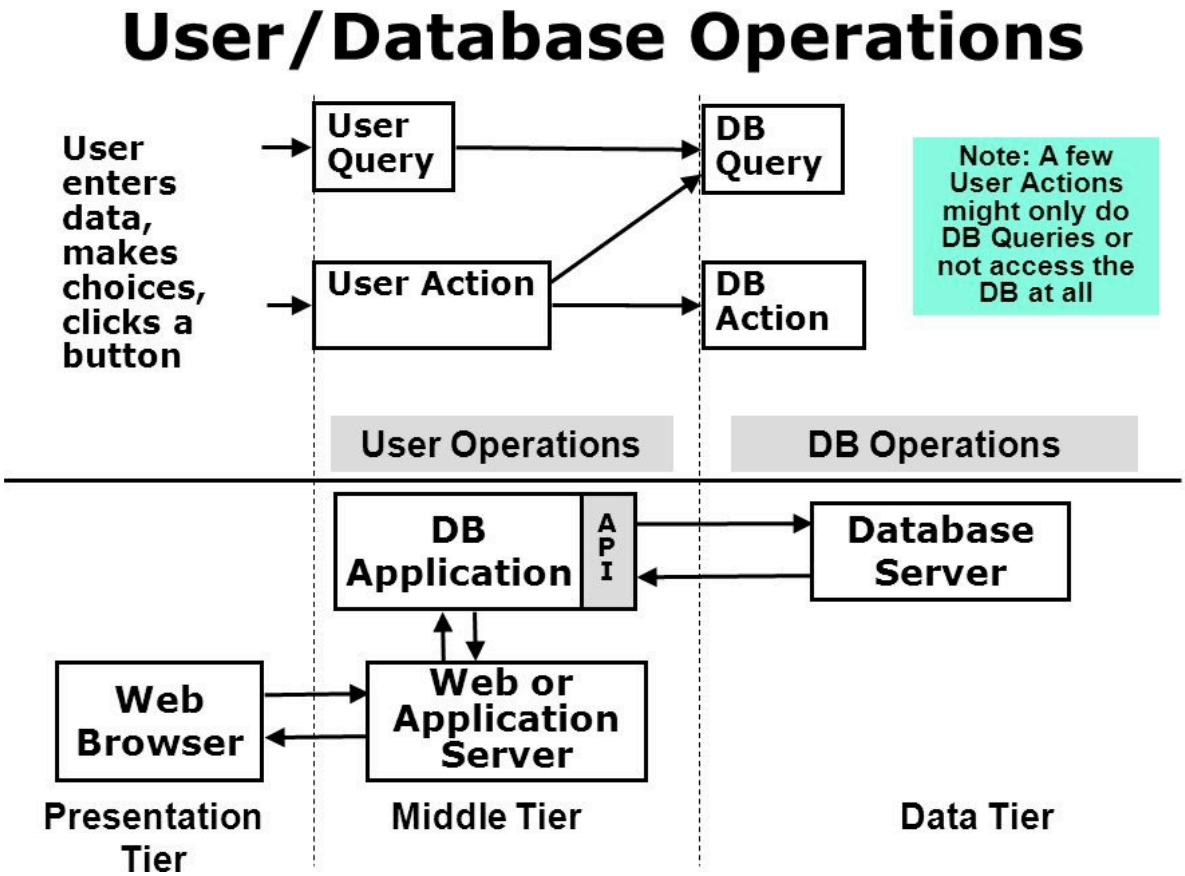
Instance: The data stored in database at a particular moment of time is called **instance** of database. Database **schema** defines the variable declarations in tables that belong to a particular database; the value of these variables at a moment of time is called the **instance** of that database.

Types of database models

- Hierarchical database model
- Relational model
- Network model
- Object-oriented database model
- Entity-relationship model
- Document model
- Entity-attribute-value model
- Star schema

Read: Database model: https://www.lucidchart.com/pages/database-diagram/database-models

A **database operation** is the vehicle through which users and applications have access to data in relational databases. Each database operation accesses one relational database.



Source: https://slideplayer.com

Figure 74: User database operations

The INSERT INTO statement is used to insert new records in a table:
INSERT INTO table_name (*column1, column2, column3, ...*)
VALUE *(value1, value2, value3, ...)*

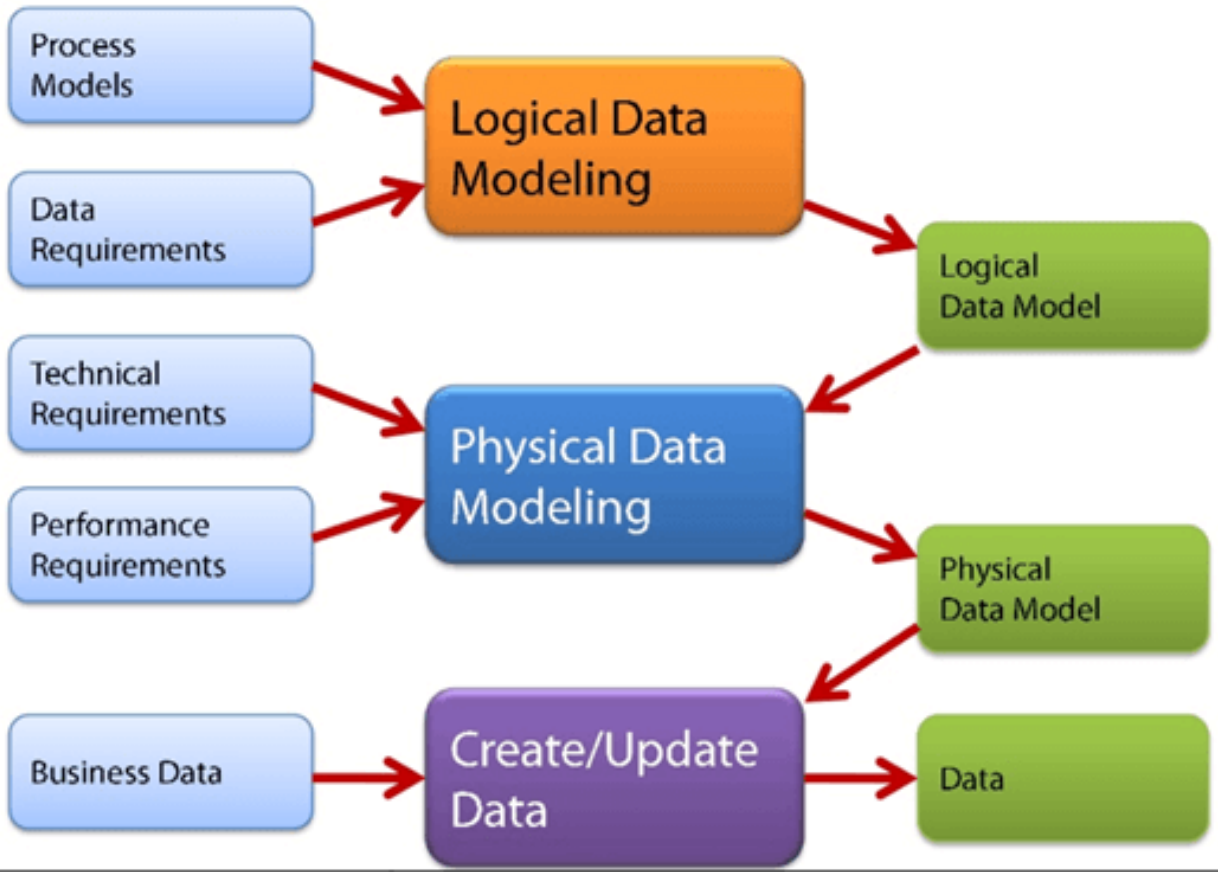
The SELECT statement is used to select data from a database:
SELECT *(column1, column 2,...)*
FROM *table_name*

The UPDATE statement is used to modify the existing records in a table:
UPDATE *table_name*
SET *column1= value1, column2 = value2, ...*
WHERE condition;

The DELETE statement is used to delete existing records in a table:
DELETE FROM *table_name* WHERE *condition*;

Watch: MySQL queries: https://youtu.be/XMY6Wt1NREg

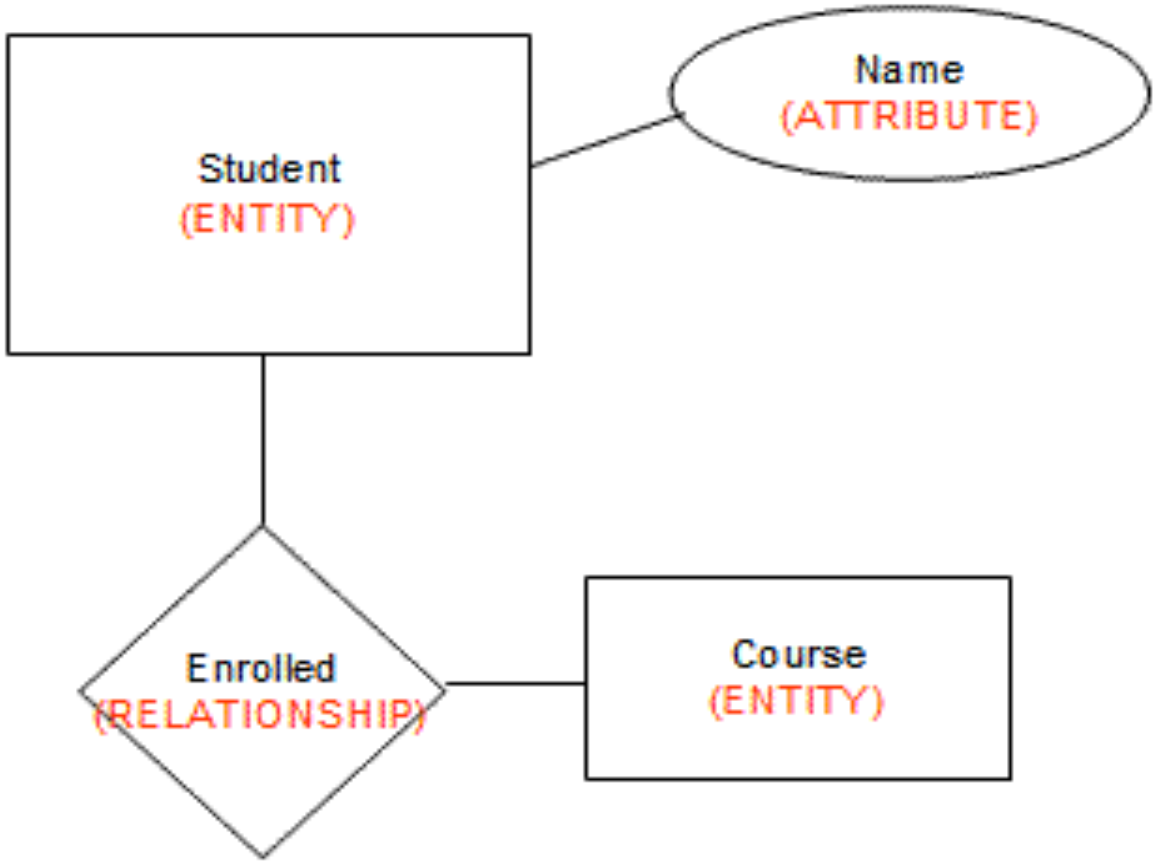
Data Models are fundamental entities to introduce abstraction in a DBMS.



Source: https://www.guru99.com

Figure 75: Data Model

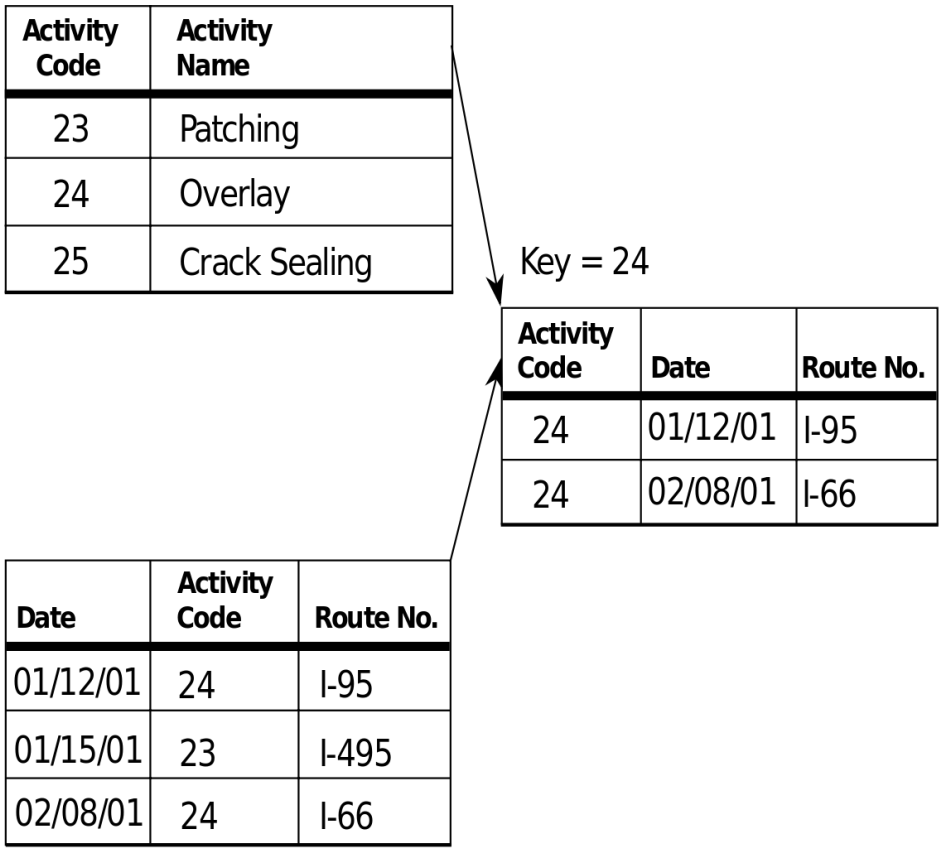
An entity–relationship model (or ER model) describes interrelated things of interest in a specific domain of knowledge. A basic **ER model** is composed of entity types (which classify the things of interest) and specifies relationships that can exist between entities (instances of those entity types).



Source: http://jcsites.juniata.edu

Figure 76: Entity-relationship model

In the relational model, all data must be stored in relations (tables), and each relation consists of rows and columns.



Source: https://en.wikipedia.org

Figure 77: Relation model

Hierarchical Models (aka Hierarchical Linear Modelsor HLM) are a type of linear regression models in which the observations fall into hierarchical, or completely nested levels. Hierarchical Models are a type of Multilevel Models.

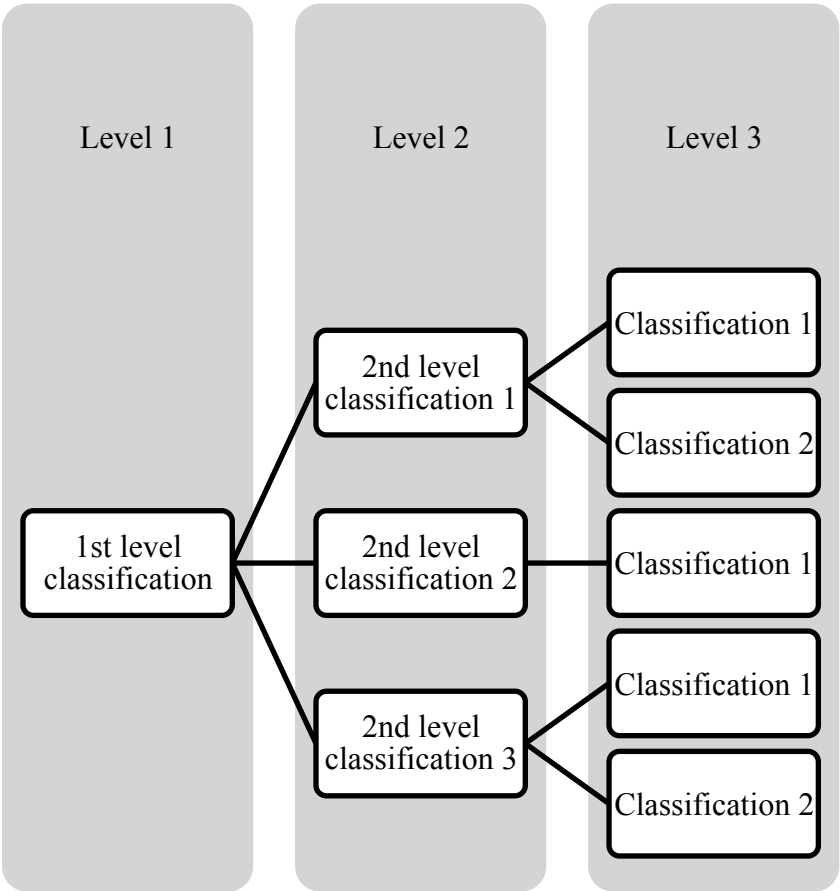
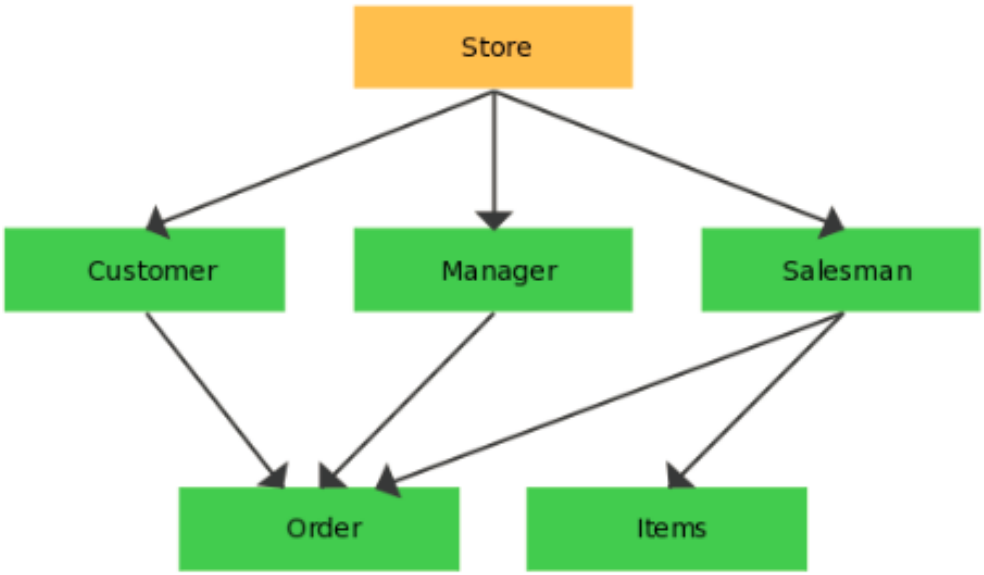


Figure 78: Hierarchical model

A network model is a database model that is designed as a flexible approach to representing objects and their relationships. A unique feature of the network model is its schema, which is viewed as a graph where relationship types are arcs and object types are nodes.



Source: http://www.dbmsinternals.com

Figure 79: Network model

9.3.3.3 Self-Assessment

i. Write a SQL query to fetch all records FROM table?
ii. Write a SQL query to create a new table with data and structure copied from another table?
iii. Who proposed the relational model?
vi. Define database model.
v. What is the purpose of SQL?
vi. What is DBMS used for?
vii. What is E-R model in the DBMS?
viii. Which SQL function is used to count the number of rows in a SQL query ?
   A. COUNT()
   B. NUMBER()
   C. SUM()
   D. COUNT(*)
ix. What mode of authentication does SQL Server NOT provide?
   A. Windows-only security
   B. Both SQL Server and Windows-only security
   C. Mixed security
   D. SQL Server only security
x. If you don't specify ASC or DESC after a SQL ORDER BY clause, the following is used by default

A. ASC
B. DESC
C. There is no default value
D. None of the mentioned

xi. Which of the following statement is true?
A. DELETE does not free the space containing the table and TRUNCATE free the space containing the table
B. Both DELETE and TRUNCATE free the space containing the table
C. Both DELETE and TRUNCATE does not free the space containing the table
D. DELETE free the space containing the table and TRUNCATE does not free the space containing the table

9.3.3.4 Tools, Equipment, Supplies and Materials

SQL Server Database Modeler, Aqua Data Studio ER Modeler, Computer

9.3.3.5 References

- https://www.w3schools.com/sql/default.asp
- https://www.softwaretestinghelp.com/database-design-tools/
- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 12 edition 2016
- SQL QuickStart Guide: The Simplified Beginner's Guide To SQL authored by ClydeBank Technology published by CreateSpace Independent Publishing Platform 2015

9.3.4 Learning Outcome 3: Create and manipulate database

9.3.4.1 Learning Activities

The following are the performance criteria:

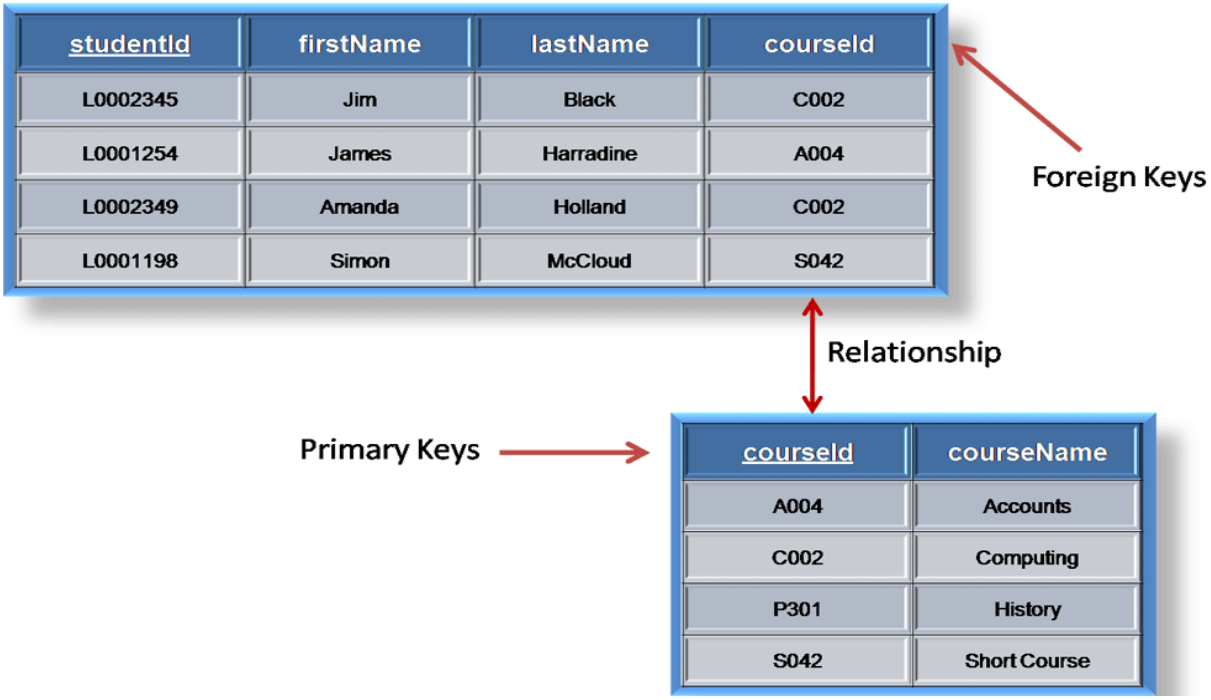
- Appropriate data Attributes are applied appropriately
- Data relationships are established as per the tables created
- Model and index of the data is done.
- Data is extracted from database using SQL

Trainees to demonstrate knowledge in relation to:
Creation of tables, Primary and secondary key
Linking of tables, Data variables, Database integration, Database Querying-SQL

9.3.4.2 Information Sheet

Tables can be created using **CREATE TABLE statement** and it actually has the following syntax:
CREATE TABLE [IF NOT EXISTS} `TableName` (`filename` dataType [optional parameters] ENGINE = storage Engine;

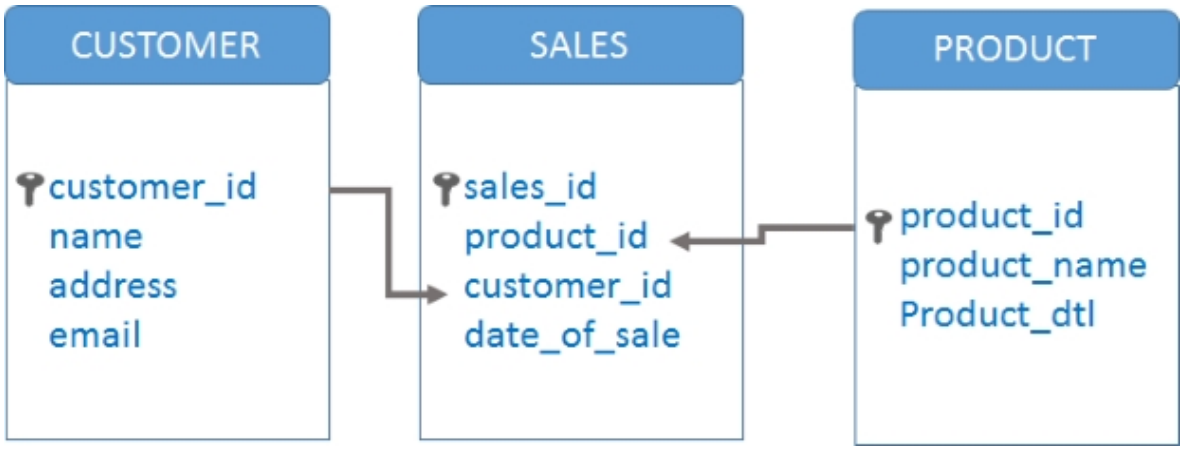
One is selected as the **primary key**. Those not selected are known as secondary keys. For example, an employee has an employee number, a National Insurance (NI) number and an email address. If the employee number is chosen as the primary key then the NI number and email address are **secondary keys.**



Source: https://www.researchgate.net

Figure 80: Database table

Linking of table is a very common requirement in SQL. Different types of data can be stored in different tables and based on the requirement the tables can be linked to each other and the records can be displayed in a very interactive way.



