

Computer Science S5

Teacher's Guide

Copyright
©2024 Rwanda Basic Education Board

All rights reserved
This book is property of the Government of Rwanda.
Credit must be given to REB when the content is quoted.

FOREWORD

Dear teacher,

Rwanda Basic Education Board is honoured to present Senior 5 Computer Science teacher's guide which serves as a guide to competence-based teaching and learning to ensure consistency and coherence in the learning of the computer science subject. The Rwandan educational philosophy is to ensure that learners achieve full potential at every level of education which will prepare them to be well integrated in society and exploit employment opportunities.

In line with efforts to improve the quality of education, the government of Rwanda emphasizes the importance of aligning teaching and learning materials with the syllabus to facilitate their learning process. Many factors influence what they learn, how well they learn and the competences they acquire. Those factors include the relevance of the specific content, the quality of teachers' pedagogical approaches, the assessment strategies and the instructional materials available. Special attention was paid to the activities that facilitate the learning process in which learners can develop ideas and make new discoveries during concrete activities carried out individually or with peers. With the help of the teachers, learners will gain appropriate skills and be able to apply what they have learnt in real life situations. Hence, they will be able to develop certain values and attitudes allowing them to make a difference not only to their own lives but also to the nation.

This is in contrast to traditional learning theories which view learning mainly as a process of acquiring knowledge from the more knowledgeable who is mostly the teacher. In competence-based curriculum, learning is considered as a process of active building and developing of knowledge and understanding, skills, values and attitudes by the learner, where concepts are mainly introduced by an activity, situation or scenario that helps the learner to construct knowledge, develop skills and acquire positive attitudes and values.

In addition, such active learning engages learners in doing things and thinking about the things they are doing. They are encouraged to bring their own real experiences and knowledge into the learning processes. In view of this, your role is to:

- Plan your lessons and prepare appropriate teaching materials.
- Organize group discussions for learners considering the importance of social constructivism suggesting that learning occurs more effectively when the learner works collaboratively with more knowledgeable and experienced people.
- Engage learners through active learning methods such as inquiry methods, group discussions, research, investigative activities and group and individual work activities.
- Provide supervised opportunities for learners to develop different competences by

giving tasks which enhance critical thinking, problem solving, research, creativity and innovation, communication and cooperation.

- Support and facilitate the learning process by valuing learners' contributions in the class activities.
- Guide learners towards the harmonization of their findings.
- Encourage individual, peer and group evaluation of the work done in the classroom and use appropriate competence-based assessment approaches and methods.

To facilitate you in your teaching activities, the content of this teacher's guide is self-explanatory so that you can easily use it. It is divided in 3 parts:

The part 1: Explains the structure of this book and gives you methodological guidance;

The part 2: Gives the sample lesson plans as reference for your lesson planning process;

The part 3: Provides details the teaching guidance for each concept given in the student book.

Even though this teacher's guide contains the answers for all activities given in the learner's book, you are requested to work through each question and activity before judging learner's findings.

I wish to sincerely appreciate all people who contributed towards the development of this teacher's guide, particularly REB staff who organized the whole process from its inception. Special gratitude goes to the University of Rwanda which provided experts in design and layout services, illustrations and image anti-plagiarism, lecturers and teachers who diligently worked to successful completion of this book. Any comment or contribution would be welcome for the improvement of this Teacher's guide for the next edition.



Dr. MBARUSHIMANA Nelson

Director General, REB



ACKNOWLEDGEMENT

I wish to express my appreciation to all the people who played a major role in development of this Computer science teacher’s book for senior five. It would not have been successful without active participation of different education stakeholders.

I owe gratitude to different Universities and schools in Rwanda that allowed their staff to work with REB in the in-house textbooks production project. I wish to extend my sincere gratitude to lecturers, teachers and all other individuals whose efforts in one way or the other contributed to the success of writing of this textbook.

Special acknowledgement goes to the University of Rwanda which provided experts in design and layout services, illustrations and image anti-plagiarism.

Finally, my word of gratitude goes to the Rwanda Basic Education Board staff particularly those from the Curriculum, Teaching and Learning Resources Department (CTLR) who were involved in the whole process of in-house textbook writing.



Joan MURUNGI,

Head of Department CTLR

Contents

FOREWORD.....	iii
ACKNOWLEDGEMENT	v
PART I. GENERAL INTRODUCTION	xii
1.0. About the teacher’s guide.....	xii
1.1. The structure of the guide.....	xii
1.2. Methodological guidance.....	xiv
1.2.1. Developing competences.....	xiv
1.2.2. Attention to special educational needs and inclusive education.....	xvii
1.2.3. Guidance on assessment.....	xix
1.3. Guidance on assessment.....	xix
1.3.1. Students’ learning styles and strategies to conduct teaching and learning process.....	xix
1.3.2. Teaching methods and techniques that promote the active learning.....	xx
PART II. SAMPLE LESSON PLAN.....	xxv
III: UNIT DEVELOPMENT.....	xxviii
Unit 1: FUNDAMENTAL OF LAPTOP AND PORTABLE DEVICES.....	1
1.1. Key Unit Competence.....	1
1.2. Prerequisite knowledge and skills.....	1
1.3. Cross-cutting issues to be addressed.....	1
1.4. Guidance on the introductory activity.....	1
1.5. List of lessons.....	3
Unit 2: DATA STRUCTURE AND ALGORITHM	29
2.1. Key unit competence.....	29
2.2. Prerequisite knowledge and skills	29
2.3. Cross-cutting issues to be addressed.....	29
2.4. Guidance on the introductory activity.....	29
2.5. List of lessons.....	30
UNIT 3: INTRODUCTION TO COMPUTER NETWORK.....	49
3.1. Key Unit Competence.....	49