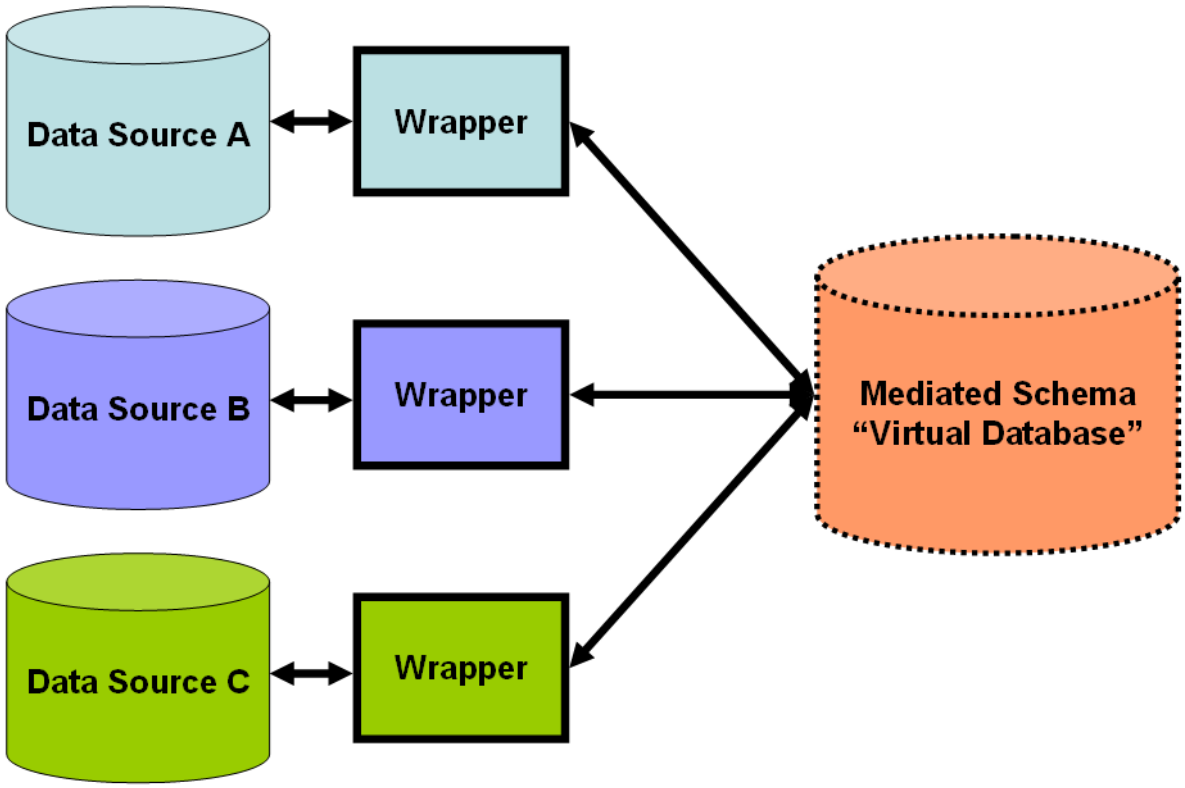
Source: https://www.plus2net.com

Figure 81: Table linkages

A **variable** is any characteristics, number, or quantity that can be measured or counted. A variable may also be called a data item. Age, sex, business income and expenses, country

of birth, capital expenditure, class grades, eye colour and vehicle type are examples of variables.

An **integration database** is a database, which acts as the data store for multiple applications, and thus integrates data across these applications (in contrast to an Application Database). An integration database needs a schema that takes all its client applications into account.



Source: https://en.wikipedia.org/wiki/Data_integration

Figure 82: Integration of database

SQL is a domain-specific language used in programming and designed for managing data held in a relational database management system, or for stream processing in a relational data stream management system.

Watch: SQL Queries: https://www.coursera.org/lecture/core-database/part-1-sql-query-language-vevDZ

9.3.4.3 Self-Assessment

i. How to create table?
ii. What is table linkage?
iii. Define data variable?
iv. What the difference between primary key and secondary key?
v. What is SQL?
vi. A medical Centre wishes to computerize all its patients' records
   a) Create database for the Centre and save it as your name and personal number.

b) InDesign View, Create a table with the following properties and save it as patient Bio Table.

Field Name	**Properties**
Patient Name	Text (20)
Sex	Text (1)
Residence	Text (20)
Patient code	Text (4)
Date of visit	Date/Time(short date)
Diagnosis	Text (25)

c) Create a form for patient Bio table and enter the records below, save it as **patient bio form**

Patient Name	Sex	Residence	Patient Code	Date of visit	Diagnosis
Victor sam	M	Kangemi	ADS011	3/8/2018	Septic Wound
Stella mugo	F	Kisumu	ADS025	9/1/2019	Malaria
Mwangi Nema	F	Buru buru	ADS014	23/4/2018	Inflamed joints
Njambi ella	F	Bulenga	ADS034	14/2/2019	Infections in chest
Michael wanyama	M	Naivasha	ADS019	3/2/2019	Malaria

d) InDesign view, create another table with the following properties and save it as patient billing Table.

Field Name	**Properties**
Patient Code	Text (4), Primary Key
Prescription	Memo
Consult_fee	Number
Treat_fee	Number
Medical bill	Number

Medical is a calculated field which is Consult_fee+ Treat_fee

e) Populate the Patient Billing Table with the following Data;

Patient Code	**Prescription**	**Consult_fee**	**Treat_fee**	**Medical bill**
ADS011	Coartem	17,000	28,000	
ADS025	Tetanous	17,000	20,000	
ADS014	Ciproflaxin tabs, PPF	17,000	25,000	
ADS034	Chloroquine Infection	17,000	17,000	
ADS019	Referref	17,000	8,000	

f) Create a one-to-one relationship between the Patient Bio Table and the Patient Billing Table.
g) Create a query which extract from patient bio table only those patients who were not diagnosed with malaria. Save it as anti-malaria.
h) i.) Create a report showing Name, Residence, Prescription and Medical Bill. Save it as clinic report.
ii.) Include a report footer of your name and personal number.
iii.) Print all your work.

vii. A logical schema is -
A. Is the entire database
B. Describe data in terms of relational tables and columns, object-oriented classes, and XML tags
C. Describes how data is actually stored on disk.
D. Both (A) and (C)

vii. The database environment has all of the following components except:
A. Users.
B. Separate files
C. Database.
D. Database administrator

viii. The way a particular application views the data from the database that the application uses is a
A. Module.
B. Relational model.
C. Schema.
D. Sub schema.

ix. Which is the subset of SQL commands to manipulate Oracle Database structures, including tables,
A. Data Definition Language (DDL)
B. Data Manipulation Language (DML)
C. Both of above
D. None

9.3.4.4 Tools, Equipment, Supplies and Materials

MySQL, Computer

9.3.4.5 References

- https://www.guru99.com/how-to-create-a-database.html
- https://www.plus2net.com/sql_tutorial/sql_linking_table.php
- https://www.coursera.org/lecture/core-database/part-1-sql-query-language-vevDZ
- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 12 edition 2016
- SQL QuickStart Guide: The Simplified Beginner's Guide To SQL authored by ClydeBank Technology published by CreateSpace Independent Publishing Platform 2015

9.3.5 Learning Outcome 4: Perform database testing

9.3.5.1 Learning Activities

The following are the performance criteria:

- Test data is prepared according to the database design
- Run the test data based on the expected output
- Check the test results based on the clients needs
- Validate the results
- Report the findings

Trainees to demonstrate knowledge in relation to:

- Integration testing, DB Query testing, Database test techniques
- Schema testing, Stored procedure, Trigger, Stress, Views, Benchmarking etc.
- Perform database testing, Generate test report

9.3.5.2 Information Sheet

Integration testing is a level of software testing where individual units are combined and tested as a group. The purpose of this level of testing is to expose faults in the interaction between integrated units. Test drivers and tests tubs are used to assist in Integration Testing.

Database Testing is checking the schema, tables, triggers, etc. of the database under test. It may involve creating complex queries to load/stress test the database and check its responsiveness it. It also checks data integrity and consistency.

Database Schema Testing: As mentioned earlier, it involves testing each object in the Schema.

Verifying Databases and devices:

- Verifying the name of database
- Verifying the data device, log device and dump device
- Verifying if enough space allocated for each database
- Verifying database option setting

Stored Procedure Tests

It involves checking whether a stored procedure is defined and the output results are compared. In a Stored Procedure test, the following points are checked:

- Stored procedure name
- Parameter names, parameter types, etc.
- Output − whether the output contains many records. Zero rows are affected or only a few records are extracted.
- What is the function of Stored Procedure and what a stored procedure is not supposed to do?
- Passing sample input queries to check if a stored procedure extracts correct data.

- Stored Procedure Parameters: Call stored procedure with boundary data and with valid data. Make each parameter invalid once and run a procedure.
- Return values: Check the values that are returned by stored procedure. In case of a failure, nonzero must be returned.
- Error messages check: Make changes in such a way that the stored procedure fails and generate every error message at least once. Check any exception scenarios when there is no predefined error message.

In a Trigger test, the tester must perform the following tasks −

- Make sure the trigger name is correct.
- Validate the trigger if it is generated for a specific table column.
- Trigger's update validation.
- Update a record with a valid data.
- Update a record with invalid data and cover every trigger error.
- Update a record when it is still referenced by a row in other table.
- Ensure rolling back transactions when a failure occurs.
- Find out any cases in which a trigger is not supposed to roll back transactions.

Stress Testing involves getting a list of major database functions and corresponding stored procedures. Follow the steps given below for Stress Testing:

- Write test scripts to try those functions and every function must be checked at least once in a full cycle.
- Perform the test scripts again and again for a specific time period.
- Verifying the log files to check any deadlocks, failure out of memory, data corruption, etc.

Benchmark Testing

If your database does not have any data problems or bugs, system performance can be checked. A poor system performance can be found in benchmark testing by checking the parameters given below:

- System level performance
- Identify most-likely-used functions/features
- Timing – maximum time, minimum time and average time to perform functions
- Access volume

Database tests are typically a three-step process:

- Setup the test. You need to put your database into a known state before running tests against it.
- Run the test. Using a database regression-testing tool, run your database tests just like you would run your application tests.
- Check the results.

9.3.5.3 Self-Assessment

i. What is database testing?

ii. Differentiate trigger testing and stress testing?

iii. When you are testing database, what do you need to check normally as an IT technician?

iv. How would you know for database testing, whether trigger is fired or not?

v. While testing stored procedures what are the steps does a tester takes?

vi. _____ involves getting a list of major database functions and corresponding stored procedures.

   A. Benchmark Testing
   B. Stress Testing
   C. Trigger test
   D. None

vii. Trigger testing which tasks tester must perform?

   A. Make sure the trigger name is correct.
   B. Validate the trigger if it is generated for a specific table column.
   C. Trigger's update validation.
   D. Update a record with a valid data.
   E. Both of above
   F. None of above

viii. _____ is checking the schema, tables, triggers.

   A. Database Testing
   B. Database Schema Testing
   C. Benchmark Testing
   D. None of above

9.3.5.4 Tools, Equipment, Supplies and Materials

LINQ, SP Test tool

9.3.5.5 References

- https://www.guru99.com/data-testing.html
- https://www.tutorialspoint.com/database_testing/database_testing_techniques.htm
- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 12 edition 2016

9.3.6 Learning Outcome 5: Implement designed database

9.3.6.1 Learning Activities

The following are the performance criteria:

- Scope is defined as per the design
- Organize database project according to time frame
- Select database management system products
- Develop initial implementation plan and schedule
- Design the database
- Install and test database
- Develop detailed conversion plan
- Convert existing applications
- Fine tune the database
- Perform training
- Periodically review database performance

Trainees to demonstrate knowledge in relation to:

- Run the designed database
- Test the design and database functionality

9.3.6.2 Information Sheet

The design process:

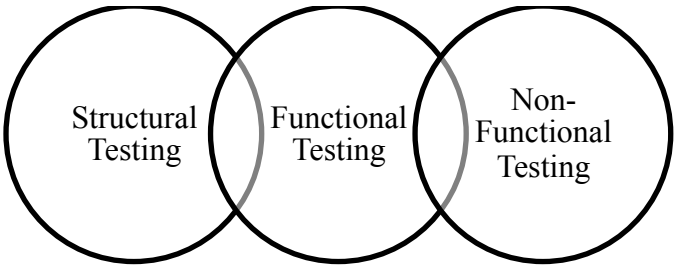
The design process consists of the following steps:

- Determine the purpose of your database

This helps prepare you for the remaining steps.

- **Find and organize the information required:** Gather all of the types of information you might want to record in the database, such as product name and order number.
- **Divide the information into tables:** Divide your information items into major entities or subjects, such as Products or Orders. Each subject then becomes a table.
- **Turn information items into columns:** Decide what information you want to store in each table. Each item becomes a field, and is displayed as a column in the table. For example, an Employees table might include fields such as Last Name and Hire Date.
- **Specify primary keys:** Choose each table's primary key. The primary key is a column that is used to uniquely identify each row. An example might be Product ID or Order ID.
- **Set up the table relationships:** Look at each table and decide how the data in one table is related to the data in other tables. Add fields to tables or create new tables to clarify the relationships, as necessary.
- **Refine your design:** Analyze your design for errors. Create the tables and add a few records of sample data. See if you can get the results you want from your tables. Make adjustments to the design, as needed.
- **Apply the normalization rules:** Apply the data normalization rules to see if your tables are structured correctly. Make adjustments to the tables, as needed.

Database Testing is checking the schema, tables, triggers, etc. of the database under test. It may involve creating complex queries to load/stress test the database and check its responsiveness. It checks data integrity and consistency.



Source: www.guru99.com

Figure 83: Types of database testing

9.3.6.3 Self-Assessment

i. What is database testing?

ii. Explain design process of database?

iii. _____ choose each table's primary key. The primary key is a column that is used to uniquely identify each row. An example might be Product ID or Order ID.
   A. Refine your design
   B. Specify primary keys
   C. The design process
   D. None of Above
   E. Both of above

iv. Analyze your design for errors. Create the tables and add a few records of sample data. See if you can get the results you want from your tables. Make adjustments to the design, as needed.
   A. Refine your design
   B. The design process
   C. None of above
   D. Both A and B
   E. Apply the normalization rules

v. An enterprise data model is a relational model that shows the high-level entities for the organization and associations among those entities.
   A. True
   B. False

vi. Term that is considered as a basis for most robust authentication schemes, is said to be
   A. Identification
   B. Registration
   C. Encryption
   D. Refine information

9.3.6.4 Tools, Equipment, Supplies and Materials

Computer, Data Factory, MockupData, SQL Server

9.3.6.5 References

- https://support.office.com/en-us/article/database-design-basics-eb2159cf-1e30-401a-8084-bd4f9c9ca1f5
- https://www.guru99.com/data-testing.html
- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 2016

9.3.7 Learning Outcome 6: Establish transaction and concurrency mechanism

9.3.7.1 Learning Activities

The following are the performance criteria:

- Transaction mechanisms used in database management system are identified
- Management of multiple transactions in database management system are identified

Trainees to demonstrate knowledge in relation to:

- Transaction mechanisms
- Concurrency mechanisms
- Management of multiple transactions

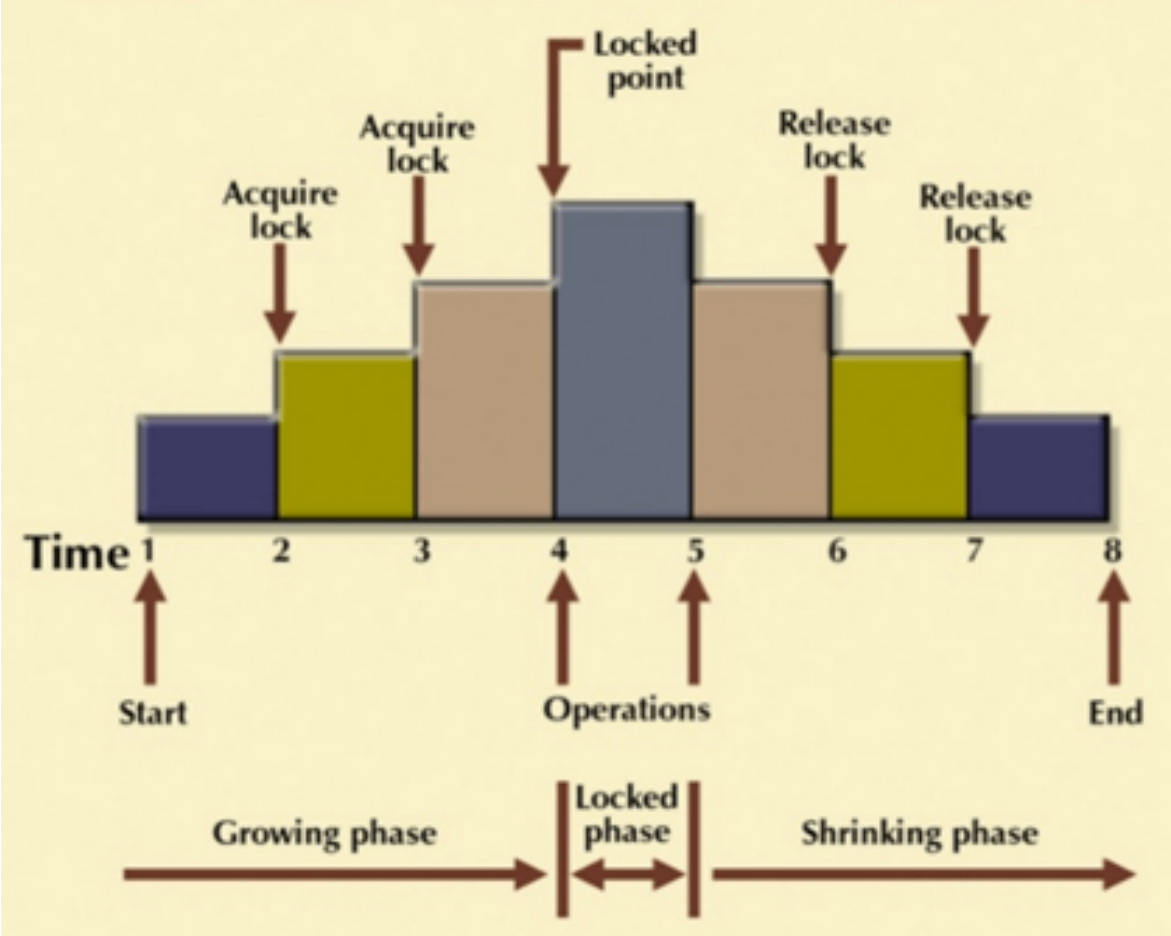
9.3.7.2 Information Sheet

Transaction mechanisms occur if the transaction does not complete successfully, a ROLLBACK statement returns the data to the state it was in prior to the beginning of the transaction. If the transaction completes successfully, a COMMIT statement permanently stores the data in the database.

Due to the nature of SQL and relational database architecture, where each update can act on only one table at a time and where there are no trailers in the usual sense, two update statements must be executed simultaneously. Both update statements must either succeed and COMMIT or fail and ROLLBACK.

In a transaction a group of updates must either COMMIT or ROLLBACK together. First a transaction is declared, and then either the COMMIT or the ROLLBACK SQL statement is issued for all the statements that have been issued since the transaction declaration.

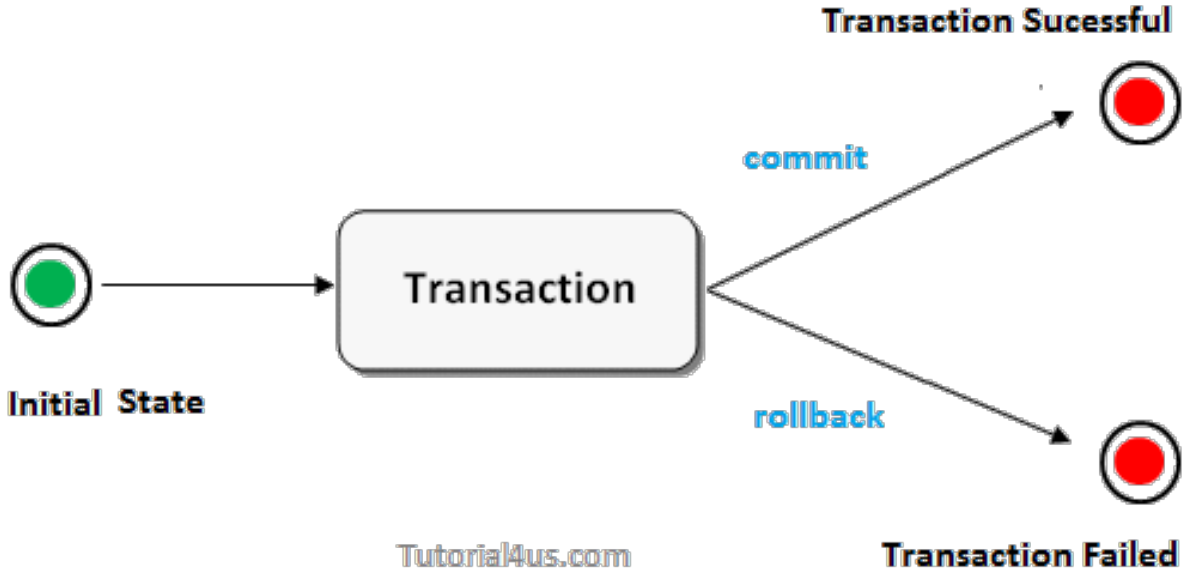
Concurrency mechanism ensures that database transactions are performed concurrently without violating the data integrity of the respective databases. Thus concurrency control is an essential element for correctness in any system where two database transactions or more, executed with time overlap, can access the same data.



Source: www.guru99.com

Figure 84: Concurrency mechanism

Managing Multiple Transactions. Transaction management is used to maintain the integrity of a data source when operations on one or more data sources need to be treated as a single operation. The most common example of transaction management comes from banking.



Source: Tutorials4us.com

Figure 85: Transaction management

9.3.7.3 Self-Assessment

i. What is transaction mechanism?

ii. Differentiate between transaction mechanism and concurrency mechanism?

iii. What is managing multiple transactions?

iv. Any non-serial interleaving of T1 and T2 for concurrent execution leads to
   A. A serializable schedule
   B. A schedule that is not conflict serializable
   C. A conflict serializable schedule
   D. A schedule for which a precedence graph cannot be drawn

v. Which of the following locks the item from change but not from read?
   A. Implicit lock
   B. Explicit lock
   C. Exclusive lock
   D. Shared lock

vi. A transaction in which either all of the database actions occur or none of them do is called:
   A. Atomic
   B. Consistent
   C. Isolated
   D. Durable

vii. Which of the following occurs when one transaction reads a changed record that has not been committed to the database?
   A. No repeatable read
   B. Phantom read
   C. Dirty read
   D. Consistent read

9.3.7.4 Tools, Equipment, Supplies and Materials

Computer, MySQL

9.3.7.5 References

- http://ftp.magicsoftware.com/www/help/uniPaaS/mergedprojects/MGHELPW/Data_Management/SQL_Considerations/Transaction_Mechanism.htm
- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 2016

9.3.8 Learning Outcome 7: Manage database security

9.3.8.1 Learning Activities

The following are the performance criteria:

- Restriction of access to the database is established
- Backup and recovery methods are identified and implemented.

Trainees to demonstrate knowledge in relation to:

- Restriction of access as per Internal policy
- Types of restrictions
- Backup and recovery methods

9.3.8.2 Information Sheet

Database security is generally planned, implemented and maintained by a database administrator and or other information security professional.

Some of the ways database security is analyzed and implemented include:

- Restricting unauthorized access and use by implementing strong and multifactor access and data management controls
- Load/stress testing and capacity testing of a database to ensure it does not crash in a distributed denial of service (DDoS) attack or user overload
- Physical security of the database server and backup equipment from theft and natural disasters
- Reviewing existing system for any known or unknown vulnerabilities and defining and implementing a road map/plan to mitigate them

Backing up and restoring data is one of the most important responsibilities of IT professionals

Following are the main types of backups:

- **Normal or Full Backups:** When a normal or full backup runs on a selected drive, all the files on that drive are backed up. This, of course, includes system files, application files, user data — everything. Those files are then copied to the selected destination (backup tapes, a secondary drive or the cloud), and all the archive bits are then cleared.
- **Incremental Backups:** A common way to deal with the long running times required for full backups is to run them only on weekends. Many businesses then run incremental backups throughout the week since they take far less time. An incremental backup will grab only the files that have been updated since the last normal backup. Once the incremental backup has run, that file will not be backed up again unless it changes or during the next full backup.
- **Differential Backups:** An alternative to incremental database backups that has a less complicated restore process is a differential backup. Differential backups and recovery are similar to incremental in that these backups grab only files that have been updated since the last normal backup. However, differential backups do not clear the archive bit.

So a file that is updated after a normal backup will be archived every time a differential backup is run until the next normal backup runs and clears the archive bit.

Read: Database backup:
https://www.solarwindsmsp.com/content/types-of-database-backups

Watch: How to backup database using MySQL: https://youtu.be/mr8Lpkx5yag

Database design Methodology
Designing of database is most important responsibility of the software professionals who are dealing with the database related projects. For this they follow the Design Methodology. It helps the designer to plan, manage, control, and evaluate database development projects.

Design methodology: A structured approach that uses procedures, techniques, tools, and documentation aids to support and facilitate the process of design. A design methodology consists of phases each containing a number of steps, which guide the designer in the techniques appropriate at each stage of the project.

Phases of Design Methodology
The database design methodology is divided into three main phases. These are:
• Conceptual database design
• Logical database design

Conceptual database design: The process of constructing a model of the information used in an enterprise, independent of all physical considerations. The conceptual database design phase begins with the creation of a conceptual data model of the enterprise, which is entirely independent of implementation details such as the target DBMS, application programs, programming languages, hardware platform, performance issues, or any other physical considerations.

Logical database design: It is a process of constructing a model of the information used in an enterprise based on specific data model, but independent of a particular DBMS and other physical considerations. The logical database design phase maps the conceptual model on to a logical model, which is influenced by the data model for the target database (for example, the relational model). The logical data model is a source of information for the physical design phase. The output of this process is a global logical data model consisting of an Entity-Relationship diagram, relational schema, and supporting documentation that describes this model, such as a data dictionary. Together, these represent the sources of information for the physical design process, and they provide the physical database designer with a vehicle for making tradeoffs that are so important to an efficient database design.

Physical database design
It is a description of the implementation of the database on secondary storage; it describes the base relations, file organizations, and indexes used to achieve efficient access to the data, and any associated integrity constraints and security measures.

Whereas logical database design is concerned with the what, physical database design is concerned with the how. The physical database design phase allows the designer to make decisions on how the database is to be implemented. Therefore, physical design is tailored to a specific DBMS. There is feedback between physical and logical design, because decisions taken during physical design for improving performance may affect the logical data model.

For example, decisions taken during physical for improving performance, such as merging relations together, might affect the structure of the logical data model, which will have an associated effect on the application design.

Steps of physical database design methodology
After designing logical database model, the steps of physical database design methodology are as follows:
Step 1: Translate global logical data model for target DBMS It includes operations like the Design of base relation, derived data and design of enterprise constraints.
Step 2: Design physical representation: It includes operations like analyzing of transactions, selection of file organizations, selection of indexes and estimates the disk space requirements. Step 2 is most important part in designing of physical design of database. It is used to determine the optimal file organizations to store the base relations and the indexes· that are required to achieve acceptable performance, that is, the way in which relations and tuples will be held on secondary storage.

One of the main objectives of physical database design is to store data in an efficient ay. There are a number of factors that we may use to measure efficiency:
• **Transaction throughput**
This is the number of transactions that can be processed in a given time interval.
In some systems, such as airline reservations, high transaction throughput is critical to the overall success of the system.
• **Disk storage**
This is the amount of disk space required to store the database files. The designer may wish to minimize the amount of disk storage used.

9.3.8.3 Self-Assessment
i. What are types of backup?
ii. What is database security?
   A. Data encryption
   B. A view
   C. Fingerprint
   D. All of the above

iii. Data security threats include
   A. Privacy invasion
   B. Hardware protection
   C. Fraudulent manipulation od data
   D. All of the above

iv. _____ is responsible for using that the database remains in a consistent state despite system failure.
   A. Storage Manager
   B. Transaction manager
   C. End user
   D. Sophisticated

v. Prevention of access to the database by unauthorized users is referred to as:
   A. Integrity
   B. Productivity
   C. Security
   D. Reliability

vi. How will you know your database is unsecure and which software will you use to make it secure

9.3.8.4 Tools, Equipment, Supplies and Materials

PostgreSQL database backup tools, MS SQL database backup solutions

9.3.8.5 References

- https://www.solarwindsmsp.com/content/types-of-database-backups
- Database Systems: Design, Implementation, & Management 12th Edition authored by Steven Morris, Carlos Coronel, published by Cengage Learning; 2016

CHAPTER 10: MANAGE INFORMATION SYSTEM

10.1 Introduction

This unit covers the competencies required to manage information system. It involves identification of information system concepts, classification of information systems, management of information resources, Planning of information system, identification of impact of information system in an organization.

10.2 Performance Report

- Identified Components of an IS
- Identified Types of Information Systems
- Identified Strategic levels of an Organization
- Identified Functional areas of an MIS
- Classified IS Resources
- Identified IS planning techniques
- Identified IS Acquisition methods

10.3 Learning Outcome

10.3.1 List of the Learning Outcomes

These are the key learning outcomes, which make up workplace function:
- Identify information system concepts
- Classify information systems
- Manage information resources
- Information system planning
- Impact of information system in organization

10.3.2 Learning Outcome 1: Identify information system concepts

10.3.2.1 Learning Activities

The following are the performance criteria:
- Definition of MIS and its terms is done
- Components of an IS are identified based on the type of Information System.
- Roles of an IS are identified
- Qualities of an Information System are identified
- Types of Information Systems are identified

Trainees to demonstrate knowledge in relation to:
- Define IS terms
- Components of an IS
- Roles of IS

- Qualities of an IS
- Types of systems
- Open , Closed, Probabilistic, Cybernetic etc

10.3.2.2 Information Sheet

A computer information system is a system composed of people and computers that processes or interprets information.

An information system is described as having five components:

1. Computer hardware. This is the physical technology that works with information.
2. Computer software. The hardware needs to know what to do, and that is the role of software.
3. Telecommunications
4. Databases and data warehouses
5. Human resources and procedures

The role of computer information system is to support the key aspects of running an organization, such as communication, record keeping, decision making, data analysis and more. Companies use this **information** to improve their business operations, make strategic decisions and gain a competitive edge. MIS system includes – collection of information, management of information and incorporating in the database.

Five characteristics of high quality information are **accuracy, completeness, consistency, uniqueness, and timeliness.** Information needs to be of high quality to be useful and accurate. The information that is input into a database is presumed to be perfect as well as accurate.

Read: Different types of system: http://ecomputernotes.com/mis/information-and-system-concepts/typesofsystems

10.3.2.3 Self-Assessment

i. Define Information system?
ii. What are characteristics of IS?
iii. _____ is a system composed of people and computers that processes or interprets information.
   A. A computer information system
   B. Information system
   C. Database system
   D. None of Above

10.3.2.4 Tools, Equipment, Supplies and Materials

Computer

10.3.2.5 References

- http://ecomputernotes.com/mis/information-and-system-concepts/typesofsystems
- https://www.guru99.com/mis-types-information-system.html
- Information and Knowledge System (Information Systems, Web and Pervasive Computing: Advances in Information Systems (1st edition) authored by Pierre-Emmanuel Arduin, Michel Grundstein, Camille Rosenthal-Sabroux published by Wiley-ISTE; 2015
- Management Information System authored by Anuranjan Misra, published by Laxmi Publications Pvt. Ltd, 2017

10.3.3 Learning Outcome 2: Classify information systems

10.3.3.1 Learning Activities

The following are the performance criteria:

- Strategic levels of an Organization are identified
- Classification of Information systems is done
- Information System processing requirements is done
- Functional areas of MIS are identified

Trainees to demonstrate knowledge in relation to:

- Strategic levels of an organization, Operational level, Knowledge level, Tactical level, Strategic level, Classification of IS, TPS (transaction processing), MIS (management, KWS (Knowledge work S), DSS (Decision support system), ESS (Executive support system)
- IS processing requirements
- Functional areas of MIS

10.3.3.2 Information Sheet

Operational strategies refers to the methods companies use to reach their objectives.

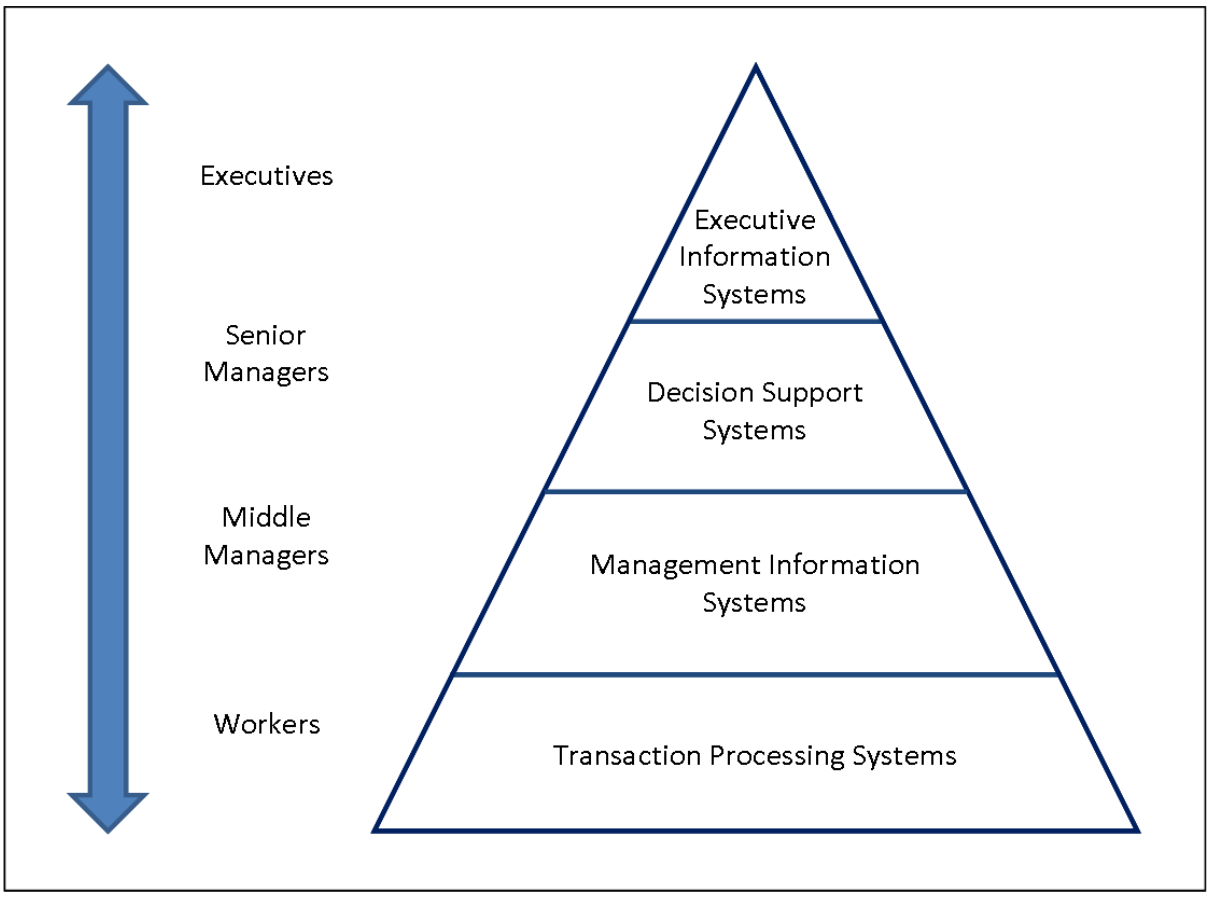
Transaction Processing System (TPS)

In manufacturing organization, there are several types of transaction across department. Typical organizational departments are Sales, Account, Finance, Plant, Engineering, Human Resource and Marketing. Across which following transaction may occur sales order, sales return, cash receipts, credit sales; credit slips, material accounting, inventory management, depreciation accounting, etc.

Read: Types of information system:

- https://www.managementstudyguide.com/types-of-information-systems.htm
- http://www.chris-kimble.com/Courses/World_Med_MBA/Types-of-Information-System.html

Management System: Managers require precise information in a specific format to undertake an organizational decision. A system which facilitates an efficient decision making process for managers is called management support system.



Source: www.wikiwand.com

Figure 86: Management System

A Decision Support System can be seen as knowledge based system, used by senior managers, which facilitates the creation of knowledge and allow its integration into the organization. These systems are often used to analyze existing structured information and allow managers to project the potential effects of their decisions into the future.

Executive Information Systems are strategic-level information systems that are found at the top of the pyramid. They help executives and senior managers analyze the environment in which, the organization operates, to identify long-term trends, and to plan appropriate courses of action.

10.3.3.3 Self-Assessment

i. What is an executive information system?

ii. Give the difference between decision support system and executive information system?

iii. Choose the correct statement about information system:
A. A system that comprises a set of interrelated elements that transform data into information.
B. A collection of facts that are meaningfully organised and are useful to their users.
C. It can exist in the form of text, numbers, images, audio and video.
D. It collects information, stores and manipulates it into raw facts.

iv. The components of an information system are human, hardware, software, procedures and _____
A. field
B. data
C. information system
D. table

10.3.3.4 Tools, Equipment, Supplies and Materials

Computer, Operation Information System (OIS), Decision Support Systems (DSS)

10.3.3.5 References

- http://www.chris-kimble.com/Courses/World_Med_MBA/Types-of-Information-System.html
- Information and Knowledge System (Information Systems, Web and Pervasive Computing: Advances in Information Systems (1st edition) authored by Pierre-Emmanuel Arduin, Michel Grundstein, Camille Rosenthal-Sabroux published by Wiley-ISTE; 2015
- Management Information System authored by Anuranjan Misra, published by Laxmi Publications Pvt. Ltd., 2017

10.3.4 Learning Outcome 3: Manage information resources

10.3.4.1 Learning Activities

The following are the performance criteria:

- Information resource management concepts are identified
- IS resources are determined
- Classification of IS Resources is done.
- Importance of managing information resources is identified

Trainees to demonstrate knowledge in relation to:

- Information resource management concepts: IS resources, Hardware, Software, Databases, Networks, Procedures, Security facilities, Physical buildings, Classification of IS Resources
- Importance of managing information resources

10.3.4.2 Information Sheet

Information Resource Management (IRM) is a broad term in IT that refers to the management of records or information or data sets as a resource. This can relate to both business or government goals and objectives.

A hardware resource includes all physical devices and materials used in information processing. Specially, it includes not only machines, such as computers and other equipment, but also all data media, that is, all tangible objects on which data is recorded, from sheets of paper to magnetic disks.

A Software Resources includes all sets of information processing instructions. This generic concept of software includes not only the sets of operating instructions called programs, which direct and control computer hardware, but also the sets of information processing instructions needed by people, called procedures.

Read: Information system resources: http://infoallsearch.blogspot.com/2013/02/information-system-resources.html

The main components of information systems are computer **hardware and software, telecommunications, databases and data warehouses, human resources, and procedures.**

Resource management is important because it enables utilization planning, it provides you with an overview of everyone and everything and it makes planning and management transparent.

10.3.4.3 Self-Assessment

i. Define Information Management Resources?
ii. What are components of IS?
iii. What is the definition of MIS?
   A. The proper way to address an unmarried woman
   B. An acronym for "Missing In Space"
   C. A computer system that organizes data and creates reports
   D. Software that dictages the movements of a business

10.3.4.4 Tools, Equipment, Supplies and Materials

Computer, Operating system, Operation Information System (OIS), Decision Support Systems (DSS)

10.3.4.5 References

- https://www.techopedia.com/definition/7722/information-resource-management-irm
- https://www.ganttic.com/blog/why-is-resource-management-important

- Information and Knowledge System (Information Systems, Web and Pervasive Computing: Advances in Information Systems (1st edition) authored by Pierre-Emmanuel Arduin, Michel Grundstein, Camille Rosenthal-Sabroux published by Wiley-ISTE; 2015
- Management Information System authored by Anuranjan Misra, published by Laxmi Publications Pvt. Ltd. 2017

10.3.5 Learning Outcome 4: Information system planning

10.3.5.1 Learning Activities

The following are the performance criteria:
- Definition of IS planning is done
- Importance of planning is identified
- IS planning process is done
- IS planning techniques are identified
- Project planning is done
- IS Acquisition methods are identified

Trainees to demonstrate knowledge in relation to:
- Definition of IS planning
- Importance of planning
- IS planning process
- IS planning techniques q Project planning
- Causes of project failure and success
- Types of IS Acquisition methods
- In house
- Off the shelf
- Hire, outsource

10.3.5.2 Information Sheet

Information Systems Planning is critical in developing and executing successful strategic plans in huge firms at global level for reach out and servicing end customer.

Following are the importance of planning:
- Increases efficiency
- Reduces business-related risks
- Facilitates proper coordination
- Aids in organizing
- Gives right direction
- Keeps good control
- Helps to achieve objectives
- Motivates the personnel

- Encourages creativity and innovation
- Helps in decision making

Six planning approaches and techniques

- Stages of growth
- Critical success factors
- Competitive forces model
- Value chain analysis
- Internet value matrix
- Linkage analysis planning

A **project management system** is a means of managing a **project by planning**, organizing, and managing its different required aspects.