3.2. Prerequisite knowledge and skills.....	49
3.3. Cross-cutting issues to be addressed.....	49
3.4. Guidance on the introductory activity.....	49
3.5. List of lessons.....	51
3.6. Unit summary.....	64

UNIT 4: INTRODUCTION TO DATABASE.....71

4.1. Key Unit Competency.....	71
4.2. Prerequisite knowledge and skills:.....	71
4.3. Cross-cutting issues to be addressed:.....	71
4.4. Guidance on the introductory activity	71
4.5. List of lessons including assessment.....	72
4.6. Unit summary.....	83
4.7. Addition of information.....	84
4.8. End unit Assessment Answer.....	87
4.9. Additional activity.....	88

UNIT 5: DATABASE DESIGN 93

5.1. Key unit competence.....	93
5.2. Prerequisite/ Knowledge/skills.....	93
5.3. Cross-Cutting Issues to be addressed.....	93
5.4. Introductory Activity.....	93
5.5. Lst of lessons.....	94
5.6. Summary of the Unit.....	110
5.7. Additional information.....	110
5.8. Answers of End of unit.....	110
1.2.1. Remedial activities and answers.....	112
1.2.5. Consolidation activities and answers.....	113

UNIT 6: POINTERS AND STRUCTURES IN C++.....121

6.1. Key Unit Competence.....	121
6.2. Prerequisite knowledge and skills.....	121
6.3. Cross-cutting issues to be addressed.....	121
6.4. Guidance on the introductory activity.....	121
6.5. List of lessons.....	122
6.6. Summary of the Unit.....	130
6.7. Addition information.....	130

6.8. Answers of End Unit Assessment answers	131
6.9. Additional activities	133
6.9.1. Remedial Activities	133
6.9.2. Consolidation activities	134
6.9.3. Extended	134

UNIT 7: OBJECT ORIENTED PROGRAMMING IN C++.....137

7.1. Key Unit Competence.....	137
7.2. Prerequisite knowledge and skills.....	137
7.3. Cross-cutting issues to be addressed.....	137
7.4. Guidance on the introductory activity.....	137
7.5. List of lessons (including assessment).....	140
7.6. Summary of the Unit.....	160
7.7. Addition information for teachers.....	162
7.8. End unit assessment answers.....	162
7.9. Additional activities.....	167
7.9.1. Remedial activities.....	167
7.9.2. Consolidation activities.....	169
7.9.3. Extended activities.....	171

UNIT 8: INTRODUCTION TO VISUAL BASIC.....175

8.1. Key Unit Competency:	175
8.2. Prerequisite knowledge and skills:	175
8.3. Cross-cutting issues to be addressed:	175
8.4. Guidance on the introductory activity	175
8.5. List of lessons.....	176
8.6. Additional activities.....	193
8.6.1. Remedial activities.....	193
8.6.2. Consolidation activities.....	194

UNIT 9: VARIABLES, OPERATORS, EXPRESSIONS AND CONTROL STRUCTURES.....199

9.1. Key Unit Competency:	199
9.2. Prerequisite knowledge and skills:.....	199
9.3. Cross-cutting issues to be addressed:.....	199
9.4. Guidance on the introductory activity.....	199
9.5. List of lessons.....	200

9.6. Unit summary.....	223
9.7. End unit assessment:.....	225
9.8. Additional activities.....	228
9.8.1. Remedial Activities.....	228
9.8.2. Consolidation activities.....	229
9.8.2. Extended activities.....	230
UNIT 10: INTRODUCTION TO JAVA.....	231
10.1. Key Unit Competency:.....	231
10.2. Prerequisite knowledge and skills:.....	231
10.3. Cross-cutting issues to be addressed.....	231
10.4. Guidance on the introductory activity.....	231
10.5. List of lessons.....	232
10.6. Unit summary.....	245
10.7. Addition information.....	246
10.8. End unit assessment.....	248
10.9. Additional activities.....	250
10.9.1. Remedial Activities:.....	250
10.9.2. Consolidation activities.....	250
UNIT 11: OOP AND JAVA.....	253
11.1. Key Unit Competence.....	253
11.2. Prerequisite knowledge and skills.....	253
11.3. Cross-cutting issues to be addressed:.....	253
11.4. Guidance on the introductory activity.....	253
11.5. List of lessons.....	255
11.6. Summary of the unit.....	269
11.7. Additional Information.....	270
11.8. Answers to end unit assessment.....	271
11.9. Additional activities.....	273
11.9.1. Remedial Activities.....	273
11.9.2. Consolidation activities:.....	273
11.9.3. Extended activities.....	275
UNIT 12: IO AND JAVA.....	277
12.1. Key unit competence:.....	277

12.2. Prerequisite.....	277
12.3. Cross-cutting issues to be addressed:.....	277
12.4. Guidance on the introductory activity:.....	277
12.5. List of lessons.....	278
12.6. Unitsummary.....	286
12.7. AdditionalInformation.....	287
12.8. End unit assessment.....	287
12.9. Additional activities.....	289
12.9.1. RemedialActivities.....	289
12.9.2. Consolidation activities.....	290
12.9.3. Extended activities.....	291
REFERENCES	293

PART I. GENERAL INTRODUCTION

1.0. About the teacher's guide

This book is a teacher's guide for computer science Senior Five in advanced level. It is designed to help teachers in the implementation of competence based curriculum specifically computer science syllabus.