Here are just some of the most common causes of project failure:

- Poorly defined **project** scope
- Inadequate risk management
- Failure to identify key assumptions
- Project managers who lack experience and training
- No use of formal methods and strategies
- Lack of effective communication at all levels

Read: Type of acquisition system:
https://www.britannica.com/topic/information-system/Acquiring-information-systems-and-services

10.3.5.3 Self-Assessment

i. What are the technics of planning?
ii. Define project panning.
iii. What are common cause of project failure?
iv. Prepare a scope for collecting primary and secondary student's demographic data collection. What may be some of the variables considered for the purposes of data. How different stakeholder holder may access and use such data effectively.

10.3.5.4 Tools, Equipment, Supplies and Materials

Network Diagram, Gantt chart, Transaction Processing Systems (TPS) Operation Information System (OIS Decision Support Systems (DSS) Enterprise resource planning (ERP)

10.3.5.5 References

- https://www.civilserviceindia.com/subject/Management/notes/information-systems-planning.html
- https://kalyan-city.blogspot.com/2012/02/importance-of-planning-why-planning-is.html
- https://www.projectsmart.co.uk/15-causes-of-project-failure.php

- Information and Knowledge System (Information Systems, Web and Pervasive Computing: Advances in Information Systems (1st edition) authored by Pierre-Emmanuel Arduin, Michel Grundstein, Camille Rosenthal-Sabroux published by Wiley-ISTE; 2015
- Management Information System authored by Anuranjan Misra, published by Laxmi Publications Pvt. Ltd., 2017

10.3.6 Learning Outcome 5: Impact of information system in organization

10.3.6.1 Learning Activities

The following are the performance criteria:

- Trends of IS Aare identified
- Organizational change in management is done
- IS maintenance is done
- Ethical issues in IS are identified
- Legal issues in IS are identified

Trainees to demonstrate knowledge in relation to:

- Trends of IS, Negative impacts, Positive impacts, Ethical, Non-disclosure NDA, Privacy, Data integrity, Code of conduct, Legal issues, Warrants, Bridge of contracts, Computer crimes, IS maintenance

10.3.6.2 Information Sheet

Technology is a double-edged sword when it comes to bringing people together. On the one hand, it makes it easier for co-workers to communicate and collaborate as they make use of email and team-chat sites. Technology saves money for business by saving time, such as the hours that would be required to compile reports by hand. In addition, meaningful and up-to-date information helps organizations to quickly recognize problems and opportunities and respond proactively. However, computers, software and the training required to maintain and upgrade them can be expensive.

The key negatives of the Information System is that in case data is not secured it can be used by malicious agencies to manipulate for personal gains. When there are data hacks, personal information, business information is susceptible to risk and lead to distrust and limited privacy.

Read: Positive and negative effects of IS: https://bizfluent.com/list-6943594-positive-negative-effects-technology-business.html

A non-disclosure agreement (NDA), also known as a confidentiality agreement (CA), confidential disclosure agreement (CDA), proprietary information agreement (PIA) or secrecy agreement (SA), is a legal contract between at least two parties that outlines confidential material, knowledge, or information that the parties wish to share with one

another for certain purposes, but wish to restrict access to or by third parties.

Privacy is the ability of an individual or group to seclude themselves, or information about themselves, and thereby express themselves selectively.

Data integrity is the maintenance of, and the assurance of the accuracy and consistency of, data over its entire life cycle, and is a critical aspect to the design, implementation and usage of any system, which stores, processes, or retrieves data.

A code of conduct is a set of rules outlining the social norms, religious rules and responsibilities of, and or proper practices for, an individual.

A warranty is a manufacturer's or seller's promise to stand behind its product and correct problems if the product fails due to a manufacturing defect or because it doesn't work as promised.

Computer crimes is substantive criminal law involving computers, which encompasses computer misuse crimes such the Computer Fraud and Abuse Act as well as general crimes often committed using computers such as identify theft, criminal copyright and child pornography offenses.

Maintenance is the process of modifying an information system to continually satisfy organizational and user requirements.

10.3.6.3 Self-Assessment

i. What is data integrity?
ii. Differentiate between data integrity and privacy?
iii. Explain negative and positive impact of Information System?
iv. What is warranty?
v. When a report is produced periodically, it is called what?
   A. Drill-Down Report
   B. Key-Indicator Report
   C. Demand Report
   D. Scheduled Report
vi. Case situation: An NGO has selected you for developing their software for collection of data related to farms and their agricultural produce. As part of the agreement, they have asked to you sign a NDA. What are the clauses that might be added in the NDA. What are the things you need to keep in mind while signing the NDA. What might be the liabilities?
viii. Go through the warranty card for the following items – laptop, mobile, keyboard, mouse etc.

10.3.6.4 Tools, Equipment, Supplies and Materials

Computer, Internet connectivity, operating system

10.3.6.5 References

- http://www.umsl.edu/~joshik/msis480/chapt16.htm
- https://definitions.uslegal.com/l/legal-issue/
- https://bizfluent.com/list-6943594-positive-negative-effects-technology-business.html
- Information and Knowledge System (Information Systems, Web and Pervasive Computing: Advances in Information Systems (1st edition) authored by Pierre-Emmanuel Arduin, Michel Grundstein, Camille Rosenthal-Sabroux published by Wiley-ISTE; 2015
- Management Information System authored by Anuranjan Misra, published by Laxmi Publications Pvt. Ltd., 2017

CHAPTER 11: GRAPHIC DESIGN

11.1 Introduction

This unit covers the competencies required to Perform Graphic Design. It involves identification of graphic design concepts, identification of elements and principles of graphic design, application of typography techniques, creation and editing of images, perform of layout design and printing of the layout design.

11.2 Performance Report

- Identified Graphic design equipment according to the design to be drawn
- Identified Graphic design elements, principles and techniques as per the design
- Identified Measurements, standards and guidelines of typography
- Identified software and tools for Graphic Design and photography
- Created and manipulated images using the appropriate software
- Used Typographic tools to create dynamic layout
- Identified tools and Equipment for printing and did the actual printing of the design

11.3 Learning Outcome

11.3.1 List of the Learning Outcomes

These are the key learning outcomes, which make up workplace function:
- Identify Graphic Design Concepts
- Identify Elements and Principles of Graphic Design
- Apply Typography Techniques
- Create and Edit Images
- Perform Layout Design
- Print and Post the Design created

11.3.2 Learning Outcome 1: Identify Graphic Design Concepts

11.3.2.1 Learning Activities

The following are the performance criteria:
- Definition of Graphic Design and terms is done
- Graphic design equipment is identified based on the design
- Applications areas of Graphic design are identified
- Benefits of Graphic Design are identified

Trainees to demonstrate knowledge in relation to:
- Definition of graphic design
- Graphic Design Equipment: Computer, Scanner, Printer, Camera, Digital Tablet Application areas, Corporate branding, Packaging, Printed materials, Online art

11.3.2.2 Information Sheet

Graphic design is the process of visual communication and problem-solving through the use of typography, photography, and illustration. The field is considered a subset of visual communication and communication design, but sometimes the term "graphic design" is used synonymously. Graphic designers create and combine symbols, images and text to form visual representations of ideas and messages. They use typography, visual arts, and page layout techniques to create visual compositions. Common uses of graphic design include corporate design (logos and branding), editorial design (magazines, newspapers and books), environmental design, advertising, web design, communication design, product packaging, and signage.

Graphic design is applied to everything visual, from road signs to technical schematics, from inter-office memorandums to reference manuals.

Design can aid in selling a product or idea. It is applied to products and elements of company identity such as logos, colors, packaging and text as part of branding and advertising. Branding has become increasingly more important in the range of services offered by graphic designers. Graphic designers often form part of a branding team.

Graphic design is applied in the entertainment industry in decoration, scenery and visual story telling. Other examples of design for entertainment purposes include novels, vinyl album covers, comic books, DVD covers, opening credits and closing credits in filmmaking, and programs and props on stage. This could also include artwork used for T-shirts and other items screenprinted for sale.

From scientific journals to news reporting, the presentation of opinion and facts is often improved with graphics and thoughtful compositions of visual information - known as information design. Newspapers, magazines, blogs, television and film documentaries may use graphic design. With the advent of the web, information designers with experience in interactive tools are increasingly used to illustrate the background to news stories. Information design can include data visualization, which involves using programs to interpret and form data into a visually compelling presentation, and can be tied in with information graphics.

A graphic design project may involve the stylization and presentation of existing text and either preexisting imagery or images developed by the graphic designer. Elements can be incorporated in both traditional and digital form, which involves the use of visual arts, typography, and page layout techniques. Graphic designers organize pages and optionally add graphic elements. Graphic designers can commission photographers or illustrators to create original pieces. Designers use digital tools, often referred to as interactive design, or multimedia design. Designers need communication skills to convince an audience and sell their designs.

Read: Graphic design equipment:
https://www.creativebloq.com/graphic-design/tools-every-graphic-designer-should-have-6133208
https://www.devsaran.com/blog/10-best-tools-graphic-designers

Corporate branding refers to the practice of promoting the brand name of a corporate entity, as opposed to specific products or services. The activities and thinking that go into corporate branding are different from product and service branding because the scope of a corporate brand is typically much broader.

Packaging is the science, art and technology of enclosing or protecting products for distribution, storage, sale, and use. Packaging also refers to the process of designing, evaluating, and producing packages.

An online art gallery is a website that display artworks. Usually, the online gallery is run as a business, with the purpose of displaying the artwork being to promote it to potential buyers.

A printer is an external hardware output device that takes the electronic data stored on a computer or other device and generates a hard copy of it.

When referring to hardware**, a scanner** or optical scanner is hardware input device that optically "reads" and image and converts it into a digital signal. For example, a scanner may be used to convert a printed picture, drawing, or document (hard copy) into a digital file, which can be edited on a computer.

A camera is a hardware device that takes photographs.

11.3.2.3 Self-Assessment

i. What is packaging?
ii. What is corporate branding?
iii. Define Graphic design?
iv. **Case situation:** As an ICT student, you are required to use suitable publication software and design a cover for the college magazine called 'Governance for better future' as follows:
    a) Use appropriate layout, paper balance, font variable and relevant pictures. Save it as your name and personal number.
    b) Insert a clip to represent the writer at the bottom of the cover
    c) Use your name as the author of the magazine.
    d) Insert automatic current date to appear as the date of publication
    e) Apply suitable background for the cover.
    f) Insert your name and personal number as a header.
    g) Save and print your work.
v. All of the following are Principles of Graphic Design except....
    A. Proximity

B. Alignment
C. Placement
D. Contrast

vi. If a logo reads UP and DOWN, it is written:
A. Horizontally
B. Vertically
C. Diagonally

vii. True or False: Artwork can also exist on many places, like on products in grocery stores:
A. True
B. False

11.3.2.4 Tools, Equipment, Supplies and Materials

Heat sealing tool, Packaging shredders, Paper roll holder, brand activation

11.3.2.5 References

- https://en.wikipedia.org/wiki/Packaging_and_labeling
- https://www.csi-products.co.uk/packaging-tools-and-materials-c-2936_2947_2961.html
- https://www.computerhope.com/jargon/p/printer.htm
- Sustainable Graphic Design (1st edition) authored by Wendy Jedlicka, published by Wiley, 2009
- Introduction to Graphic Design authored by Aaris Sherin, published by Bloomsbury Visual Arts, 2017

11.3.3 Learning Outcome 2: Identify elements and principles of graphic design

11.3.3.1 Learning Activities

The following are the performance criteria:

- Elements of graphic design are defined
- Types of Graphic design elements are identified
- Graphic Design principles are identified as per the design
- Identification of Graphic design principles techniques is done
- Importance of graphic design principles are identified

Trainees to demonstrate knowledge in relation to:

- Definition of Elements: Colour, Line, Shape, Space, Texture, Value
- Principles of Graphic design: Balance, Contrast, Emphasis, Harmony, Proportion, Pattern, Unity

11.3.3.2 Information Sheet

The Elements of good graphic design are the components or parts of a work of art or design.

More simply put, they are the ingredients of art. Take one part colour; a pinch of texture, and a whole lot of shape and the result will be some well-designed graphic design.

- **LINE:** Lines, in graphic design, can be used for a wide range of purposes: stressing a word or phrase, connecting content, creating patterns and more.
- **COLOUR:** Colour is used to generate emotions, define importance, create visual interest and unify branding.
- **TEXTURE:** Texture relates to the surface of an object. Using texture in graphic design adds depth and visual interest. This can be applied graphically in the form of pattern or through the choice of printable surface.
- **SIZE:** In graphic design, size is used to convey importance, attract attention and create contrast.
- **SHAPE:** The three basic shape types are Geometric (Circles, Squares, Triangles etc.), Natural (leaves, trees, people etc.) and abstract (icons, stylisations and graphic representations). Use carefully to create a visually pleasing design and eye-catching design.
- **SPACE:** A vital part of any good graphic design, Space is the area around the elements in a design. It can be used to separate or group information. Use it effectively to give the eye a rest, define importance and lead the eye to where you want it to travel.
- **VALUE:** Value is how light or dark an area looks in a design. It is everything from the darkest of blacks through to the brightest of whites. Used correctly it will create depth, contrast and emphasis.

Read: Elements of graphic designs: https://www.unahealydesign.com/elements-of-good-graphic-design/

The principles and elements of design both carry the same weight in executing an effective piece. If you disregard the principles, then you have a visual piece that lacks a story.

Read: Principle of graphic design https://visme.co/blog/elements-principles-good-design/#jlHfsVaRKtDxATmm.99

11.3.3.3 Self-Assessment

i. Explain briefly element?
ii. What are the principle of graphic design?
iii. Design a letter head for a company.
iv. Design a visiting card using appropriate tool.
v. Design a roll-up banner with for Awareness of Against Use of Drugs
vi. Design a banner for a birthday celebration.

11.3.3.4 Tools, Equipment, Supplies and Materials

Visual CSS tools, InDesign secrets, DaviantART, PHOTOSHOP

11.3.3.5 References

- https://www.unahealydesign.com/elements-of-good-graphic-design/
- https://visme.co/blog/elements-principles-good-design/#jlHfsVaRKtDxATmm.99

11.3.4 Learning Outcome 3: Apply typography techniques

11.3.4.1 Learning Activities

The following are the performance criteria:

- Definition of typography is done
- Identification and application of anatomy is done.
- Types of Typographies are identified
- Identification of measurements and standards of typography is done
- Typography guidelines are identified

Trainees to demonstrate knowledge in relation to:

- Definition of Typography
- Definition and application of Anatomy
- Types of Typography: Old style, Transitional, Modern, Slab serif, Gothic etc.
- Typography Techniques
- Kern upside down
- Blur it
- Kern with balloons
- Rough our headlines etc.

11.3.4.2 Information Sheet

Typography is the art and technique of arranging type to make written language legible, readable, and appealing when displayed.

Watch: Understand the power of typography: https://youtu.be/C_RzDqgGcao

In typography, **Old Style** is a style of serif font developed by Renaissance typographers in the 15th century. **Transitional typefaces** are a mix between Old Style and Modern **typefaces**. **Modern typography** was a reaction against the perceived decadence of typography and design of the late 19th century.

Read: Different techniques of typography: https://medium.com/gravitdesigner/the-art-of-kerning-be16be25344f

Watch: Typography design tutorials and tips:
https://youtu.be/CAAbMj_vaW8
https://youtu.be/QrNi9FmdlxY

https://youtu.be/sByzHoiYFX0
https://youtu.be/VH8QT73Gxwo
https://youtu.be/iniUd-NZ-T8

In typography, **kerning** is defined as the adjustment of space between two individual letters.

Watch: Tutorials for kerning: https://youtu.be/j6MBrSmi7_M

Watch: Kerning approaches for designing: https://youtu.be/sorp8_5GreQ

11.3.4.3 Self-Assessment

i. What is typography?
ii. Differentiate old style and transitional typography?
iii. Design a visiting card for a pastry shop.
iv. Design a webpage blog for a fiction-writer author.
v. Kerning is _____
   A. Weight of letters
   B. Spacing between letters
   C. Spacing between words
   D. Font style
vi. Use appropriate software to prepare awareness poster slogan on a topic of your choice.

11.3.4.4 Tools, Equipment, Supplies and Materials

Adobe illustrator, Adobe after effect

11.3.4.5 References

- https://www.jotform.com/blog/a-crash-course-in-typography-the-basics-of-type/
- https://www.avantgraphic.com/10-typography-tricks-every-designer-should-know/
- https://medium.com/gravitdesigner/the-art-of-kerning-be16be25344f
- https://experience.sap.com/basics/what-makes-a-good-typeface/
- https://uxdesign.cc/how-to-make-the-typography-of-your-ios-app-not-suck-a6de09fb7c41

11.3.5 Learning Outcome 4: Create and edit images

11.3.5.1 Learning Activities

The following are the performance criteria:

- Software and tools for graphic design and photography are identified
- Identification of image file types is done.
- Creation of letterforms, lines of type and body copy, using appropriate software is done,
- Creation and manipulation of images using appropriate software is done.

Trainees to demonstrate knowledge in relation to:

- Types of Graphic design software: Adobe Photoshop, Adobe InDesign, Corel Draw, Paint.net
- Types of Image file types: Raster,Vector,
- Creation of: Letterforms, Lines of type, Body copy , Techniques of image manipulation Colour blending, Image merging, Texture use, Proportion etc. Creation of Images using Adobe Photoshop

11.3.5.2 Information Sheet

Graphics software creates, edits, and manages two-dimensional images. These computer graphics may be clip art, web graphics, logos, headings, backgrounds, digital photos, or other kinds of digital images.

Read: Different types of graphic design software:
https://blog.templatetoaster.com/graphic-design-software/

Following are the various image file types:

- **Raster Format:** JPEG/JFIF, JPEG 2000,Exif, TIFF, GIF, BMP, PNG, PPM, PGM, PBM, and PNM
- **Vector Format:** Vector files such as AI and EPS can remain editable so you can open them back up in Illustrator and edit any text or other elements within the graphic.

Read: Difference of raster and vector format:
https://en.wikipedia.org/wiki/Image_file_formats#Vector_formats

Read the following for further details on the types of files and their characteristics:

TIFF (.tif, .tiff): TIFF or Tagged Image File Format are lossless images files meaning that they do not need to compress or lose any image quality or information (although there are options for compression), allowing for very high-quality images but also larger file sizes.
Compression**:** Lossless - no compression. Very high-quality images.
Best For: High quality prints, professional publications, archival copies
Special Attributes: Can save transparencies

Bitmap (.bmp): BMP or Bitmap Image File is a format developed by Microsoft for Windows. There is no compression or information loss with BMP files which allow images to have very high quality, but also very large file sizes. Due to BMP being a proprietary format, it is generally recommended to use TIFF files.
Compression: None
Best For: High quality scans, archival copies

JPEG (.jpg, .jpeg): JPEG, which stands for Joint Photographic Experts Groups is a "lossy" format meaning that the image is compressed to make a smaller file. The compression does

create a loss in quality but this loss is generally not noticeable. JPEG files are very common on the Internet and JPEG is a popular format for digital cameras - making it ideal for web use and non-professional prints.
Compression: Lossy - some file information is compressed or lost.
Best For: Web Images, Non-Professional Printing, E-Mail, Powerpoint
Special Attributes: Can choose amount of compression when saving in image editing programs like Adobe Photoshop or GIMP.

GIF (.gif): GIF or Graphics Interchange Format files are widely used for web graphics, because they are limited to only 256 colors, can allow for transparency, and can be animated. GIF files are typically small is size and are very portable.
Compression: Lossless - compression without loss of quality
Best For: Web Images
Special Attributes: Can be Animated, Can Save Transparency

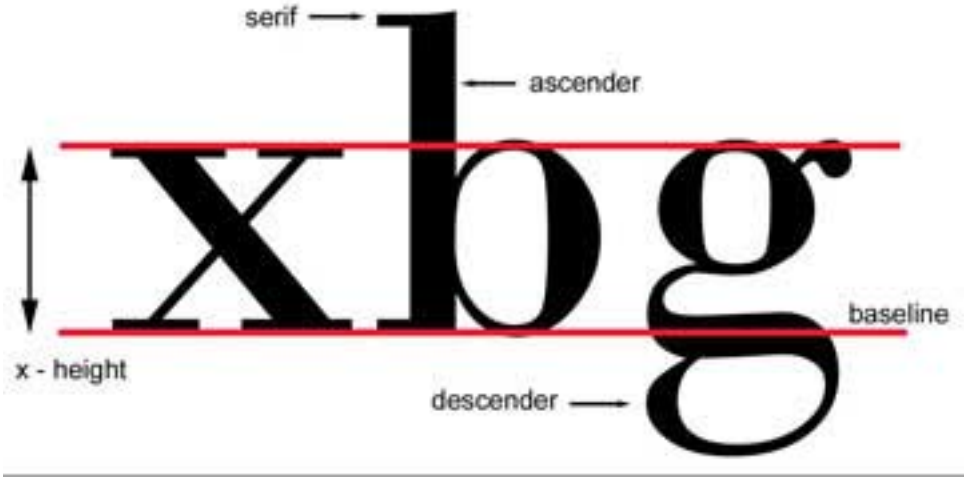
PNG (.png): PNG or Portable Network Graphics files are a lossless image format originally designed to improve upon and replace the gif format. PNG files are able to handle up to 16 million colors, unlike the 256 colors supported by GIF.
Compression: Lossless - compression without loss of quality
Best For: Web Images
Special Attributes: Save Transparency

EPS (.eps): An EPS or Encapsulated PostScript file is a common vector file type. EPS files can be opened in many illustration applications such as Adobe Illustrator or CorelDRAW.
Compression: None - uses vector information
Best For: Vector artwork, illustrations
Special Attributes: Saves vector information

RAW Image Files (.raw, .cr2, .nef, .orf, .sr2, and more)
RAW images are images that are unprocessed that have been created by a camera or scanner. Many digital SLR cameras can shoot in RAW, whether it be a .raw, .cr2, or .nef. These RAW images are the equivalent of a digital negative, meaning that they hold a lot of image information, but still need to be processed in an editor such as Adobe Photoshop or Lightroom.
Compression: None
Best For: Photography
Special Attributes: Saves metadata, unprocessed, lots of information

Read: About file types and characteristics:
https://guides.lib.umich.edu/c.php?g=282942&p=1885348

A letterform, letter-form or letter form, is a term used especially in typography, paleography, calligraphy and epigraphy to mean a letter's shape



Source: http://www.csun.edu

Figure 87: Letterform

Types of Lines

- Straight line
- Curved line
- Horizontal lines: The lines drawn horizontally are called horizontal lines.
- Vertical lines: The lines drawn vertically are called vertical lines.
- Oblique or slanting lines: The lines drawn in a slanting position are called oblique or slanting lines.

The body text or body copy is the text forming the main content of a book, magazine, web page, or any other printed or digital work.