As suggested by its name, this is a guide that will help teachers in their daily preparations of lessons. Teachers will take advice provided for in this book but are advised to be more creative and consider their specific classes' contexts and prepare accordingly.

1.1. The structure of the guide

This section outlines the general structure whereby the content is organized in units and the sub-heading structure in order to provide to teachers more understanding of the different sections of this guide and what they should expect to find in each section.

- **Overall structure**

This consists of three main parts:

- ❖ **Part I: General Introduction.**

This part provides general guidance on how to develop the generic competences, how to integrate cross cutting issues, how take into consideration special educational needs, active methods and techniques of teaching computer science and guidance on assessment.

- ❖ **Part II: Sample lesson plan**

This provides to teachers a model lesson plan that they can learn from in dividing their own lesson plans.

- ❖ **Part III: Unit development**

This is the main part of the guide in which each unit is thoroughly developed. The guide ends with references.

Each unit is made of the following sections:

- **Unit title:** from the syllabus
- **Key unit competence:** from the syllabus
- **Prerequisites (knowledge, skills, attitudes and values)**

The section indicates knowledge, skills and attitudes required for the successful carrying out of the unit. The competence-based approach requires connections between units/ topics within a

subject and interconnections between different subjects. The teacher will find an indication of those prerequisites and guidance on how to establish connections.

- **Cross-cutting issues to be addressed**

This section suggests cross cutting issues that can be integrated depending on the unit content. It gives guidance on how to integrate those issues. The suggested issues are indicative and teachers are free to take any other cross-cutting issue which is related to the learning environment.

- **Guidance on the introductory activity**

Each unit begins with an introductory activity in the learner’s book. This section of the teacher’s guide provides guidance on how to conduct this activity and related answers.

Learners are not expected to necessarily give right solutions but are invited to provide possible solutions or answers through discovery activities organized at the beginning of lessons or during the lesson.

- **List of lessons**

The section of “list of lessons” provides a suggestion on the list of lessons, lesson objectives

copied or adapted from the syllabus and duration for each lesson. Each lesson / subheading is then developed.

- **End of each unit**

At the end of each unit the teacher’s guide provides the following sections:

- Summary of the unit which provides the key points of content developed in the student’s book.
- Additional information which provides additional content compared to the student’s book for the teacher to have a deeper understanding of the topic.
- End unit assessment which provides the answers to questions of end unit assessment in the textbook and suggests additional questions and related answers to assess the key unit competence.
- Additional activities: remedial, consolidation and extended activities). The purpose of these activities is to accommodate each learner (slow, average and gifted) based on end unit assessment results.

Structure of each sub heading

Each lesson/sub-heading is made of the following sections:

Lesson Sub heading title 1:

- **Prerequisites/Revision/Introduction:**

The section provides clear instruction to teachers on how to begin the lesson

- **Teaching resources**

This section provides suggestions on the teaching aid or other resources needed with activities in order to achieve the learning objectives. Teachers have full ownership of which teaching aid they can use depending on those available in their working environment.

- **Learning activities**

This section provides a short description of the methodology and any important aspect to consider. It provides also answers to learning activities with cross reference to text book:

- **Exercises/application activities**

This provides questions and answers for exercises/ application activities/

1.2. Methodological guidance

1.2.1. Developing competences

Since the introduction of the competency based curriculum for pre-primary, primary and general secondary education in 2015 Rwanda shifted from to the knowledge based system to new way of teaching and learning which put the learner at the center. In this new approach teachers are not only responsible for the transfer of knowledge but also for enhancing student's learning achievement, and creating safe and supportive learning environment. It implies also that a learners will have to show what they are able to do using the knowledge, skills, values and attitude acquired in a new or different situation.

The competence-based curriculum approach bases teaching and learning on discrete skills rather than relying on only knowledge or the cognitive domain of learning. It puts an emphasis on what learners can do rather than what they know. Learners develop basic competences through specific subject unit competences with specific learning objectives broken down into knowledge, skills and attitudes. These competences are developed through learning activities disseminated in learner-centered rather than the traditional didactic approach. The student is evaluated against set standards to achieve before moving on.

Adding to specific subject competences, learners also get an opportunity to develop

generic competences which are transferable throughout a range of learning areas and situations in life. Below are examples of how generic competences can be developed in Computer Science:

Generic competence	Examples of activities that develop generic competences
Critical thinking	<ul style="list-style-type: none"> • Compare the protected computer to the computer exposed to various security threats • Demonstrate advantage of a computer network, having a database in a school or an institution.
Research and Problem solving	<ul style="list-style-type: none"> • Research using internet or books from the library • Build a computer network by responding the initial request. • Design and develop a website or an application software for his/her school or institution. • Demonstrate strategies that can be used to disinfect the computer or network attacked by threats.
Innovation and creativity	<ul style="list-style-type: none"> • Translate the algorithms in a computing program • Identify local computing problems and ways to resolve them.
Cooperation, Personal and Interpersonal management and life skills	<ul style="list-style-type: none"> • Sharing resources on the network, emails • Protecting his/her own data and school or institution data to. • Work in Pairs • Small group work • Large group work
Communication	<ul style="list-style-type: none"> • Organise and present in writing and verbally a complete and clear report of their computing activities • Develop accurate diagrams for networks topology, model • Design with talking diagram a database of the school. • Select and use appropriate formats and presentations, such as tables, graphs and diagrams.
Lifelong learning	<ul style="list-style-type: none"> • Exploit all opportunities available to improve on knowledge and skills. Use open source technologies and other digital materials to keep informed.

Among the changes in the competence based curriculum is the integration of cross cutting issues as an integral part of the teaching learning process-as they relate to and must be considered within all subjects to be appropriately addressed. The eight cross cutting issues identified in the national curriculum framework are: genocide studies,

environment and sustainability, gender, Comprehensive Sexuality Education (CSE), Peace and Values Education, Financial Education, standardization Culture and Inclusive Education.

Some cross cutting issues may seem specific to particular learning areas or subjects but the teacher need to address all of them whenever an opportunity arises. In addition, learners should always be given an opportunity during the learning process to address these cross cutting issues both within and out of the classroom so as to progressively develop related attitudes and values.

Below are examples on how crosscutting issues can be addressed in Computer Science:

Cross-cutting issue	Examples on how to integrate the cross-cutting issue
Inclusive education	<p>Involve all learners in all activities without any bias.</p> <p>Eg:</p> <ul style="list-style-type: none"> • Allow a learner with physical disability (using wheelchair) to take notes or lead the team during computer lab activities. • Student without arms can learn computer science using their toes. • Sign language can be used to address the need of students with hearing impairments.
Gender	<ul style="list-style-type: none"> • Involve both girls and boys in all activities: No activity is reserved only to girls or boys. • Teachers should ensure equal participation of both girls and boys during computing activities as well as during cleaning and tidying up related activities after computer lab activities.
Peace and Values Education	<ul style="list-style-type: none"> • During group activities, debates and presentations, the teacher will encourage learners to help each other and to respect opinions of colleagues. • Students must be warned about cyber security crimes and enabled to prevent hacking and stealing one’s data or prevent unauthorised access of data of a person or institution. • Student must develop values of browsing relevant content on the internet (students should not spend their time browsing irrelevant and harmful content website.
Standardization culture	<ul style="list-style-type: none"> • Students should be familiar with standards used in network technologies in their daily interaction with different tools used in networking. • For tasks involving calculations, they have to always present accurate results.

Financial Education	<ul style="list-style-type: none"> • Student should develop this by comparing the use of digital technologies with the traditional paper based practices. • Eg. Compare the cost of sharing a 100 pages document on the network of 50 users and printing 50 copies of 100 pages on individual copy. • Different technologies used in networking should be an opportunity to study cost implication of individual technology. • Students do analysis of financial benefits of having a database. • Students must be aware of loss that can be caused by lacking security in computing.
---------------------	--

1.2.2. Attention to special educational needs and inclusive education

In the classroom, students learn in different way depending to their learning pace, needs or any other special problem they might have. However, the teacher have the responsibility to know how to adopt his/her methodologies and approaches in order to meet the learning needs of each student in the classroom. Also teachers need to understand that student with special needs, have to be taught differently or need some accommodations to enhance the learning environment. This will be done depending to the subject and the nature of the lesson.

In order to create a well-rounded learning atmosphere, teachers need to:

- Remember that students learn in different ways so they have to offer a variety of activities (e.g. role-play, music and singing, word games and quizzes, and outdoor activities)
- Maintain an organized classroom and limits distraction. This will help students with special needs to stay on track during lesson and follow instruction easily.
- Vary the pace of teaching to meet the needs of each students. Some students process information and learn more slowly than others;
- Break down instructions into smaller, manageable tasks. Students with special needs often have difficulty understanding long-winded or several instructions at once. It is better to use simple, concrete sentences in order to facilitate them understand what you are asking;
- Use clear consistent language to explain the meaning (and demonstrate or show pictures) if you introduce new words or concepts;
- Make full use of facial expressions, gestures and body language;
- Pair a student who has a disability with a friend. Let them do things together and learn from each other. Make sure the friend is not over protective. Both students will benefit from this strategy;
- Use multi-sensory strategies. As all students learn in different ways, it is important to make every lesson as multi-sensory as possible. Learners with learning disabilities might have difficulty in one area, while they might excel in another. For example, use both visual and auditory cues.

Below are general strategies related to each main category of disabilities and how to deal with every situation that may arise in the classroom. However, the list is not exhaustive because each student is unique with different needs and that should be handled differently.

Strategy to help a learner with developmental impairment:

- Use simple words and sentences when giving instructions.
- Use real objects that students can feel and handle. Rather than just working abstractly with pen and paper.
- Break a task down into small steps or learning objectives. The student should start with an activity that s/he can do already before moving on to something that is more difficult.
- Gradually give the student less help.
- Let the student work in the same group with those without disability.

Strategy to help a student with visual impairment:

- Help students to use their other senses (hearing, touch, smell and taste) to play and carry out activities that will promote their learning and development.
- Use simple, clear and consistent language.
- Use tactile objects to help explain a concept.
- If the student has some sight, ask him/her what he/she can see.
- Make sure the student has a group of friends who are helpful and who allow him/ her to be as independent as possible.
- Plan activities so that students work in pairs or groups whenever possible

Strategies to help a student with hearing disabilities or communication difficulties:

- Always get the student's attention before you begin to speak.
- Encourage the student to look at your face.
- Use gestures, body language and facial expressions.
- Use pictures and objects as much as possible.
- Keep background noise to a minimum.