Not every image you use is going to match your background, your texture, or even your other images. So that is where **color blending** comes in. Things like Photo Filters and Gradient Maps are used in Photoshop to either add or take away color in your images.

Now **textures** don't necessarily add to the realism of your art, but they do add a nice kick to blend all your images together evenly. Blending is a huge part of photo manipulation, so textures are something you have to carefully pick out.

Read: Different techniques of image Manipulation:
https://design.tutsplus.com/tutorials/10-techniques-that-are-essential-for-successful-photo-manipulation-artwork--psd-242

HOW TO CREATE A NEW IMAGE IN PHOTOSHOP

- Choose File→New.
- Type a name for the new file.

- In the New dialog box, select a preset image category from the Preset pop-up menu. If you selected an image category from the Preset menu in
- Select your desired preset Size for that category.

Read: How to create new image in Photoshop
https://www.dummies.com/software/adobe/photoshop/how-to-create-a-new-image-in-photoshop-cs6/

Watch: Creating basic image: https://youtu.be/o5a1TyLvFxM

11.3.5.3 Self-Assessment

i. What are types of lines?
ii. Differentiate raster and vector format?
iii. What is the role of Graphic Software?
iv. How to create new image using Photoshop step-by-step?
v. Edit photographs using Photoshop.
vi. **Case situation:** You have been asked by your high school principal to collate old pictures and prepare a collage for your school's annual day. Some of the pictures are old and torn. How will you help your school?
vii. In typography, a key component in graphic design, the Bauhaus school was instrumental in developing fonts with what style?
   A. Modern
   B. Sans Serif
   C. Gothic
   D. Old Style
viii. If you write the word "HOPE" in large, block letters and write the words "for the best" in tiny cursive letters, what two elements did you just contrast?
   A. Form and line
   B. Typography and line
   C. Texture and typography
   D. Shape and color
ix. Which of the following professions would be MOST responsible for creating the visuals on a product package?
   A. Software engineers
   B. Web designer
   C. Graphic designer
   D. Project management professional
x. If you want to include pictures on your website, a good resolution would be _____.
   A. 320 PPI
   B. 64 PPI
   C. 1200 PPI
   D. 96 PPI

11.3.5.4 Tools, Equipment, Supplies and Materials
Photoshop, Computer

11.3.5.5 References
- https://www.lifewire.com/what-is-graphics-software-1701504
- https://modassicmarketing.com/understanding-image-file-types
- https://design.tutsplus.com/tutorials/10-techniques-that-are-essential-for-successful-photo-manipulation-artwork--psd-242
- Sustainable Graphic Design (1st edition) authored by Wendy Jedlicka, published by Wiley; 2009
- Introduction to Graphic Design authored by Aaris Sherin, published by Bloomsbury Visual Arts, 2017

11.3.6 Learning Outcome 5: Perform Layout Design

11.3.6.1 Learning Activities
The following are the performance criteria:
- Understanding of proportion and its application in layout design is done
- Creation of unified systems out of dissimilar elements is done.
- Manipulation of typographic tools to create dynamic layout is done.
- Development of a type and image project is done.
- Introduction to multi-page layout planning, in design is done.
- Development of advanced typographic layout is done.
- Development of a multi-page magazine layout is done.

Trainees to demonstrate knowledge in relation to:
- Proportion and its application areas
- Types of Unified systems
- Typographic tools

11.3.6.2 Information Sheet
Proportion refers to the relative size and scale of the various elements in a design. The issue is the relationship between objects, or parts, of a whole.

Unified design blends all its parts to make a single impression. It is more visible and potent than it's flabby alternative: a bunch of individual impressions.

Read: Unified type and different part: https://alexanderwwhite.wordpress.com/designer/type-design/"putting-it-together-achieving-a-unified-design"/

Read: Typographic tools:
https://webflow.com/blog/9-of-the-best-typography-tools-for-designers
https://uxplanet.org/12-helpful-typography-tools-ea0d808eb70b

https://medium.com/@exokim/10-amazing-online-typography-tools-for-graphic-designers-91471a2939cd

Watch: Tutorials on layout design and typography
https://youtu.be/stOtKLMbP8c
https://youtu.be/atS36kzr8zg

11.3.6.3 Self-Assessment

i. What is proportion?
ii. Use online tutorials to learn and practice layout design application
iii. Identify 5 typography free tools from online

11.3.6.4 Tools, Equipment, Supplies and Materials

Fontface ninja, computer, paint.net, Corel Draw

11.3.6.5 References

- https://webflow.com/blog/9-of-the-best-typography-tools-for-designers
- https://alexanderwwhite.wordpress.com/designer/type-design/"putting-it-together-achieving-a-unified-design"/
- Sustainable Graphic Design, (1st edition) authored by Wendy Jedlicka, published by Wiley, 2009
- Introduction to Graphic Design authored by Aaris Sherin, published by Bloomsbury Visual Arts, 2017

11.3.7 Learning Outcome 6: Print and post the design created

11.3.7.1 Learning Activities

The following are the performance criteria:

- Tools and equipment for printing are identified.
- Types of printing are identified based on the design.
- Classification of Paper according to its types, sizes and paper weight is done
- Identification of the chemicals used in printing is done
- Printing of the actual design is done

Trainees to demonstrate knowledge in relation to:

- Tools and equipment for printing
- Types of printing
- Printing papers classification

11.3.7.2 Information Sheet

Digital printing refers to methods of printing from a digital-based image directly to a variety of media. It usually refers to professional printing where small-run jobs from desktop

publishing and other digital sources are printed using large-format and/or high-volume laser or inkjet printers. Digital printing has a higher cost per page than more traditional offset printing methods.

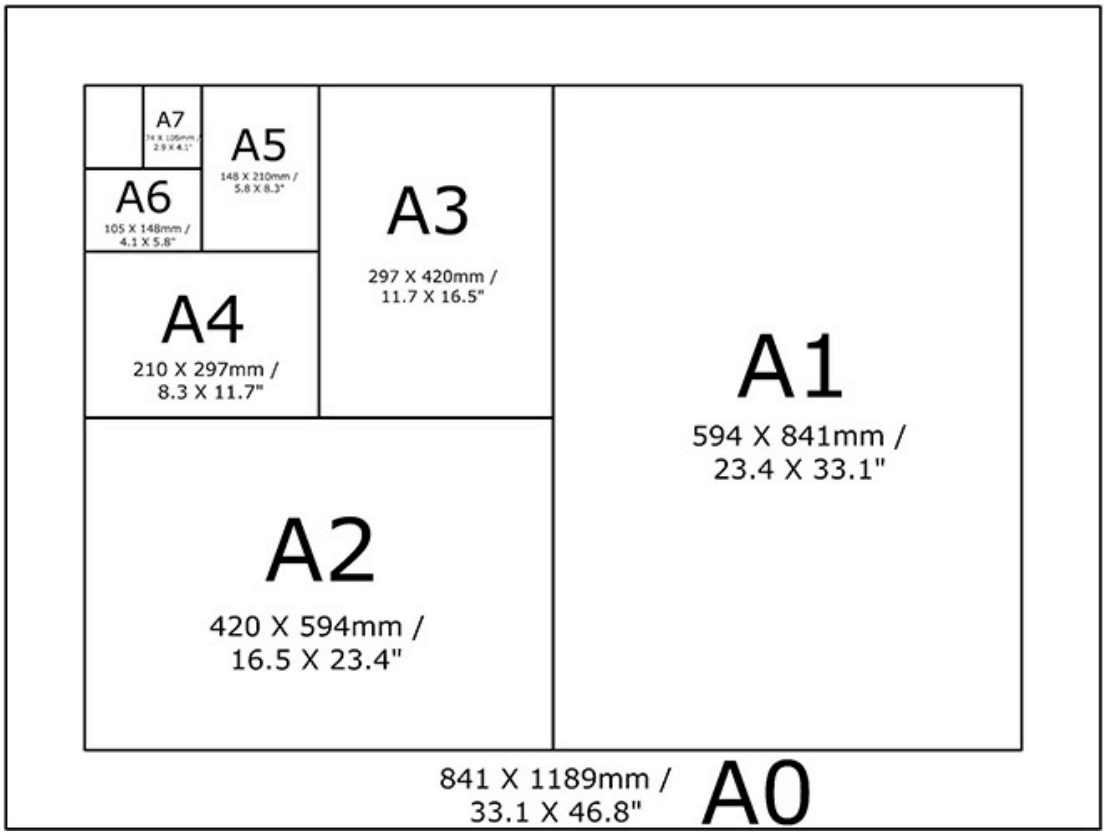
Read: Tools and equipment of printing:
https://www.rushordertees.com/blog/five-tools-screen-printing/
https://canapa.com.tr/2018/07/09/thetoolsandequipmentused/

Digital Printing is when you reproduce a digital based image to print format, using a physical surface like paper, film, plastic, photographic paper or cloth.

Offset Printing. Offset printing is a type of print that makes use of plates. Other printing techniques include such as – flexography, letterpress printing, screen printing etc.

Read: Types of printing: http://imprimerie-sanjose.com/what-are-the-different-types-of-printing/

Here are some of the most popular types of printing paper:
Inkjet Printer Paper. This type of paper is designed for specific use with inkjet printers.
Laser Printer Paper. Laser paper is best used with a laser printer. Papers come in different varieties - Matte, Bright White, Glossy, Card Stock



Source: http://resources.lasertekservices.com

Figure 88: Paper size and printing formats

Table 12: Printing paper by weight

Paper weight	Use
80 gms	Everyday printing
90 gms	Ideal for colour printing
100 gms	Most popular for executive documentation, presentation and mail
120 gms	High quality paper for presentation
160 gms	A lightweight card and special projects

Source: www.paperstone.co.uk

Read: Types of printing paper: https://www.printerland.co.uk/blog/printer-buying-guide/in-depth-guide-to-printer-paper/

Read: Approaches for digital printing: https://www.fellesforbundet.no/globalassets/dokumenter/grafisk/publikasjoner/ngu-digital-print-report-2016.pdf

11.3.7.3 Self-Assessment

i. What are the different types of printing?

ii. What are the different types of printing paper?

iii. What type of paper will you use for printing visiting cards for a top executive?

iv. What are the key factors for selecting paper quality?

v. Set page for different printing set up - A5, A4, A3, A2

vi. **Case situation:** You are working in a photocopy shop. You have noticed that there are a lot of query related to architecture drawing printing since the time a college near by has opened interior designing course. What kind of printer and paper will you suggest to your manager?

vii. **Case situation**: For a home user that has casual printing needs, most important specification of a printer is

A. Cost Of Use
B. Resolution
C. Speed
D. Paper Size

vii. Printer which uses carbon forms is

A. Daisy Wheel
B. Dot Matrix
C. Laser
D. Thimble

ix. Screen printing utilizes a _____ to control the location of the ink.

A. Layer
B. Mask
C. Point
D. Spot

x. _____ is held against the surface to be printed, and ink is forced through the _____ (and supporting screen) with utilize of a squeegee.

11.3.7.4 Tools, Equipment, Supplies and Materials

Printer, Computer, Papers, Digital Tablet

11.3.7.5 References

- https://www.printerland.co.uk/blog/printer-buying-guide/in-depth-guide-to-printer-paper/
- http://imprimerie-sanjose.com/what-are-the-different-types-of-printing/
- https://www.fellesforbundet.no/globalassets/dokumenter/grafisk/publikasjoner/ngu-digital-print-report-2016.pdf
- Sustainable Graphic Design authored by Wendy Jedlicka, published by Wiley; 1 edition 2009
- Introduction to Graphic Design authored by Aaris Sherin, published by Bloomsbury Visual Arts 2017

CHAPTER 12: COMPUTER PROGRAMMING

12.1 Introduction

This unit specifies competencies required to develop computer program. It involves Identifying program and programming concepts, identifying phases of program development, perform program design and Analysis, develop a Computer program, Perform Program testing and debugging, Perform User training and Program Maintenance.

12.2 Performance Report

- Identified types of programming languages and concepts
- Identified Approaches of program development
- Identified Phases of program development
- Identified Program design and Analysis tools
- Identified Format of a computer program
- Adopted well written and readable programs using disciplined coding styles and standards
- Developed Maintenance schedule
- Determined Maintenance tools and techniques

12.3 Learning Outcome

12.3.1 List of the Learning Outcomes

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

- Identify program and programming concepts
- Identify Phases of Program development
- Perform program design and Analysis
- Develop a Computer program
- Perform Program testing and debugging
- Perform user training and Program Maintenance

12.3.2 Learning Outcome 1: Identify program and programming concepts

12.3.2.1 Learning Activities

The following are the performance criteria:

- Definition of program and programming is done
- Types of programming languages are identified
- Programming concepts are identified
- Approaches of program development are identified

Trainees to demonstrate knowledge in relation to:

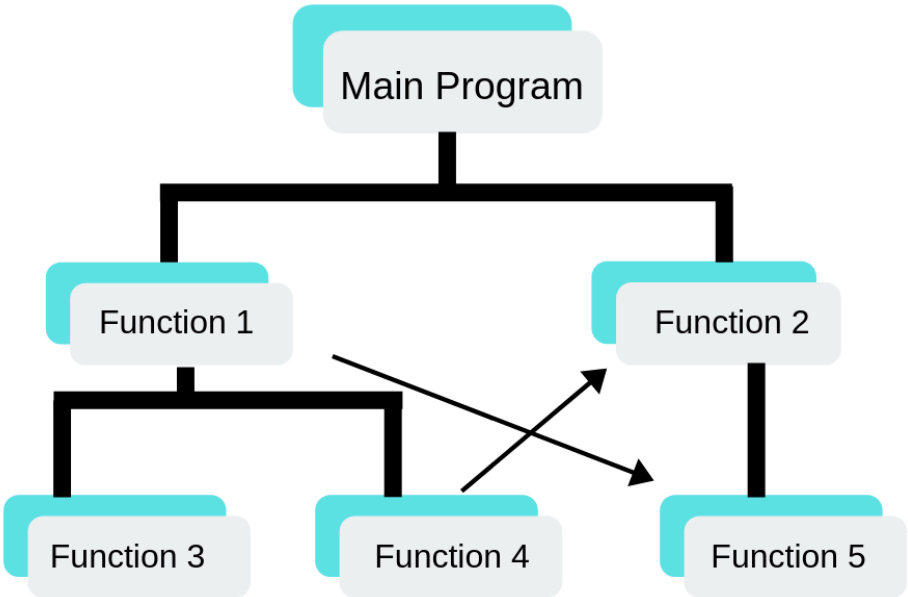
- Definition of program and programming
- Programming concepts
- Program structure: Variable declaration, Looping structures, Control structures, Syntax
- Programming languages: Object oriented, Functional, Imperative, Declarative
- Approaches of program development: Waterfall, Agile, Spiral etc

12.3.2.2 Information Sheet

A computer program is a collection of instructions that performs a specific task when executed by a computer. Most computer devices require programs to function properly.

A programming language is a set of commands, instructions, and other syntax use to create a software program.

Program structure The overall form of a program, with particular emphasis on the individual components of the program and the interrelationships between these components.



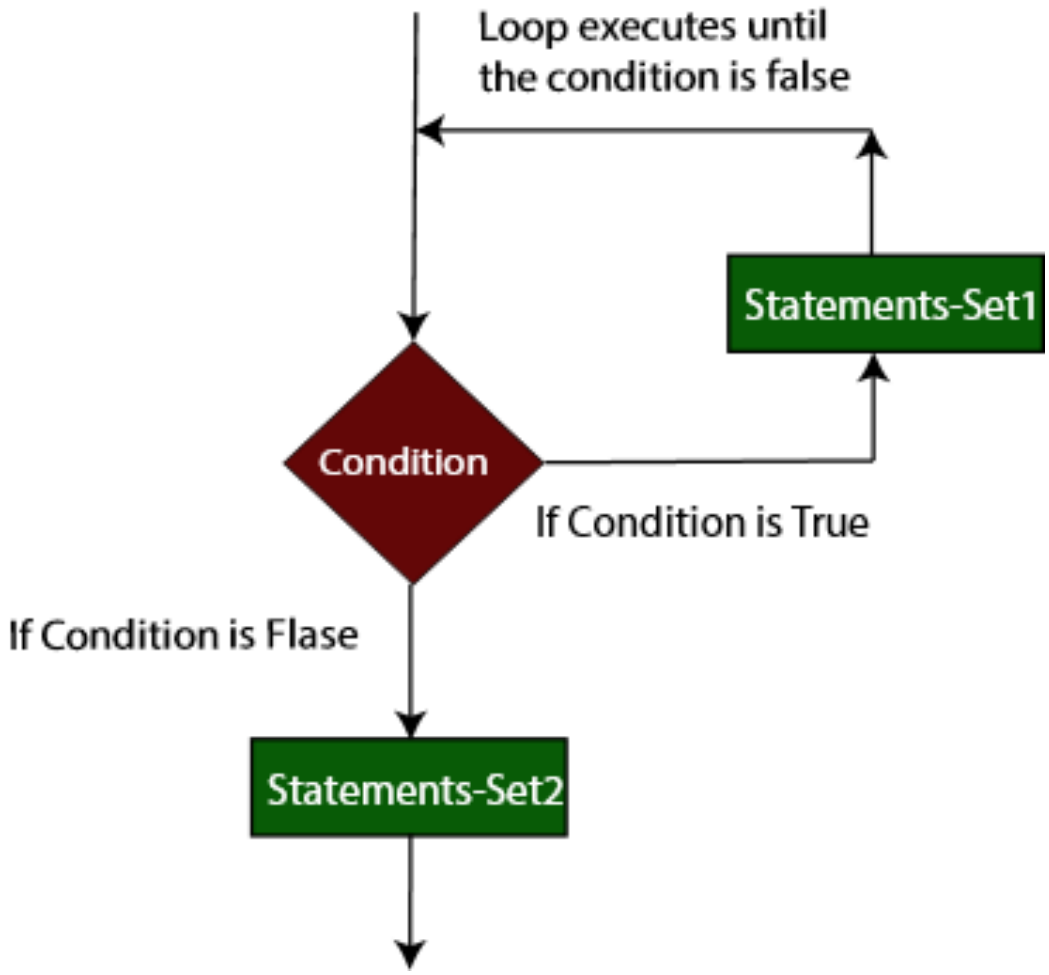
Source: www.codeavail.com

Figure 89: Program structure

A declaration of a variable is where a program says that it needs a variable. For small programs, place declaration statements between the two braces of the main method. The declaration gives a name and a data type for the variable. It may also ask that a particular value be placed in the variable.

Read: Declaration of variable: https://chortle.ccsu.edu/Java5/Notes/chap09A/ch09_3.html

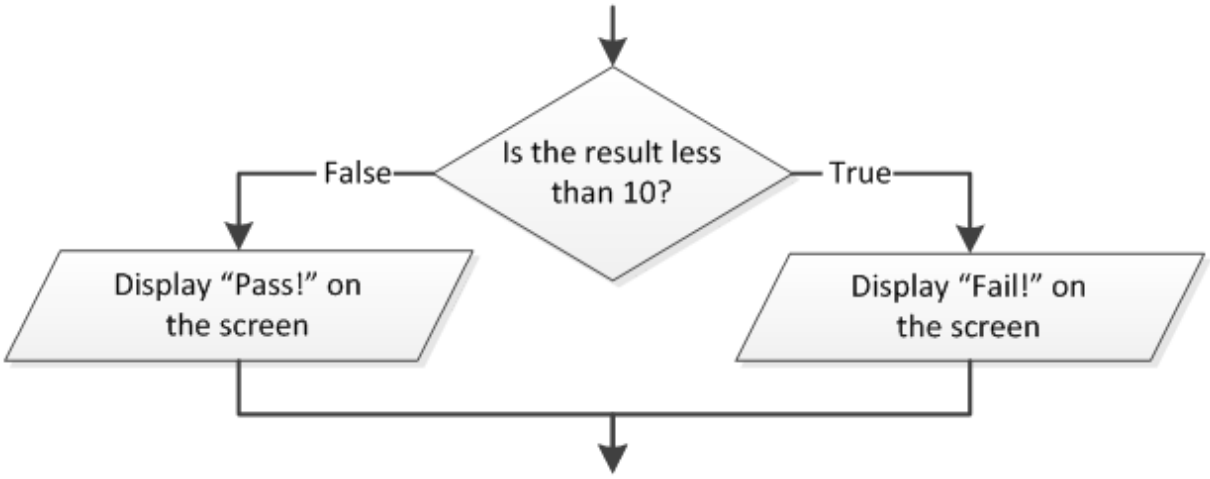
Loops are control structures used to repeat a given section of code a certain number of times or until a particular condition is met.



Source: www.tutorialscampus.com

Figure 90: Loops

A control structure is a block of programming that analyses variables and chooses a direction in which to go based on given parameters.



Source: https://www.bouraspage.com

Figure 91: Control structure

The syntax of a computer language is the set of rules that defines the combinations of symbols that are considered to be a correctly structured document or fragment in that language.