Strategies to help a student with physical disabilities or mobility difficulties:

- Adapt activities so that students who use wheelchairs or other mobility aids, can participate.
- Ask parents/caregivers to assist with adapting furniture e.g. The height of a table may need to be changed to make it easier for a student to reach it or fit their legs or wheelchair under.
- Get advice from parents or a health professional about assistive devices.

1.2.3. Guidance on assessment

Each unit in the teacher’s guide provides additional activities to help learners achieve the key unit competence. Results from assessment inform the teacher which learner needs remedial, consolidation or extension activities. These activities are designed to cater for the needs of all categories of learners; slow, average and gifted learners respectively.

1.3. Guidance on assessment

Assessment is an integral part of teaching and learning process. The main purpose of assessment is for improvement. Assessment for learning/ **Continuous/ formative assessment** intends to improve learners’ learning and teacher’s teaching whereas assessment of learning/summative assessment intends to improve the entire school’s performance and education system in general.

Continuous/ formative assessment

It is an ongoing process that arises out of interaction during teaching and learning process. It includes lesson evaluation and end of sub unit assessment. This formative assessment should play a big role in teaching and learning process. The teacher should encourage individual, peer and group evaluation of the work done in the classroom and uses appropriate competence-based assessment approaches and methods.

In Senior Five computer science textbook, formative assessment principle is applied through checking up activities that are planned in each lesson to ensure that lesson objectives are achieved before moving on. At the end of each unit, the end unit assessment is formative when it is done to give information on the progress of students and from there decide what adjustments need to be done. Assessment standards are taken into consideration when setting tasks.

Summative assessment

The assessment done at the end of the term, end of year, is considered as summative. The teacher, school and parents are informed on the achievement of educational objectives and think of improvement strategies. There is also end of level/ cycle assessment in form of national examinations.

1.3.1. Students’ learning styles and strategies to conduct teaching and learning process

There are different teaching styles and techniques that should be catered for. The selection of teaching method should be done with the greatest care and some of the factors to be considered are: the uniqueness of subjects; the type of lessons; the particular learning objectives to be achieved; the allocated time to achieve the objective; instructional available materials; the physical/sitting arrangement of the classroom, individual students’ needs, abilities and learning styles.

There are mainly four different learning styles as explained below:

a. Active and reflective learners

Active learners tend to retain and understand information best by doing something active with it, discussing or applying it or explaining it to others. Reflective learners prefer to think about it quietly first.

b. Sensing and intuitive learners

Sensing learners tend to like learning facts; intuitive learners often prefer discovering possibilities and relationships. Sensors often like solving problems by well-established methods and dislike complications and surprises; intuitive learners like innovation and dislike repetition.

c. Visual and verbal learners

Visual learners remember best what they see—pictures, diagrams, flow charts, time lines, films, demonstrations, etc.; verbal learners get more out of words—written and spoken explanations.

d. Sequential and global learners

Sequential learners tend to gain understanding in linear steps, with each step following logically from the previous one. Global learners tend to learn in large jumps, absorbing material almost randomly without seeing connections, and then suddenly “getting it.”

1.3.2. Teaching methods and techniques that promote the active learning

The different student learning styles mentioned above can be catered for, if the teacher uses active learning whereby learners are really engaged in the learning process.

What is Active learning?

Active learning is a pedagogical approach that engages students in doing things and thinking about what they are doing. In active learning, learners are encouraged to bring their own experience and knowledge into the learning process.

The role of the teacher in active learning

- The teacher engages learners through active learning methods such as inquiry methods, group discussions, research, investigative activities and group and individual work activities.
- He/she encourages individual, peer and group evaluation of the work done in the classroom and uses appropriate competence-based assessment approaches

and methods.

- He provides supervised opportunities for learners to develop different competences by giving tasks which enhance critical thinking, problem solving, research, creativity and innovation, communication and cooperation.
- Teacher supports and facilitates the learning process by valuing learners' contributions in the class activities.

The role of learners in active learning

Learners are key in the active learning process. They are not empty vessels to fill but people with ideas, capacity and skills to build on for effective learning. A learner engaged in active learning:

- Communicates and shares relevant information with other learners through presentations, discussions, group work and other learner-centred activities (role play, case studies, project work, research and investigation)
- Actively participates and takes responsibility for their own learning
- Develops knowledge and skills in active ways
- Carries out research/investigation by consulting print/online documents and resourceful people, and presents their findings
- Ensures the effective contribution of each group member in assigned tasks through clear explanation and arguments, critical thinking, responsibility and confidence in public speaking
- Draws conclusions based on the findings from the learning activities.

Some active techniques that can be used in computer Science

The teaching methods strongly emphasised in the competence Based Curriculum (CBC) are active methods.

When a teacher is planning his/her lesson, he/she should establish criteria for performance and behaviour changes at the beginning of a unit. Then at the of end of every unit, the teacher should ensure that all the learners have mastered the stated key unit competences basing on the criteria stated, before going to the next unit. The teacher will assess how well each learner masters both the subject and the generic competences described in the syllabus and from this, the teacher will gain a picture of the all-round progress of the learner. The teacher will use one or a combination of the following: : a) Manipulation, (b)Computer and task/practice (c) observation, (d) pen and paper, and (e) oral questioning

A. Computing activities

Many of the activities suggested in the computer science curriculum as well as in the student's book are practical activities and projects.