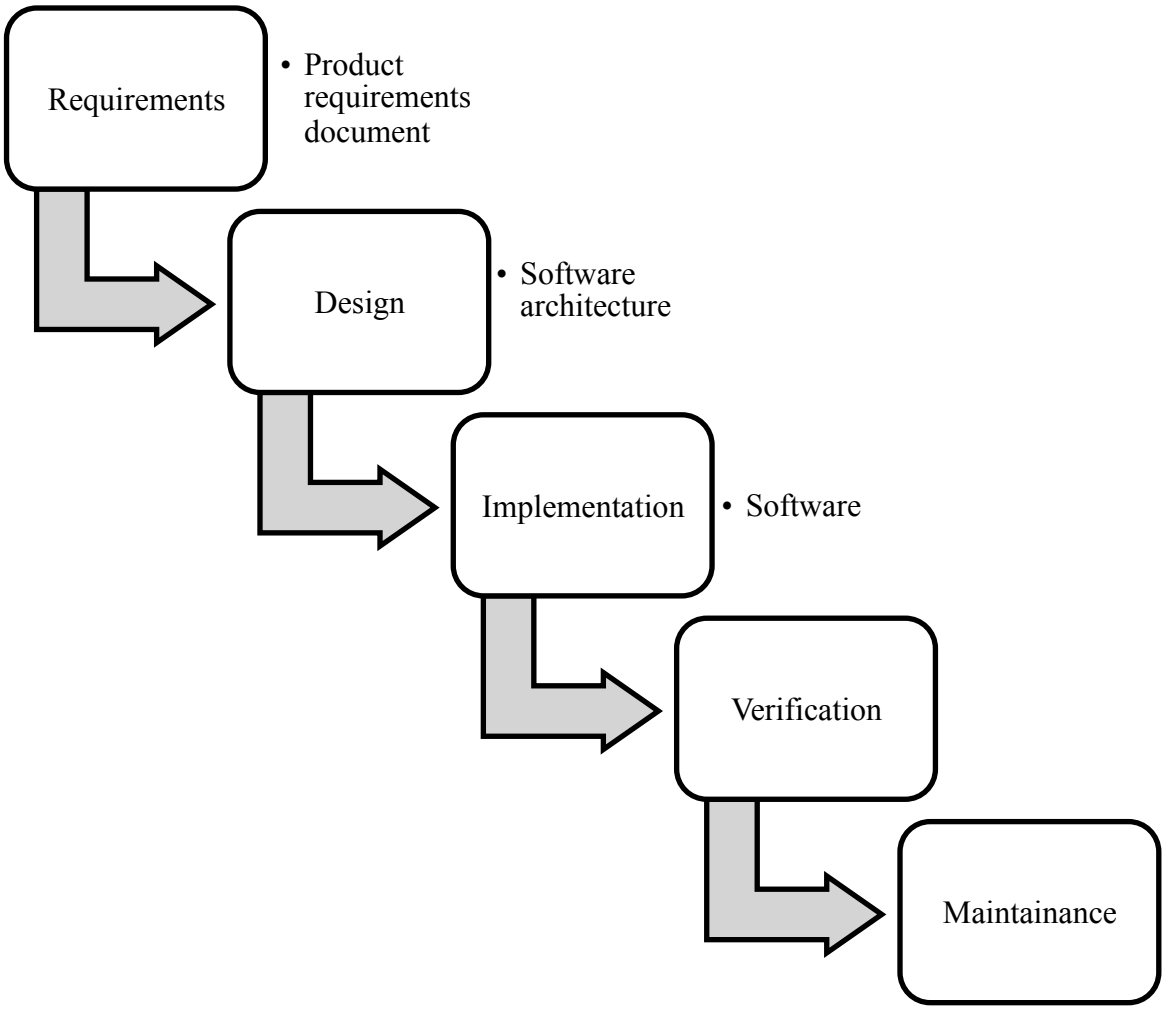
Object-oriented programming (OOP) is a programming paradigm based on the concept of "objects", which can contain data, in the form of fields (often known as attributes), and code, in the form of procedures (often known as methods).

A function is a block of organized, reusable code that is used to perform a single, related action.

Imperative programming is a programming paradigm that uses statements that change a program's state.

Declarative programming is a **programming** paradigm a style of building the structure and elements of computer programs that expresses the logic of a computation without describing its control flow.

The waterfall model is a breakdown of project activities into linear sequential phases, where each phase depends on the deliverables of the previous one and corresponds to a specialization of tasks.



Source: https://en.wikipedia.org/wiki/Waterfall_model

Figure 92: Waterfall model

Agile software development is an approach to software development under which requirements and solutions evolve through the collaborative effort of self-organizing and cross-functional teams and their customer/end user.

Spiral Model is a combination of a waterfall model and iterative model. Each phase in spiral model begins with a design goal and ends with the client reviewing the progress.

Read: Introduction to computer programming:
http://cs.brown.edu/courses/cs173/2012/book/book.pdf

12.3.2.3 Self-Assessment

i. What is Agile software development model?
ii. What are the benefits of agile approach?
iii. What is waterfall approach?

iv. If you needed to execute some code repeatedly based on a certain condition, which of the following would you use?
   A. Variable
   B. Compiler
   C. Loop
   D. Conditional

v. Before source code can be compiled, it has to be _____
   A. Saved in a separate file
   B. Viewed in a command prompt
   C. Capitalized
   D. Parsed

vi. You need special software to write programs?
   A. True
   B. False

vii. What is object-oriented programming?
   A. A type of programming involving a structured method of creating programs
   B. A type of programming using only numbers
   C. A type of programming not in use anymore
   D. A type of programming involving data types representing data structures

12.3.2.4 Tools, Equipment, Supplies and Materials

Computer, Documentation, Flowcharts, Pseudocode, Programming language

12.3.2.5 References

- https://techterms.com/definition/programming_language
- https://docs.microsoft.com/en-us/dotnet/visual-basic/programming-guide/language-features/control-flow/loop-structures
- https://www.tutorialspoint.com/computer_programming/computer_programming_functions.htm
- Computer Programming: Learn It, Try It!, authored by Brad Edelman published by Capstone Global Library Ltd., 2017
- Computer Programming and Computer Systems authored by Anthony Hassitt, Anthony Ralston published by Academic Press, 2014

12.3.3 Learning Outcome 2: Identify phases of program development

12.3.3.1 Learning Activities

The following are the performance criteria:

- Processes of creating programs are identified
- Phases of program development are identified
- Activities that take place during Program Development are identified

Trainees to demonstrate knowledge in relation to:

- Phases of program development
- Planning
- System analysis and design
- System development
- Testing
- Implementation

12.3.3.2 Information Sheet

Requirement gathering and analysis or planning: Business requirements are gathered in this phase. This phase is the main focus of the project managers and stakeholders. Meetings with managers, stakeholders and users are held in order to determine the requirements like; Who is going to use the system? How will they use the system? What data should be input into the system? What data should be output by the system? These are general questions that get answered during a requirements gathering phase. After requirement gathering these requirements are analyzed for their validity and the possibility of incorporating the requirements in the system to be development is also studied.

Design: In this phase the system and software design is prepared from the requirement specifications, which were studied, in the first phase. System Design helps in specifying hardware and system requirements and also helps in defining overall system architecture. The system design specifications serve as input for the next phase of the model.

Implementation: On receiving system design documents, the work is divided in modules/units and actual coding is started. Since, in this phase the code is produced so it is the main focus for the developer. This is the longest phase of the software development life cycle.

Testing: After the code is developed it is tested against the requirements to make sure that the product is actually solving the needs addressed and gathered during the requirements phase. During this phase all types of functional testing like unit testing, integration testing, system testing, acceptance testing are done as well as non-functional testing are also done.

Deployment: After successful testing the product is delivered / deployed to the customer for their use.

Read: Phase of program development: https://www.linkedin.com/pulse/what-software-development-life-cycle-sdlc-phases-private-limited

12.3.3.3 Self-Assessment

i. What are the phases of program development?
ii. Prepare a timeline based on the phases of development for a developing a website.
iii. Prepare a timeline based on the phases of development for a mobile application.
iv. Read about software development processes.
v. Risk analysis of a project is done in:
   A. System Analysis Phase
   B. Feasibility Study
   C. Implementation phase
   D. Maintenance phase
vi. Which is the first step in the software development life cycle?
   A. Analysis
   B. Design
   C. Problem/Opportunity Identification
   D. Development and Documentation
vii. Which tool is use for structured designing?
   A. Program flowchart
   B. Structure chart
   C. Data-flow diagram
   D. Module
viii. A step-by-step instruction used to solve a problem is known as:
   A. Sequential structure
   B. A List
   C. A plan
   D. An Algorithm
ix. An iterative process of system development in which requirements are converted to a working system that is continually revised through close work between an analyst and user is called
   A. Waterfall modeling
   B. Iterative modeling
   C. Spiral modeling
   D. None of these above

12.3.3.4 Tools, Equipment, Supplies and Materials

Computer, software

12.3.3.5 References

- https://www.linkedin.com/pulse/what-software-development-life-cycle-sdlc-phases-private-limited

- Computer Programming and Computer Systems authored by Anthony Hassitt, Anthony Ralston published by Academic Press, 2014
- Computer Programming: Learn It, Try It!, authored by Brad Edelman published by Capstone Global Library Ltd., 2017

12.3.4 Learning Outcome 3: Perform program design and analysis

12.3.4.1 Learning Activities

The following are the performance criteria:

- Program design and Analysis tools are identified
- Algorithm writing tools are identified
- Factors affecting program design and analysis are identified.
- System development methodologies are identified
- Criteria for choosing the appropriate methodology is done

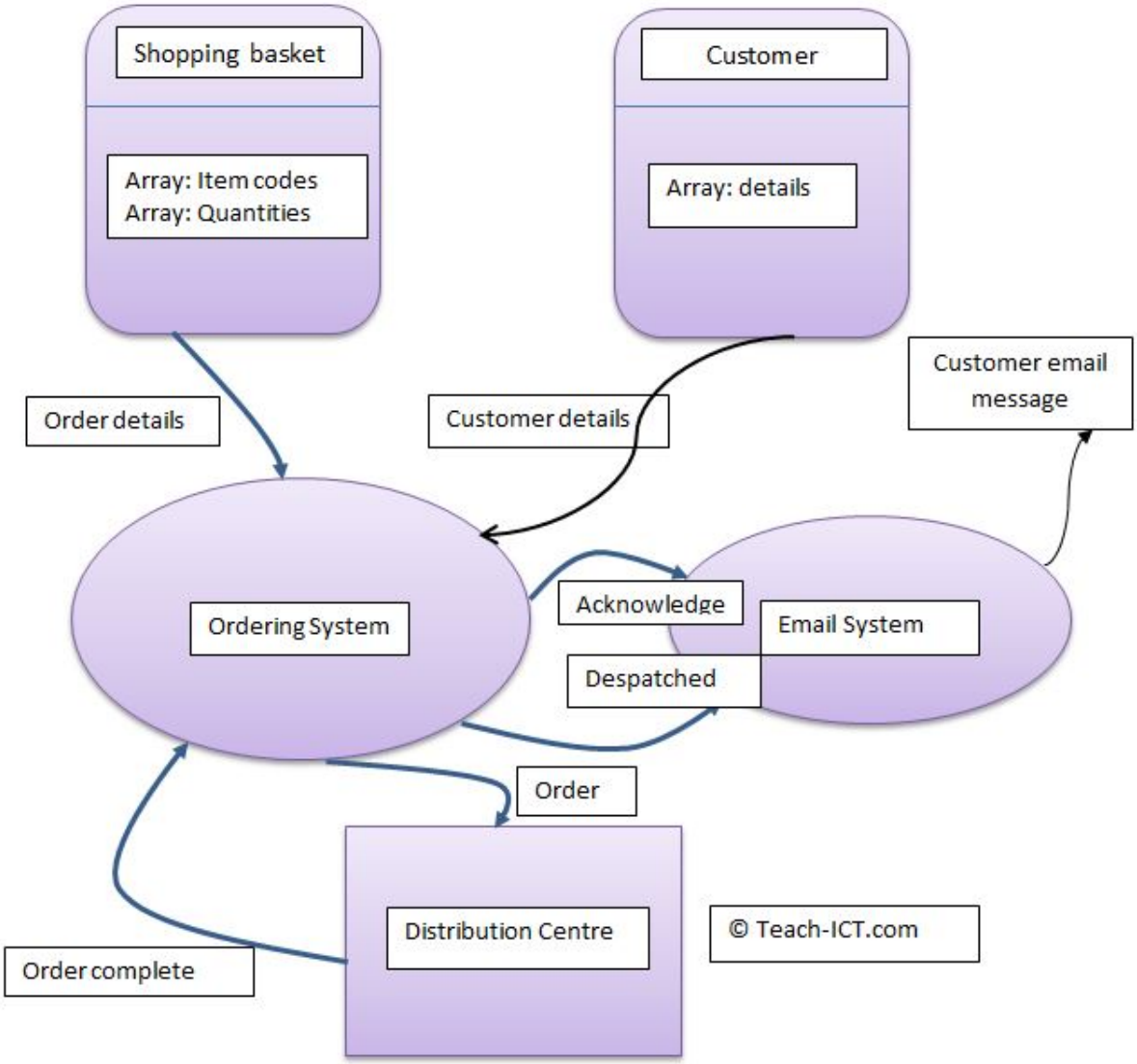
Trainees to demonstrate knowledge in relation to:

- Definition of program design and analysis
- Program design and analysis tools
- Dataflow diagram, Pseudocode, HIPO Diagram, Structure charts
- Software design levels
- High level design
- Detailed design
- Architectural design
- Types of system design
  Form design, File organization design, Database design

12.3.4.2 Information Sheet

Program design is the process by which an agent creates a specification of a software artifact, intended to accomplish goals, using a set of primitive components and subject to constraints. **Program analysis** helps the team understand key constraints that must be addressed for a program to be successful.

A data-flow diagram is a way of representing a flow of a data of a process or a system.



Source: https://www.teach-ict.com

Figure 93: Data flow

Pseudocode is an informal high-level description of the operating principle of a computer program or other algorithm.

HIPO (Hierarchical Input Process Output) diagram is a combination of two organized method to analyze the system and provide the means of documentation.

A **structure chart** in software engineering and organizational theory is a chart, which shows the breakdown of a system to its lowest manageable levels.

The architectural design is the highest abstract version of the system. It identifies the software as a system with many components interacting with each other. At this level, the designers get the idea of proposed solution domain.

The **high-level design** breaks the 'single entity-multiple component' concept of architectural design into less-abstracted view of sub-systems and modules and depicts their interaction with each other. High-level design focuses on how the system along with all of its components can be implemented in forms of modules. It recognizes modular structure of each sub-system and their relation and interaction among each other.

Detailed design deals with the implementation part of what is seen as a system and its sub-systems in the previous two designs. It is more detailed towards modules and their implementations. It defines logical structure of each module and their interfaces to communicate with other modules.

Read: Types of system design:
https://www.tutorialspoint.com/system_analysis_and_design/system_design.htm

12.3.4.3 Self-Assessment

i. What is HIPO diagram?
ii. Define high-level design.
iii. Differentiate between data-flow diagram and HIPO diagram?
iv. What is pseudocode?
v. Explain software design levels?
vi. Which of the following data structure is not linear data structure?
   A. Arrays
   B. Linked lists
   C. Both of the above
   D. None of the above
vii. A system flow chart describes the:
   A. Details of each program module
   B. Line diagram for particular program
   C. Data files and operations and decision for a particular program
   D. Sequence of operations techniques is used to simplify defining problem
viii. Which of the following items are discussed during the system implementation phase of the application:
   A. Program Specification
   B. Software specification
   C. Software maintenance
   D. All of the above
ix. A system that groups a number of transactions for later processing is known is:
   A. Client server
   B. Batch system
   C. Online system
   D. Real time system

12.3.4.4 Tools, Equipment, Supplies and Materials

Lucidchart, Microsoft visio, Flow charts, Data flow diagram

12.3.4.5 References

- https://www.teach-ict.com/as_as_computing/ocr/H047/F451/312/slc_analysis/miniweb/pg4.htm
- https://www.tutorialspoint.com/software_engineering/software_design_basics.htm
- Computer Programming and Computer Systems, authored by Anthony Hassitt, Anthony Ralston published by Academic Press, 2014
- Computer Programming: Learn It, Try It!, authored by Brad Edelman published by Capstone Global Library Ltd, 2017

12.3.5 Learning Outcome 4: Develop a Computer program

12.3.5.1 Learning Activities

The following are the performance criteria:

- Format of a computer program is identified
- Fundamentals of structured programming using C language are done
- Fundamentals of Object Oriented programming using Java are done
- Well written and readable programs using disciplined coding styles and standards are adopted

Trainees to demonstrate knowledge in relation to:

- Format of a computer program
- Source code, Components of the program: Program header, declarations, main body Interrelationships between components, Data structures
- Fundamentals of structured programming using C language, Special features, Structure of C language, Variables and constants, Input/output functions, Literal reserved words, Identifiers, Data types and their sizes, Conditional statements, Loop control, C functions, Library functions, User defined functions, Arguments and parameters
- Fundamentals of Object Oriented programming using Java, Object oriented programming, Java language, Java Virtual Machine, Java Libraries, Program structure, Java Output, Variables and expressions, Classes and objects, Input in Java, Data types and operators, Boolean statements, Loops and program flow, Arrays, Exception handling

12.3.5.2 Information Sheet

Source code is the list of human-readable instructions that a programmer writes often in a word processing program when he is developing a program.

A data structure is a specialized format for organizing and storing data. General data structure types include the array, the file, the record, the table, the tree, and so on. Any data structure is designed to organize data to suit a specific purpose so that it can be accessed and worked with in appropriate ways.

C is called a structured programming language because to solve a large problem, C programming language divides the problem into smaller modules called functions or procedures each of which handles a particular responsibility.

A function is a group of statements that together perform a task. Every C program has at least one function, which is main, and all the most trivial programs can define additional functions.

You can divide up your code into separate functions. How you divide up your code among different functions is up to you, but logically the division is such that each function performs a specific task.

A function declaration tells the compiler about a function's name, return type, and parameters. A function definition provides the actual body of the function.

The C standard library provides numerous built-in functions that your program can call. For example, strcat() to concatenate two strings, memcpy() to copy one memory location to another location, and many more functions.

A function can also be referred as a method or a sub-routine or a procedure, etc.

A function definition in C programming consists of a function header and a function body. Here are all the parts of a function

Return Type: A function may return a value. The return_type is the data type of the value the function returns. Some functions perform the desired operations without returning a value. In this case, the return_type is the keyword void.

Function Name: This is the actual name of the function. The function name and the parameter list together constitute the function signature.

Parameters: A parameter is like a placeholder. When a function is invoked, you pass a value to the parameter. This value is referred to as actual parameter or argument. The parameter list refers to the type, order, and number of the parameters of a function. Parameters are optional; that is, a function may contain no parameters.

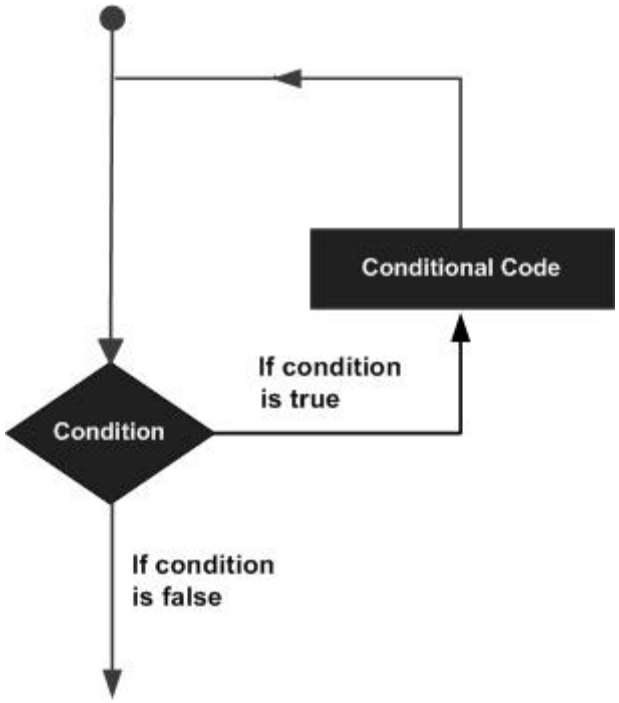
Function Body: The function body contains a collection of statements that define what the function does.

A function declaration tells the compiler about a function name and how to call the function. The actual body of the function can be defined separately.

Read: Programming in C: http://www.vssut.ac.in/lecture_notes/lecture1424354156.pdf

You may encounter situations, when a block of code needs to be executed several number of times. In general, statements are executed sequentially: The first statement in a function is executed first, followed by the second, and so on.
Programming languages provide various control structures that allow for more complicated execution paths.

A loop statement allows us to execute a statement or group of statements multiple times. Given below is the general form of a loop statement in most of the programming languages



Source: www.tutorialspoint.com

Figure 94: Loop statement

C programming language provides the following types of loops to handle looping requirements.

- **While loop:** Repeats a statement or group of statements while a given condition is true. It tests the condition before executing the loop body.
- **For loop:** Executes a sequence of statements multiple times and abbreviates the code that manages the loop variable.
- **Do...while loop:** It is more like a while statement, except that it tests the condition at the end of the loop body.
- **Nested loops:** You can use one or more loops inside any other while, for, or do..while loop.

A loop becomes **an infinite loop** if a condition never becomes false. The ‘for’ loop is traditionally used for this purpose. Since none of the three expressions that form the 'for' loop are required, you can make an endless loop by leaving the conditional expression empty.

```
#include <stdio.h>

  int main () {

    for( ; ; ) {

    printf("This loop will run forever.\n");    }

  return 0;

}
```

When the conditional expression is absent, it is assumed to be true. You may have an initialization and increment expression, but C programmers more commonly use the for(;;) construct to signify an infinite loop.