Practical activities are mandatory in learning computer science; this method gives the learner the opportunity to implement a series of activities and leads to the development of both cognitive and hands-on skills.

A practical lesson is done in following stages:

- **Preparation:** Checking materials, computers and install required programs to ensure they are available and at good state; try the activity before the lesson; think of safety rules and give instructions to lab technician if you have any.
- **Performance:** Arrangement of students and hand-on of individual student. Preparing the next generation of experts in the field of computer science require student to experience what they are learning; Let the students perform and facilitate accordingly.
- **Debugging:** In computer Science student may not arrive at the desired output, inspire him/her to debug from his/her own work without starting from scratch where applicable.
- **Discussion:** Student should discuss what they are doing and challenges they are facing. they should discuss also the implications of the results of their activities.

In some cases, demonstration by the teacher is recommended when for example the activity requires the use of sophisticated materials or very expensive materials or when safety is a major factor like disassembling a laptop in laboratory and it needs specific skills to be learnt first.

In case your school does not have enough computers, activities and projects can be done in groups but make sure every student participates.

B. Research work

Each learner or group of learners is given a research topic. They have to gather information from internet, available books in the library or ask experienced people and then the results are presented in verbal or written form and discussed in class.

C. Computer Based project

Computer science teachers are encouraged to sample and prepare project works and engage their students in, as many as possible. Learners in groups or individually, are engaged in a self-directed work for an extended period of time to investigate and respond to a complex question, problem, or challenge. The work can be presented to classmates or other people beyond the school. Projects are based on real-world problems that capture learners' interest. This technique develops higher order thinking as the learners acquire and apply new knowledge in a problem-solving context.

There are project proposed in different topic area programming, database and network that students must perform to show what they learnt can be put into real life situations.

D. Field trip

One of the main aims of teaching Computer science in Rwanda is to apply its knowledge for development. Students may visit an computer related work or equipments in an institution around the school to satisfy their inquiries and curiosity.

Main steps for a lesson in active learning approach

All the principles and characteristics of the active learning process highlighted above are reflected in steps of a lesson as displayed below. Generally the lesson is divided into three main parts whereby each one is divided into smaller steps to make sure that learners are involved in the learning process. Below are those main part and their small steps:

1. Introduction

Introduction is a part where the teacher makes connection between the current and previous lesson through appropriate technique. The teacher opens short discussions to encourage learners to think about the previous learning experience and connect it with the current instructional objective. The teacher reviews the prior knowledge, skills and attitudes which have a link with the new concepts to create good foundation and logical sequencings.

2. Development of the new lesson

The development of a lesson that introduces a new concept will go through the following small steps: discovery activities, presentation of learners' findings, exploitation, synthesis/summary and exercises/application activities, explained below:

❖ Discovery activity

Step 1

- The teacher discusses convincingly with students to take responsibility of their learning
- He/she distributes the task/activity and gives instructions related to the tasks (working in groups, pairs, or individual to instigate collaborative learning, to discover knowledge to be learned)

Step 2

- The teacher let the students work collaboratively on the task.
- During this period the teacher refrains to intervene directly on the knowledge
- He/she then monitors how the students are progressing towards the knowledge to be learned and boost those who are still behind (but without communicating to them the knowledge).

❖ **Presentation of learners' productions**

- In this episode, the teacher invites representatives of groups to presents the students' productions/findings.
- After three/four or an acceptable number of presentations, the teacher decides to engage the class into exploitation of the students' productions.

❖ **Exploitation of learner's productions**

- The teacher asks the students to evaluate the productions: which ones are correct, incomplete or false
- Then the teacher judges the logic of the students' products, corrects those which are false, completes those which are incomplete, and confirms those which correct.

❖ **Institutionalization (summary/conclusion/ and examples)**

- The teacher summarises the learned knowledge and gives examples which illustrate the learned content.

❖ **Exercises/Application activities**

- Exercises of applying processes and products/objects related to learned unit/sub-unit
- Exercises in real life contexts
- Teacher guides learners to make the connection of what they learnt to real life situations. At this level, the role of teacher is to monitor the fixation of process and product/object being learned.

3. Assessment

In this step the teacher asks some questions to assess achievement of instructional objective. During assessment activity, learners work individually on the task/activity. The teacher avoids intervening directly. In fact, results from this assessment inform the teacher on next steps for the whole class and individuals. In some cases the teacher can end with a homework assignment.

PART II. SAMPLE LESSON PLAN

School Name:

Teacher's name:

Term	Date	Subject	Class	Unit N°	Lesson N°	Duration	Class size
Term 1	14 /02/ 2018	Computer Science	S5	3	1 of 9	80 minutes	40
Type of Special Educational Needs to be catered for in this lesson and number of learners in each category				<ul style="list-style-type: none"> low vision students: they will seat near the blackboard and be provided with a large print text. slow learners 			
Unit title		INTRODUCTION TO COMPUTER NETWORK					
Key Unit Competence:		To be able to explain principles, standards and purposes of computer network					
Title of the lesson		Fundamental of computer Network					
Instructional Objective		After observing a computer network, students will be able to identify computer network properties and type of computer network, and justify advantage /disadvantages of computer network					
Plan for this Class (location: in / outside)		<ul style="list-style-type: none"> This class will be held indoors and students will be organize in small groups 					
Learning Materials (for ALL learners)		<ul style="list-style-type: none"> Computer lab Internet and textbooks to facilitate research 					
References							
Timing for each step	Description of teaching and learning activity					Generic competences and cross cutting issues to be addressed + a short explanation	
	Questions and answers technique is used to facilitate students, group activities and presentation of findings is used to make students involved in the content development and then the harmonization of the group findings is made by the teacher to make the summary. Finally, the lesson assessment is individually and then peer assessment/ correction is done by students after the collective correction on the board.						
		Teacher activities			Learner activities		