12.3.5.3 Self-Assessment

i. Explain the syntax for loop.
ii. Can a program be compiled without main() function?
iii. What is the advantage of declaring void pointers?
iv. What are command line arguments?
v. What is a variable?
vi. What is the output of the following program?

```
#include<stdio.h>

{

int x = 1;

switch(x)

 {

default: printf("Hello");

case 1: printf("hi"); break;

} }
```

A. Hello
B. Hi
C. HelloHi
D. Compile error

vii. What is JV? Why is Java called the “Platform Independent Programming Language”?
viii. What are the features in JAVA?
ix. What is a class and give an example of class?

x. If, a moderately active person cuts their calorie intake by 500 calories a day, they can typically lose about 4 pounds a month.
Write a Java and C program that lets the user enter their starting weight, then creates and displays a table showing what their expected weight will be at the end of each month for the next six month If they stay in this diet.

xi. Write a Java program that will calculate total of calories for every food classes (protein, carbohydrate and fat) and then total up the calories of all the food classes. The number of calories per gram of carbohydrate, fat and protein are 4, 7 and 9. The program will allow user to enter the number of grams for every food class.

xii. Write a C program to compute the sum of the two given integer values. If the two values are the same, then return triple their sum.

xiii. Which is a mechanism where one object acquires all the properties and behaviors of the parent object?
   A. Inheritance
   B. Encapsulation
   C. Polymorphism
   D. None of the above

xiv. Java Virtual Machine is platform independent.
   A. True
   B. False

xv. Who is father of C Language?
   A. Bjarne Stroustrup
   B. James A. Gosling
   C. Dennis Ritchie
   D. Dr. E.F. Codd

12.3.5.4 Tools, Equipment, Supplies and Materials

JDK (Java Development Kit), Eclipse IDE, Netbeans IDE, Junit, Codeblocks

12.3.5.5 References

- https://www.thoughtco.com/source-code-definition-958200
- http://www.vssut.ac.in/lecture_notes/lecture1424354156.pdf
- https://dzone.com/articles/15-tools-make-life-easy-java
- https://www.programiz.com/java-programming/basic-input-output
- https://www.tutorialspoint.com/cprogramming/c_functions.htm
- Java Programming 24-Hour Trainer (1st edition) authored by Yakov Fain published by Wrox; 2011
- Computer Programming and Computer Systems authored by Anthony Hassitt, Anthony Ralston published by Academic Press, 2014
- Computer Programming: Learn It, Try It!, authored by Brad Edelman published by Capstone Global Library Ltd., 2017

12.3.6 Learning Outcome 5: Perform Program testing and debugging

12.3.6.1 Learning Activities

The following are the performance criteria:

- Difference between testing and debugging is understood.
- Testing types, levels and methods are identified
- Debugging steps, requirements, principles and techniques are identified
- Error correction is done

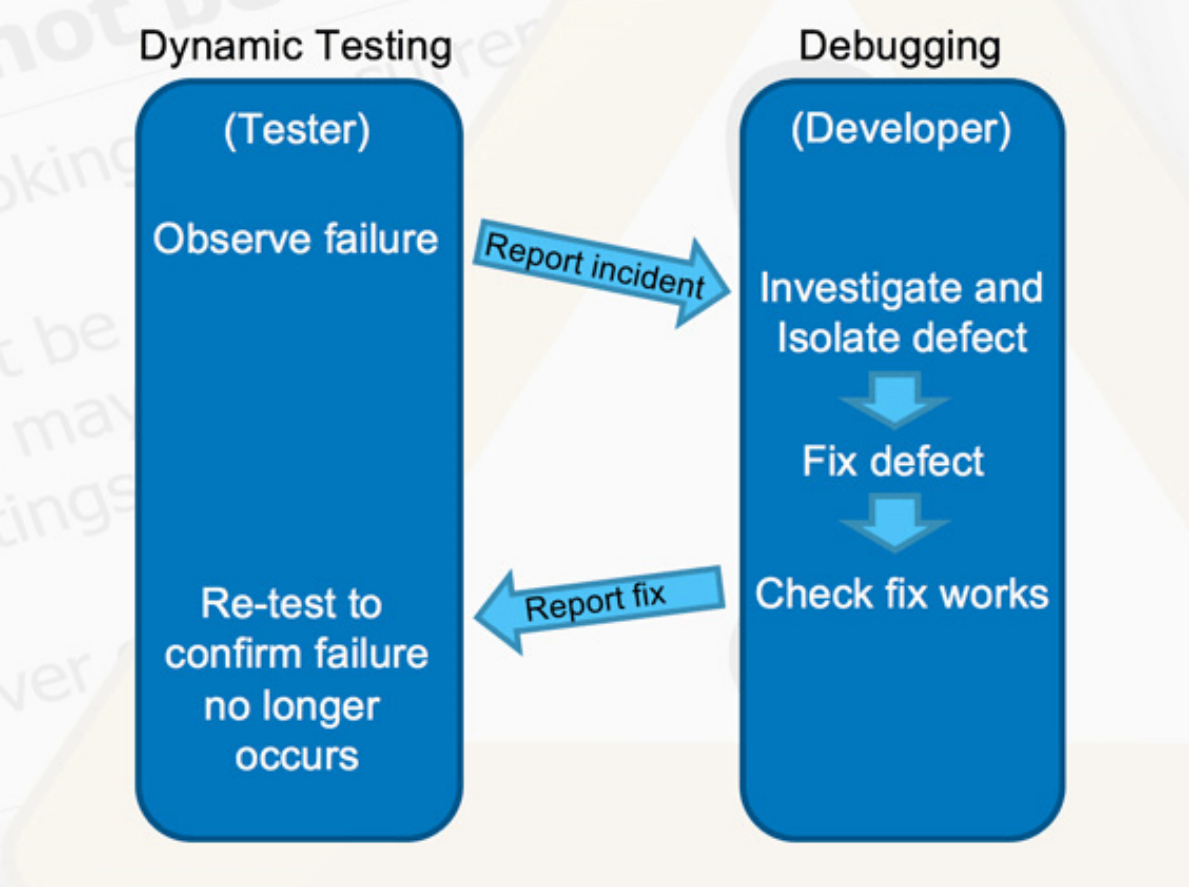
Trainees to demonstrate knowledge in relation to:

- Difference between testing and debugging.
- Types of testing: Smoke, Functional, Usability, Security, Performance, Regression, Compliance
- Levels of testing: Unit, Integration, System, Acceptance
- Methods of testing: Black box, White box, Gray box, Agile, Adhoc
- Debugging steps
- Debugging requirements
- Debugging principles
- Debugging techniques

12.3.6.2 Information Sheet

Testing: Fundamentally, testing is a process to check if the system is working same as it was supposed to do, and not working, as it was not supposed to do. It is done by the tester to identify the defects in the system (actual result of test case execution is not matching with expected result).

Debugging is the activity performed by developers to fix the bug found in the system. This is manual step-by-step unstructured and unreliable process to find and removes a specific bug from the system.



Source: https://dzone.com/articles/the-differences-between-testing-and-debugging

Figure 95: Dynamic testing and debugging

Smoke Testing: Whenever a new build is provided by the development team then the software testing team validates the build and ensures that no major issue exists.

Functional Testing: This type of testing ignores the internal parts and focuses only on the output to check if it is as per the requirement or not. It is a Black-box type testing geared to the functional requirements of an application.

Security Testing: It is a type of testing performed by a special team of testers. A system can be penetrated by any hacking way.

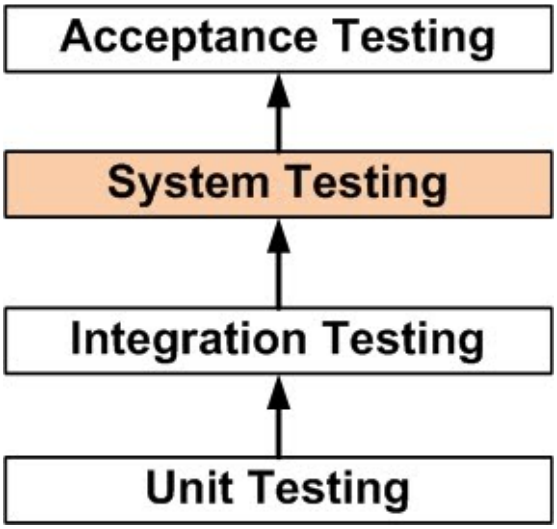
Usability Testing, user-friendliness check is done. Application flow is tested to know if a new user can understand the application easily or not. Proper help document is prepared if a user gets stuck at any point. Basically, system navigation is checked in this testing.

Performance Testing is done to check whether the system meets the performance requirements. Different performance and load tools are used to do this testing.

Regression Testing an application as a whole for the modification in any module or functionality is termed as Regression Testing. It is difficult to cover all the system in Regression Testing, so typically automation-testing tools are used for these types of testing.

Read: Software testing: https://www.softwaretestinghelp.com/types-of-software-testing/

Unit testing is a smallest testable portion of system or application, which can be compiled, liked, loaded, and executed. This kind of testing helps to test each module separately.



Source: guru99.com

Figure 96: Flow of unit testing

Read: Different type of testing: https://www.guru99.com/levels-of-testing.html

Black Box Testing: a software testing method in which the internal structure/design/implementation of the item being tested is not known to the tester. These tests can be functional or non-functional, though usually functional. Test design techniques include Equivalence partitioning, Boundary Value Analysis, Cause-Effect Graphing.

White Box Testing: a software testing method in which the tester knows the internal structure/design/implementation of the item being tested. Test design techniques include Control flow testing, Data flow testing, Branch testing, Path testing.

Gray Box Testing: A software testing method which is a combination of Black Box Testing method and White Box Testing method.

Agile Testing: A method of software testing that follows the principles of agile software development.

Ad Hoc Testing: A method of software testing without any planning and documentation.

Read: Debugging steps: https://kencoding.wordpress.com/2015/06/06/the-four-steps-of-debugging/

Watch: Software debugging steps: https://youtu.be/Kmx_NL4_2Fk

12.3.6.3 Self-Assessment

i. What is Functional Testing?

ii. Describe level of software testing?

iii. What is the difference between testing and debugging?

iv. Some incorrect word sequence in a program would generate

   A. Semantics error
   B. Syntax error
   C. Runtime error
   D. Logical error

v. Examination of the program step by step is called _____

   A. Controlling
   B. Tracing
   C. Stepping
   D. Testing

vi. The examination of changing values of variables is called stepping.

   A. True
   B. False

vii. _____ creates an inferior process that runs your program.

   A. run
   B. exit
   C. execute
   D. e

12.3.6.4 Tools, Equipment, Supplies and Materials

Test IO, TestCraft

12.3.6.5 References

- http://www.softwaretestingclass.com/difference-between-testing-and-debugging/
- https://www.guru99.com/levels-of-testing.html
- http://softwaretestingfundamentals.com/software-testing-methods/
- Computer Programming and Computer Systems authored by Anthony Hassitt, Anthony Ralston published by Academic Press, 2014
- Computer Programming: Learn It, Try It!, authored by Brad Edelman published by Capstone Global Library Ltd., 2017

12.3.7 Learning Outcome 6: Perform User training and Program Maintenance

12.3.7.1 Learning Activities

The following are the performance criteria:

- User training needs are identified
- Methods of user training are identified
- User training manuals are generated
- Maintenance schedule is developed
- Maintenance tools and techniques are determined.
- System performance is monitored, bugs are rectified and requested changes are made.

Trainees to demonstrate knowledge in relation to:

- Identification of user training needs
- Methods of user training
- User training manuals
- Maintenance schedule
- System maintenance tools and techniques.
- Monitoring of system performance
- Rectification of bugs
- Handling requested changes

12.3.7.2 Information Sheet

Read: User training method:
https://www.hr.com/en/communities/training_and_development/list-of-training-methods_eacwezdm.html

Software maintenance in **software** engineering is the modification of a **software** product after delivery to correct faults, to improve performance or other attributes.

Read: Maintenance technics: https://www.researchgate.net/figure/Maintenance-tools-and-techniques_tbl1_227131529
http://ecomputernotes.com/software-engineering/tools-for-software-maintenance

Monitoring system performance is knowing whether a computer has issues is fairly straightforward when the computer is right in front of you. In order to keep your system fit for purpose, your monitoring activities need to cover the following priorities:

- Acceptable delivery speeds
- Constant availability
- Preventative maintenance
- Software version monitoring and patching
- Intrusion detection
- Data integrity
- Security monitoring
- Attack mitigation

- Virus prevention and detection

Rectification of bugs: A bug is any mismatch or an error in a program that produces unexpected results and prevents the software to behave correctly.

Read: How to handle request: https://www.researchgate.net/figure/Maintenance-tools-and-techniques_tbl1_227131529

12.3.7.3 Self-Assessment

i. What is software maintenance?

ii. Maintenance consist of the following action(s)
   A. Replace of component
   B. Repair of component
   C. Service of component
   D. All of the above

iii. Software Maintenance includes
   A. Error corrections
   B. Enhancements of capabilities
   C. Deletion of obsolete capabilities
   D. All of the mentioned

iv. The modification of the software to match changes in the ever changing environment, falls under which category of software maintenance?
   A. Corrective
   B. Adaptive
   C. Perfective
   D. Preventive

v. _____ measures the ability of a regression test selection technique to handle realistic applications.
   A. Efficiency
   B. Precision
   C. Generality
   D. Inclusiveness

12.3.7.4 Tools, Equipment, Supplies and Materials

Debugger, ManageEngine OpManager, SolarWinds Server Health Monitor

12.3.7.5 References

- https://www.researchgate.net/figure/Maintenance-tools-and-techniques_tbl1_227131529
- http://ecomputernotes.com/software-engineering/tools-for-software-maintenance
- https://www.hr.com/en/communities/training_and_development/list-of-training-methods_eacwezdm.html
- https://www.researchgate.net/figure/Maintenance-tools-and-techniques_tbl1_227131529

- Computer Programming and Computer Systems authored by Anthony Hassitt, Anthony Ralston published by Academic Press, 2014
- Computer Programming: Learn It, Try It!, authored by Brad Edelman published by Capstone Global Library Ltd., 2017

CHAPTER 13: MOBILE APPLICATION DEVELOPMENT

13.1 Introduction

This unit specifies competencies required to develop computer program. It involves Identifying Mobile application concepts, identifying mobile application development environment, identifying Application Design Issues, actual Development of mobile application, testing of the developed mobile application and Publishing and Commercializing the developed Application.

13.2 Performance Report

- Identified Mobile application development platforms
- Identified Mobile application development frameworks and tools
- Installed and Configured Appropriate mobile development software
- Built the project prototype into a debuggable APK that can be installed to an emulator or Android powered device.
- Tested and Debugged the Application
- Published the Application

13.3 Learning Outcome

13.3.1 List of the Learning Outcomes

These are the key learning outcomes, which make up workplace function:
- Identify mobile application concepts
- Identify mobile application development environment
- Identify application design issues
- Develop mobile application
- Test the developed mobile application
- Publish and commercialize the developed application

13.3.2 Learning Outcome 1: Identify mobile application concepts

13.3.2.1 Learning Activities

The following are the performance criteria:
- Definition of Mobile application is done
- Types of mobile applications are identified
- Mobile application development platforms are identified
- Mobile application development approaches are identified
- Reasons for mobile application development are identified.

Trainees to demonstrate knowledge in relation to:
- Definition of Mobile application

- Types of Mobile applications: Hybrid, Native
- Mobile application development approaches: Native, Hybrid Native, Hybrid web, Progressive web
- Reasons for mobile application

13.3.2.2 Information Sheet

A mobile application, most commonly referred to as an app, is a type of application software designed to run on a mobile device, such as a smartphone or tablet computer.

There are 3 types of apps:

1. Native apps

iOS on Objective-C or Swift
Android on Java
Windows Phone on Net

2. Hybrid apps for all platforms altogether with Xamarin, React Native, Ionic, and Angular Mobile Sencha Touch etc.

3**. Web apps** as responsive versions of website to work on any mobile device.

Read: Types of application: https://thinkmobiles.com/blog/popular-types-of-apps/
Read: Approaches of apps: https://www.telerik.com/docs/default-source/whitepapers/choose-right-approach-mobile-app-developmentbb581d10116543e79a9febdb187fd0a3.pdf?sfvrsn=0

Following are the reasons for building a mobile application:

Generate additional sales, reduce cost to serve, reduce marketing cost, enhance the customer experience, broaden your market coverage, create stickiness, deliver speed and get feedback.

Read: Reason to build mobile app:
http://www.matchboard.com.au/MatchBoard/Forms/Article/App%20Appeal%20%2010%20Great%20Reasons%20to%20build%20a%20Mobile%20App.aspx

13.3.2.3 Self-Assessment

i. Give 5 reasons to build successful mobile applications?
ii. Define mobile application.
iii. Explain types of mobile application?
iv. Language, which is supported by Android for application development?
   A. PHP
   B. VB.NET
   C. Java
   D. C++
v. Each application can have zero or more activities. True or False? Justify in short.
vi. Android is based on Linux for the following reason.

A. Portability
B. Security
C. Networking
D. All of these

vii. What was the main reason for replacing the Java VM with the Dalvik VM when the project began?
A. Java VM ran too slow
B. Java VM was too complicated to configure
C. Java virtual machine was not free
D. There was not enough memory capability

viii. From a phone manufacturer's point of view, what makes Android so great?
A. Aside from some specific drivers, it provides everything to make a phone work
B. It allows them to compete with Apple's iPhone
C. It makes the hardware work better
D. It allows users to create apps, generating revenue for the companies

13.3.2.4 Tools, Equipment, Supplies and Materials

Software, Android SDK, Integrated Development Environment (IDE)

11.3.2.5 References

- https://mashable.com/article/build-mobile-apps/
- http://www.matchboard.com.au/MatchBoard/Forms/Article/App%20Appeal%20%2010%20Great%20Reasons%20to%20build%20a%20Mobile%20App.aspx
- https://www.telerik.com/docs/default-source/whitepapers/choose-right-approach-mobile-app-developmentbb581d10116543e79a9febdb187fd0a3.pdf?sfvrsn=0
- Android Application Development All-in-One For Dummies authored by Barry A. Burd published by John Wiley & Sons Inc, 2015
- Beginning Android Programming With Android Studio (4th edition) authored by Jerome DiMarzio published by Wrox;, 2016

13.3.3 Learning Outcome 2: Identify mobile application development environment

13.3.3.1 Learning Activities

The following are the performance criteria:

- Mobile Application Architecture and Design is identified
- Mobile application development frameworks and tools are identified
- Techniques and methodologies for mobile application development are introduced

Trainees to demonstrate knowledge in relation to:

- Definition of Mobile Application Development Architecture
- Mobile Application Development Architecture: Stack, Linux Kernel, DVM – Dalvik virtual Machine, SDK
- Reference Architecture; Model view presenter, Wildlife

- Mobile development frameworks; Native script, Flutter, React Native
- Mobile application development tools: Integrated Development Environment (IDE), Graphic User Interface (GUI), Emulator, Android SDK

13.3.3.2 Information Sheet

Mobile app architecture is a set of techniques and patterns used to develop fully structured mobile applications based on industry and vendor specific standards. While formulating the app architecture, the procedures that work on the wireless mobile device like smartphones and tablets are also taken into consideration.

An application stack is a suite or set of application programs that help in performing a certain task.

The Linux kernel is a free and open-source, monolithic, Unix-like operating system kernel. The Linux family of operating systems is based on this kernel and deployed on both traditional computer systems.

Dalvik is a discontinued process virtual machine in Google's Android operating system that executes applications written for Android.

A Software Development Kit (SDK) is typically a set of software development tools that allows the creation of applications for a certain software package, software framework, hardware platform, computer system, video game console, operating system, or similar development platform.

Reference architecture is a document or set of documents to which a project manager or other interested party can refer for best practices.

Read: Model view: https://www.raywenderlich.com/7026-getting-started-with-mvp-model-view-presenter-on-android

Watch: Introduction to model view: https://youtu.be/NNZO9zA0yEY

Native script this has been ranked as the top frameworks for the development of the hybrid apps. Telerik, a Bulgaria based software company, which supports this framework and the creator is Progress. The apps using the Native Scripts utilize the same APIs similar to using Xcode or the Android Studio. You will get sufficient help in the form of tutorials from the official website.

Flutter was launched by Google and is an open-source mobile application development SDK. It is a popular cross-platform app development and is written in the Dart language.

React Native is basically an open-source framework offering ample support to the IDEs and the other mobile app development tools.

Read: Mobile Development framework: https://www.mindinventory.com/blog/mobile-app-development-framework-2019/

An integrated development environment (IDE) is a software application that provides comprehensive facilities to computer programmers for software development.

The graphical user interface (GUI) is a form of user interface that allows users to interact with electronic devices through graphical icons and visual indicators such as secondary notation, instead of text-based user interfaces, typed command labels or text navigation.

A mobile emulator is a resource for emulating or simulating a mobile device or smartphone environment. It allows developers to test URLs or other technologies on a mobile device's operating system and display interface.

Read: Mobile applications:
https://www.cs.cmu.edu/~bam/uicourse/830spring09/BFeiginMobileApplicationDevelopment.pdf

13.3.3.3 Self-Assessment

i. Explain mobile architecture?
ii. Explain briefly mobile development architecture?
iii. What is emulator?
iv. What is the name of the program that converts Java byte code into Dalvik byte code?
   A. Mobile Interpretive Compiler (MIC)
   B. Dex compiler
   C. Dalvik Converter
   D. Android Interpretive Compiler (AIC)
v. Required folder when Android project is created.
   A. Build
   B. Build/
   C. Bin
   D. Bin/
vi. Which of the following is not a component of an APK file?
   A. Dalvik executable
   B. Native Libraries
   C. Resources
   D. All of these are components of the APK
vii. Select a component which is NOT part of Android architecture.
   A. Android framework
   B. Libraries
   C. Linux kernel
   D. Android document

13.3.3.4 Tools, Equipment, Supplies and Materials

Software, Emulator, Mobile Device, Android SDK

13.3.3.5 References

- https://www.techopedia.com/definition/6010/application-stack
- https://www.cs.cmu.edu/~bam/uicourse/830spring09/BFeiginMobileApplicationDevelopment.pdf
- https://searchsoftwarequality.techtarget.com/definition/integrated-development-environment
- https://www.techopedia.com/definition/30676/mobile-emulator
- Android Application Development All-in-One For Dummies authored by Barry A. Burd published by John Wiley & Sons Inc., 2015
- Beginning Android Programming With Android Studio (4th edition) authored by Jerome DiMarzio published by Wrox, 2016

13.3.4 Learning Outcome 3: Identify application design issues

13.3.4.1 Learning Activities

The following are the performance criteria:

- Mobile development lifecycle is explained
- Overarching Design principles and Guidelines are explained
- Mobile application navigation patterns are identified
- User interface design is explained

Trainees to demonstrate knowledge in relation to:

- Mobile development lifecycle, Setup, Develop, Test and Debug, Publish
- Overarching Design principles and Guidelines, Platform, Customer Benefit, Device, Scalability etc.
- Mobile application Navigation Patterns - Hamburger Menu, Tab bar, Gesture based

11.3.4.2 Information Sheet

The lifecycle of mobile development is largely no different than the SDLC for web or desktop applications.

Read: Mobile development lifecycle: https://docs.microsoft.com/en-us/xamarin/cross-platform/get-started/introduction-to-mobile-sdlc

Hamburger Menu: Screen space is a precious commodity on mobile, and the hamburger menu (or side drawer) is one of the most popular mobile navigation patterns for helping you save it. The drawer panel allows you to hide the navigation beyond the left edge of the screen and reveal it only upon a user's action.

The tab bar pattern is inherited from desktop design. It usually contains relatively few destinations, and those destinations are of similar importance and require direct access from anywhere in the app.

Read: Mobile application navigation patterns:
https://www.smashingmagazine.com/2017/05/basic-patterns-mobile-navigation/

13.3.4.3 Self-Assessment

i. Explain lifecycle of mobile development?
ii. Explain briefly navigation patterns and give example?
iii. Universal front end to database applications that connects to back end through Internet, are the
   A. Web browsers
   B. Applications
   C. Tools
   D. Software programs
iv. _____ is largely no different than the SDLC for web or desktop applications. The lifecycle of mobile development
   A. Android application
   B. Mobile development
   C. None of the above
   D. Both of the above

13.3.4.4 Tools, Equipment, Supplies and Materials

Graphic user interface GUI, Buildfire, Ionic, software,

13.3.4.5 References

- https://www.smashingmagazine.com/2017/05/basic-patterns-mobile-navigation/
- https://www.corephp.com/blog/mobile-app-development-lifecycle/
- https://medium.com/@soulless/top-8-mobile-navigation-menu-design-for-your-inspiration-8a2d925bffc0
- Android Application Development All-in-One For Dummies authored by Barry A. Burd published by John Wiley & Sons Inc 2015
- Beginning Android Programming With Android Studio authored by Jerome DiMarzio published by Wrox; 4 edition 2016

13.3.5 Learning Outcome 4: Develop mobile application

13.3.5.1 Learning Activities

The following are the performance criteria:

- Appropriate mobile development software is installed
- Creation of the project structure is done by project wizard
- Configuration of the AndroidManifest.XML file is done

- Resources are defined in XML
- Framework components are defined
- SQL lite database is introduced
- Configuration of the Google play SDK is done
- Project prototype is created as per the scope
- Build the project prototype into a debuggable APK
- That can be installed to an emulator or Android powered device

Trainees to demonstrate knowledge in relation to:

- Mobile Application development software: Integrated Development Environment (IDE) , Android SDK Androidmanifest.XML Configuration, Resources defined in XML, Res/Layout, Res/Menu, Res/Value, Res/Drawable
- Framework component: Activity, Services, Broadcast receiver
- Content provider: SDK Configuration, Building and setting up of the Application

11.3.5.2 Information Sheet

Every application must have an AndroidManifest.xml file (with precisely that name) in its root directory. The manifest presents essential information about the application to the Android system; information the system must have before it can run any of the application's code.

Read: App manifest overview
https://developer.android.com/guide/topics/manifest/manifest-intro
https://stuff.mit.edu/afs/sipb/project/android/docs/guide/topics/manifest/manifest-intro.html

XML files that define a user interface **layout.** They are saved in res/layout/ and accessed from the **R.layout** class.

XML files that define application m**enus,** such as an Options Menu, Context Menu, or Sub Menu. They are saved in res/menu/ and accessed from the **R.menu class.**

Read: Android resources: https://www.tutorialspoint.com/android/android_resources.htm

An activity is the entry point for interacting with the user. It represents a single screen with a user interface. For example, an email app might have one activity that shows a list of new emails, another activity to compose an email, and another activity for reading emails.

A service is a general-purpose entry point for keeping an app running in the background for all kinds of reasons. It is a component that runs in the background to perform long-running operations or to perform work for remote processes.

A broadcast receiver is a component that enables the system to deliver events to the app outside of a regular user flow, allowing the app to respond to system-wide broadcast

announcements. Because broadcast receivers are another well-defined entry into the app, the system can deliver broadcasts even to apps that aren't currently running.

A content provider manages a shared set of app data that you can store in the file system, in a SQLite database, on the web, or on any other persistent storage location that your app can access. Through the content provider, other apps can query or modify the data if the content provider allows it.

Read: SDK Configuration:
https://www.ntu.edu.sg/home/ehchua/programming/android/Android_HowTo.html

Read: Building your first app: https://developer.android.com/training/basics/firstapp

13.3.5.3 Self-Assessment

i. What is activity?
ii. What is service?
iii. Explain briefly Resources defined in XML
iv. Differentiate XML and SDK?
v. How Long Does It Take To Build An App?
vi. What Is A Resource?
vii. Create Android program convert Temperature from Celsius to Fahrenheit and Fahrenheit to Celsius?
viii. What happen if we all execute () more than once in Async Task
   A. Nothing will happen
   B. It will create those many threads
   C. It will throw an error
   D. It will throw an execution
ix. ADB is located in platform-tools folder under android-SDK
   A. True
   B. False
x. Can we create a different layout files for portrait and landscape mode?
   A. One cannot create different layout files for portrait and landscape mode
   B. One can create different layout files for portrait and landscape mode
x. A task can have multiple apps?
   A. True
   B. False

13.3.5.4 Tools, Equipment, Supplies and Materials

Software, Computer, Mobile device, Graphic user interface, Emulator

13.3.5.5 References

- https://www.tutorialspoint.com/android/android_resources.htm
- https://developer.android.com/guide/components/fundamentals

- https://www.ntu.edu.sg/home/ehchua/programming/android/Android_HowTo.html
- Android Application Development All-in-One For Dummies authored by Barry A. Burd published by John Wiley & Sons Inc, 2015
- Beginning Android Programming With Android Studio (4th edition) authored by Jerome DiMarzio published by Wrox, 2016

13.3.6 Learning Outcome 5: Test and developed mobile application

13.3.6.1 Learning Activities

The following are the performance criteria:

- Testing techniques and procedures are identified
- Debugging techniques are identified
- Debugging of the application is done

Trainees to demonstrate knowledge in relation to:

- Testing techniques and procedures: Usability testing, Installation testing, Cloud testing etc.
- Definition of debugging
- Debugging techniques

13.3.6.2 Information Sheet

Mobile application testing is a process by which application software developed for handheld mobile devices is tested for its functionality, usability and consistency. Mobile application testing can be an automated or manual type of testing.

Key challenges for mobile application testing

- **Must be downloadable:** The application must be obtainable for the particular platform, generally from an app store.
- **Diversity in mobile platforms/OSes:** There are different mobile operating systems in the market. The major ones are Android, iOS, and Windows Phone. Each operating system has its own limitations.
- **Device availability:** Access to the right set of devices when there is an ever-growing list of devices and operating system versions is a constant mobile application testing challenge. Access to devices can become even more challenging if testers are spread across different locations.
- **Mobile network operators:** There are over 400 mobile network operators in the world; some are CDMA, some GSM, and others use less common network standards like FOMA, and TD-SCDMA.
- **Scripting:** The variety of devices makes executing a test script (scripting) a key challenge. As devices differ in keystrokes, input methods, menu structure and display properties single script does not function on every device.

- **Test method:** There are two main ways of testing mobile applications: testing on real devices or testing on emulators. Emulators often miss issues that can only be caught by testing on real devices, but because of the multitude of different devices in the market, real devices can be expensive to purchase and time-consuming to use for testing.
- **Compatibility:** It is necessary to test the compatibility; suppose an application can work on the high resolution and it doesn't work on the lower resolution.
- **Variety of mobile devices:** Mobile devices differ in screen input methods (QWERTY, touch, normal) with different hardware capabilities.

Testing applications on mobile devices is more challenging than testing web apps on the desktop due to:

- Different range of mobile devices with different screen sizes and hardware configurations like a hard keypad, virtual keypad (touch screen) and trackball etc.
- Wide varieties of mobile devices like HTC, Samsung, Apple and Nokia.
- Different mobile operating systems like Android, Symbian, Windows, Blackberry and IOS.
- Different versions of operation system like iOS 5.x, iOS 6.x, BB5.x, BB6.x etc.
- Different mobile network operators like GSM and CDMA.
- Frequent updates – (like Android- 4.2, 4.3, 4.4, iOS-5.x, 6.x) – with each update a new testing cycle is recommended to make sure no application functionality is impacted.

Types of mobile application testing

- **Functional testing** ensures that the application is working as per the requirements. Most of the tests conducted for this is driven by the user interface and call flow.
- **Laboratory testing**, usually carried out by network carriers, is done by simulating the complete wireless network. This test is performed to find out any glitches when a mobile application uses voice and/or data connection to perform some functions.
- **Performance testing** is undertaken to check the performance and behavior of the application under certain conditions such as low battery, bad network coverage, low available memory, simultaneous access to the application's server by several users and other conditions. Performance of an application can be affected from two sides: the application's server side and client's side. Performance testing is carried out to check both.
- **Memory leakage testing**: Memory leakage happens when a computer program or application is unable to manage the memory it is allocated resulting in poor performance of the application and the overall slowdown of the system. As mobile devices have significant constraints of available memory, memory leakage testing is crucial for the proper functioning of an application.
- **Interrupt testing**: An application while functioning may face several interruptions like incoming calls or network coverage outage and recovery. The different types of interruptions are:
    - Incoming and outgoing SMS and MMS
    - Incoming and outgoing calls
    - Incoming notifications

    - Battery removal
    - Cable insertion and removal for data transfer
    - Network outage and recovery
    - Media player on/off
    - Device power cycle
    - An application should be able to handle these interruptions by going into a suspended state and resuming afterwards.
- **Usability testing** is carried out to verify if the application is achieving its goals and getting a favorable response from users. This is important as the usability of an application is its key to commercial success (it is nothing but user friendliness). Another important part of usability testing is to make sure that the user experience is uniform across all devices. This section of testing hopes to address the key challenges of the variety of mobile devices and the diversity in mobile platforms/OS, which is also called device fragmentation. One key portion of this type of usability testing is to be sure that there are no major errors in the functionality, placement, or sizing of the user interface on different devices.
- **Installation testing:** Certain mobile applications come pre-installed on the device whereas others have to be installed by the store. Installation testing verifies that the installation process goes smoothly without the user having to face any difficulty. This testing process covers installation, updating and uninstalling of an application
- **Certification testing:** To get a certificate of compliance, each mobile device needs to be tested against the guidelines set by different mobile platforms.
- **Security testing** checks for vulnerabilities to hacking, authentication and authorization policies, data security, session management and other security standards.
- **Location testing**: Connectivity changes with network and location.
- **Outdated software testing**: Not everyone regularly updates their operating system. Some Android users might not even have access to the newest version. Professional testers can test outdated software.
- **Load testing:** When many users all attempt to download, load, and use an app or game simultaneously, slow load times or crashes can occur causing many customers to abandon your app, game, or website. In-country human testing done manually is the most effective way to test load.
- **Black box testing** doesn't include the internally coding logic of the application. The tester tests the application with functionality without peering with internally structure of the application. This method of test can be applied virtually to every level of software testing: unit, integration, system and acceptance.
- **Crowdsourced testing:** In recent years, crowdsourced testing has become popular as companies can test mobile applications faster and cheaper using a global community of testers. Due to growing diversity of devices and operating systems as well as localization needs, it is difficult to comprehensively test mobile applications with small in-house testing teams. A global community of testers provides easy access to different devices and platforms. A globally distributed team can also test it in multiple locations and under different network conditions. Finally, localization issues can be tested by hiring testers in

required geographies. Since real users using real devices test the application, this is more likely to find issues faced by users under real world conditions.

Basic Difference Between Mobile And Desktop Application Testing: Few obvious aspects that set mobile app testing apart from the desktop testing

- On the desktop, the application is tested on a central processing unit. On a mobile device, the application is tested on handsets like Samsung, Nokia, Apple, and HTC.
- Mobile device screen size is smaller than a desktop.
- Mobile devices have less memory than a desktop.
- Mobiles use network connections like 2G, 3G, 4G or WIFI where desktop use broadband or dial-up connections.
- The automation tool used for desktop application testing might not work on mobile applications.

Read: Mobile application development and testing:
https://www.softwaretestinghelp.com/beginners-guide-to-mobile-application-testing/

The debugger allows you to control the execution of your application by:

- Setting breakpoints.
- Suspending launched applications.
- Stepping through your code.
- Examining the contents of the variables and view them on an emulator.

The debug types available include the following (android studio):

- Auto (C or C++ code in your project)
- Java
- Native: (Available only with C/C++ code.)
- Dual: (Available only with C/C++ code.) Select if you want to switch between debugging both Java and native code.

Read: Debugging mobile application:
https://docs.oracle.com/cd/E37975_01/doc.111240/e24475/debugging.htm#ADFMF1047
https://www.wavemaker.com/learn/hybrid-mobile/debugging-mobile-apps/
https://developer.android.com/studio/debug

Read: Case study on debugging:
https://www.objc.io/issues/19-debugging/debugging-case-study/

13.3.6.3 Self-Assessment

i. What is debugging?
ii. How is mobile application testing different for different mobile?
iii. You are to prepare a mobile application of online grocery shopping (android). What are the key parameters for testing and debugging?

iv. _____ ensures that the application is working as per the requirements. Most of the tests conducted for the user drives this interface and call flow.

A. Black box testing
B. Functional testing
C. Location testing
D. None of above

v. _____ connectivity changes with network and location.

A. Location testing
B. Installation testing
C. Testing
D. Program testing

13.3.6.4 Tools, Equipment, Supplies and Materials

Computer, software

11.3.6.5 References

- https://www.softwaretestinghelp.com/beginners-guide-to-mobile-application-testing/
- https://docs.oracle.com/cd/E37975_01/doc.111240/e24475/debugging.htm#ADFMF1047
- Android Application Development All-in-One For Dummies authored by Barry A. Burd published by John Wiley & Sons Inc., 2015
- Beginning Android Programming With Android Studio (4th edition) authored by Jerome DiMarzio published by Wrox, 2016

13.3.7 Learning Outcome 6: Publish and commercialize the developed application

13.3.7.1 Learning Activities

The following are the performance criteria:

- Application distribution through application stores is done
- Monetizing applications through mobile money APIs is done.
- Routine upgrading, and patching of the application is done.

Trainees to demonstrate knowledge in relation to:

- Application distribution through application stores
- Monetizing applications through mobile money APIs
- Upgrading and patching of the application

13.3.7.2 Information Sheet

The idea of an enterprise application store arose in response to consumer-oriented app stores, such as Apple's App Store and Google Play. By deploying corporate software through an app store, an information technology (IT) department can manage desktop, mobile, cloud and Web app software licenses (EULAs) and maintain a level of control over security.

API monetization is the process by which businesses create revenue from their application programming interfaces (APIs). APIs are the cornerstone of what is widely seen as the next iteration of business development, where having well-developed APIs establishes and maintains relationships in a digital economy. APIs are the wholesale version of a web presence, allowing others to access and integrate your data and resources into their public or private sites and applications.

Read: API Monetizing: https://www.redhat.com/en/topics/api/what-is-api-monetization

An update to an application can be provided to users as a Windows **Installer patch package**. A patch can contain an entire file or only the file bits necessary to update part of a file.
A patch is a software update comprised code inserted (or patched) into the code of an executable program. Typically, a patch is installed into an existing software program. Patches are often temporary fixes between full releases of a software package. Patches may do any of the following:

- Fix a software bug
- Install new drivers
- Address new security vulnerabilities
- Address software stability issues
- Upgrade the software

13.3.7.3 Self-Assessment

i. What is API?

ii. Define application distribution through application stores

iii. _____ is the process by which businesses create revenue from their application programming interfaces (APIs).
   A. API terminal
   B. API monetization
   C. API content
   D. None of above

iv. You are mobile developer and your client ask you to cerate for him a e-commerce mobile application and he wanted users to pay through mobile money how will you do it?

v. _____ is a software update comprised code inserted into the code of an executable program.
   A. Enterprise application
   B. Patch
   C. Update
   D. Upgrade
   E. None of above

13.3.7.4 Tools, Equipment, Supplies and Materials

SolarWinds Patch Manager, LANDesk Patch Manager, REST-Assured

11.3.7.5 References

- https://docs.microsoft.com/en-us/windows/desktop/msi/patching-and-upgrades
- https://www.redhat.com/en/topics/api/what-is-api-monetization
- Android Application Development All-in-One For Dummies authored by Barry A. Burd published by John Wiley & Sons Inc 2015
- Beginning Android Programming With Android Studio authored by Jerome DiMarzio published by Wrox; 4 edition 2016

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%20Systems.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

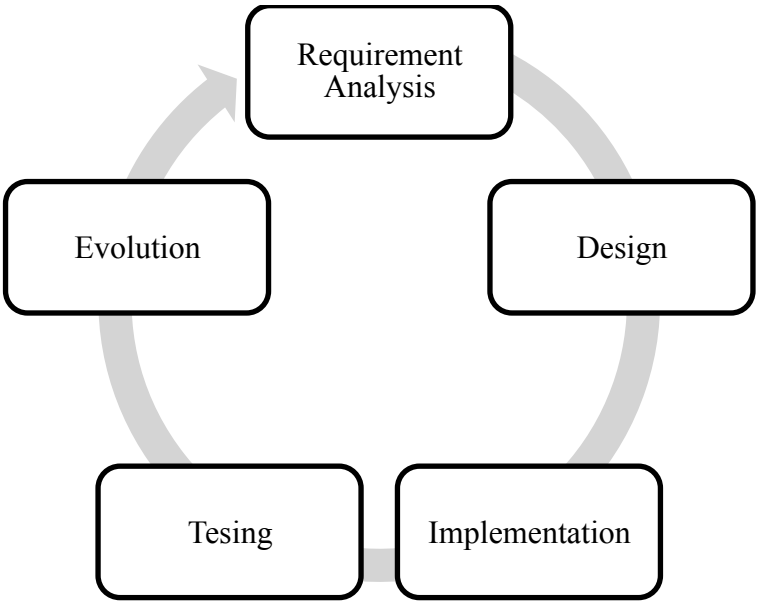
Trainees to demonstrate knowledge in relation to:

- 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:

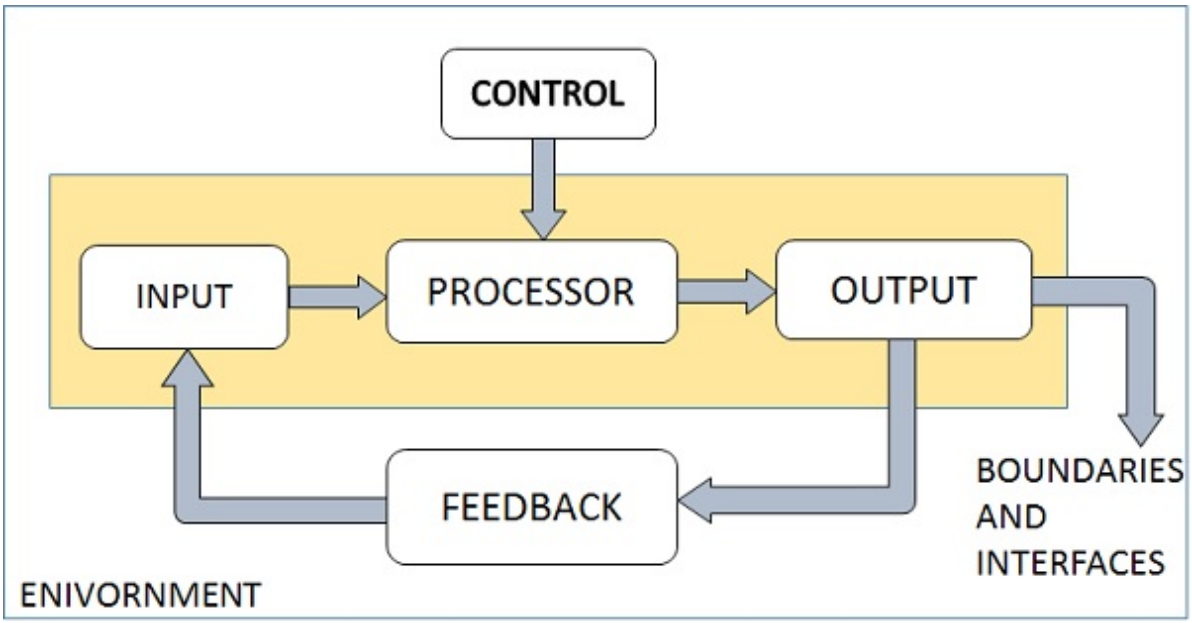
- Overview of system analysis is done.
- Attributes of structured analysis are identified
- Tools and techniques of system analysis are identified.
- Activities performed during System analysis are identified

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

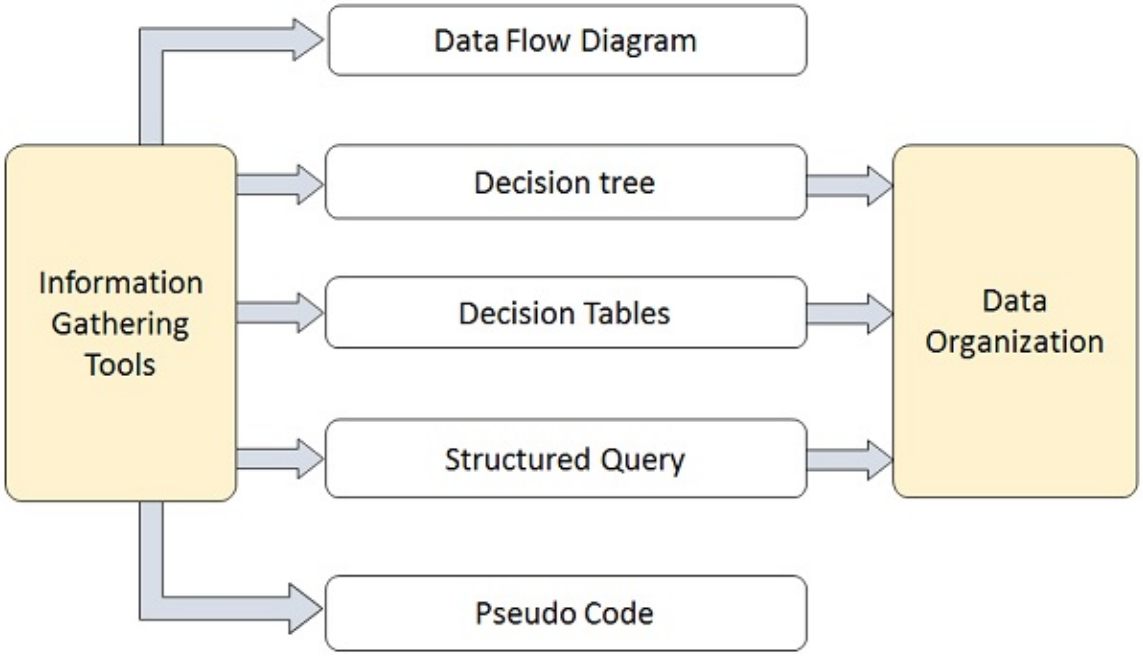
A **systems analyst** is a person who uses analysis and design techniques to solve business problems using information technology. Systems analysts may serve as change agents who identify the organizational improvements needed, design systems to implement those changes, and train and motivate others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

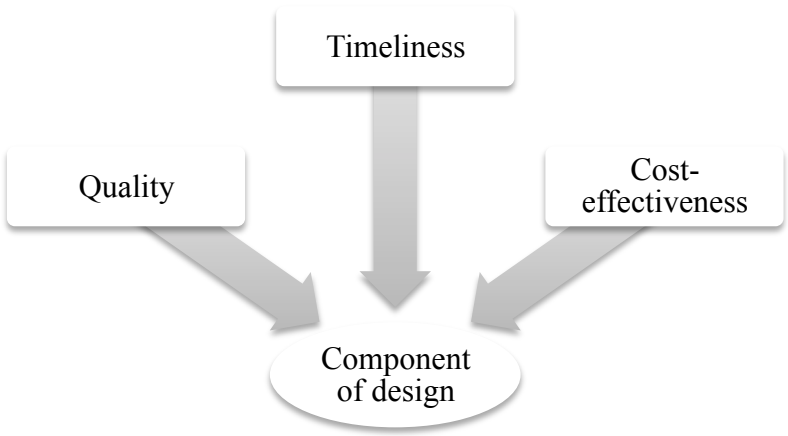


Figure 100: Components of system design
Read: Components of system design: https://info.knowledgeleader.com/the-3-components-of-a-successful-systems-design
https://medium.com/the-andela-way/system-design-in-software-development-f360ce6fcbb9

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 filed-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 on 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

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