<p>Introduction</p> <p>15 minutes</p>	<p>Teacher give the instruction on how to perform the Introductory Activity, Learning Activity 3.1, Application Activity 3.2 , Application Activity 3.3 to students</p> <p>Teacher asks students to form groups of 5 students</p>	<p>students form groups of 5 students</p> <p>Students elect the chair and secretary of the group</p>	<p>Inclusive education:</p> <p>When forming groups mix slow learners with those who can help them.</p>
<p>Development of the lesson</p> <p>(Harmonization and summary)</p>	<p>Teacher monitors the work in groups</p> <p>Teacher walks around to monitor what students are doing.</p>	<p>Students work in formed groups</p>	
<p>50 minutes (task 1: 20 minutes , task 2: 20 minutes, task 3:10 minutes)</p>	<p>Teacher see how students are progressing towards the required knowledge</p> <p>Teachers reacts on the presentation the Introductory Activity, Learning Activity 3.1, Application Activity 3.2 , Application Activity 3.3 to students</p> <p>Teacher corrects false answers</p> <p>Teacher completes the incomplete answers</p> <p>Teacher summarize the contents (Note in students book)</p> <p>Teacher gives examples: should be done by students</p>	<p>Students work on the activity</p> <p>Group 1 presents their answers on the introductory activity.</p> <p>Group 2 reacts on answers of the group 1, before representing answers of the learning activity 3.1</p> <p>Group 3 reacts on answers of the group 1, before representing answers of the learning activity 3.2</p> <p>Group 4 reacts on answers of the group 1, before representing answers of the learning activity 3.3</p>	

<p>Conclusion: (Assessment) 15 minutes</p>	<p>Application activities Remedial questions In pairs students do the Application activity 3.1 Compensation questions In pairs students do the Application activity 3.2 Extension questions Individually students do the Application activity 3.3</p>	<p>Students work in formed pairs Students work individually on the Application activity 3.3</p>	<p>Inclusive education: During individual work, the teacher takes few minutes to give extra help to slow learners where they still struggling.</p>
<p>Teacher self-evaluation</p>	<p>To be completed by the teacher after the lesson</p>		

III: UNIT DEVELOPMENT

Unit 1: FUNDAMENTALS OF LAPTOP AND PORTABLE DEVICES

1

1.1. Key Unit Competence

To be able to identify, use and maintain safely laptops and other portable devices.

1.2. Prerequisite knowledge and skills

Students have learnt computer fundamentals and Safe and ethical use of computer. They have some knowledge and skills related to computer hardware and computer software maintenance learnt in senior 4 in the unit of Computer Architecture, Assembling and Disassembling a Computer and unit of Computer software installation.

1.3. Cross-cutting issues to be addressed

Financial Education: Students must be aware of cost related to different portable devices and other peripheral devices like projectors, network devices and cleaning products needed in school computer lab.

- **Standardization Culture:** To be covered when explaining the standard required in choosing portable devices, cleaning materials, products and other peripherals to be used in the computer lab.
- **Inclusive Education:** Covered when all students (students with and with no disabilities) take place and are involved in the same class.
- **Peace and Values Education:** Students must be aware of internet based crimes like hacking and prevent accessing people's data without permission while using portable devices.
- **Gender education:** To be covered when both (girls and boys) are involved in all learning and application activities in a class.
- **Environment and sustainability:** Students should be aware of taking care working place because portable devices need to be used in proper environment.

1.4. Guidance on the introductory activity

Instruction to do the introductory activity

1. This activity take place in the computer lab (where students can access different mobile devices) and each student must have a laptop if possible.
2. Teacher organizes students into groups
3. The teacher asks students to do the introductory activity in their respective groups.
4. Teacher lets the students work independently on the activity.
5. The teacher moves around to see how students are working.
6. The teacher invites representatives of groups to presents their findings (2 or 3groups).
7. The teacher asks the rest of the class to evaluate findings.
8. The teacher may ask some questions to boost the students.
9. The teacher tells the students that they will have complete answers in the coming lessons.

1.5. List of lessons

#	Lesson title	Learning objectives (from the syllabus including knowledge, skills and attitudes):	Number of periods
1	PORTABLE DEVICES	Identify and describe the types of portable devices and their differences.	1
2	LAPTOP FUNDAMENTALS (common use, features, evolution and components)	Describe the use functions of laptops Identify internal and external components of laptop	2
3	LAPTOP COMPARISON WITH DESKTOP (Motherboard, Processor, Expansion capabilities and Power Management)	Explain the difference between laptops and desktop components Configure power management on laptop	2
4	SMARTPHONES, PDAS, TABLETS	Identify common uses and features of laptops, tablets and smartphones.	1
5	LAPTOP AND PORTABLE DEVICES CLEANING PROCEDURES	Identify external components of laptop that can be cleaned and explain their cleaning procedures Clean laptop and portable device	2
	Assessment		

Guidance on different lessons outlined above

Lesson 1: Portable devices

Duration: 1 period: 40 minutes

a. Prerequisites/Revision/Introduction:

Teacher invites students in computer lab and asks students to observe each device in order to respond to the questions in the activity 1.1. From the students' answers, teacher explains students and introduce the lesson using technical explanations.

b. Teaching resources:

- a. Computer lab with different portable devices
- b. Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- Teacher organizes students in group in order to do Activity 1.1
- Students elect the group leader and secretary
- Teacher gives the instructions on how to do Activity 1.1
- Teacher asks the students to work independently in groups on Activity 1.1 during some given time.
- Learners observe portable devices in computer lab and do Activity 1.1
- Teacher walks around and sees if students are doing activity in their respective group
- Representatives of 3 or 4 groups present their answer to the rest of class.
- Students react on the finding/ answers from other groups
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents or teacher refers to notes in students' book and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activity 1.1
- Teacher requests students to do Application activity 1.1 in the groups as they have done Activity 1.1

- Students do Application activity 1.1

Answers to learning activity 1.1.

1.

- Let students describe the portable devices available in lab
 - Let students discuss the types, similarities and differences of available portable devices and others which are not available in the lab. The types, similarities and differences of different portable devices are discussed in Students Book.
 - Teacher check students' examples of other portable devices which are not in the lab
2. When you want to buy a device, first check its quality then compare its prices in different markets so that you can buy it at low price. So with question 4, you will prefer to buy your laptop in supermarket B.

d. Answers to application activity 1.1.

1. A smart phone supports all features of PDA plus mobile phone features. In table below are features differentiating PDA from Smartphone

Feature	PDA	Smartphone
Global System(GPS)	No	Yes
SIM Card function	No	Yes
Sensor	No	Yes

NOTE: Modern PDAs have GPS and sensor

- Tablets are somewhat of a cross between smart phones and laptops. They tend to have a bigger screen than smart phones and are mainly able to do everything that a smart phone can, except making calls and sending SMS.
- Smartphone is more useful than cell phone, PDA, Laptop and tablet because of the following five reasons:
 - Always available: the smart phone is almost always within arm's reach. Wherever you go it is in your pocket or purse.
 - Connectivity: a smart phone has a 3G (or maybe even 4G) signal. Many smart phones can also act as a Wi-Fi hotspot, enabling you to share the cellular data connection.
 - Voice calls: with smart phone, you can make and receive calls from virtually anywhere.

- Text Messaging: Along with voice calls, smart phones also enable communication via text messaging.
- Versatility: a smart phone can be a phone, or a camera, or a portable music player, or a GPS device, or an e-reader, or just about anything else you need it to be.

Lesson 2: Laptop Computer Fundamentals

(Common use, features, evolution and components)

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Students get prerequisites from Computer System and Maintenance topic area of Senior four and the previous lesson “PORTABLE DEVICES”. Activity 1.2. must be done in group and students gather ideas on evolution, common uses, characteristics and description about components of laptop computers. Answers from students vary according to students’ experiences. The target of this activity is to introduce to students *Laptop computer fundamentals*.

b. Teaching resources:

- Laptops in computer lab
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- Teacher organizes students in group in order to do the activity.
- Teacher forms the following groups:
 - A group of students that work on question 1 and 4.
 - A group of students that work on question 2
 - A group of students that work on question 3
 - A group of students that work on question 5
 - A group of students that work on question 6
- Learners do Activity1.2. by using internet and textbooks
- Students groups work independently
- Students present their answer to the rest of class.

- Students react on the findings/ answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- incomplete
- Teacher summarizes the contents or teacher refers to notes in students' book and gives examples that should be done by students.
- Teacher gives the instructions on how to do Application activity 1.2.
- Each student must do question 1,2. and 4 independently.
- Question 3 must be done by two students chosen randomly:
 - The first will do
 - 3) a. sub question in front of the whole class and **the second will do**
 - 3) b. sub question in front of the whole class
- Students do Application activity 1.2.
- **Answers to learning activity 1.2**

1. Teacher provides internet and let students discuss:

- Common uses of laptop, evolution of laptop, and characteristics of laptop
- Describe external
- Internal components of laptop.

Note: The common uses of laptop, evolution of laptop, characteristics of laptop and describe external and internal components of laptop are discussed in Students Book.

- Some laptop keyboard keys have many roles, with this reason laptop keyboard has Fn key while desktop keyboard does not have Fn key. Fn key is used to activate every function key for a particular role. Examples:

Combination of -Fn and F8 keys decreases screen light

- Fn and F9 keys increases screen light
- Fn and F5 keys decreases volume of sound
- Fn and F5 keys increases volume of sound
- Fn and F7 keys opens window used to manage screens use

- Steps to be followed while applying for National ID at www.irembo.gov.rw site is below:

- Type www.irembo.gov.rw in address bar of a browser and press Enter key
- e. Click Application for National ID button of home page
- f. Wait for a new window (webpage) opens and Click Apply button

Wait for a new window (webpage) opens and complete the APPLICANT DETAILS form and then Click SUBMIT button.

g. Answers to application activity 1.2

1.

- a. If you want to connect your laptop computer to internet use Network cable
- b. VGA (Video Graphic Array) cable is used to connect laptop computer to another display device

AC Power cable is used to connect your laptop to the electrical outlet

- 2. Connect a projector to your laptop using one of HDMI (High-Definition Multimedia Interface) and VGA (Video Graphic Array) connector according to the architecture of every device.
- 3. After connecting a desktop to your laptop, open PROJECT window using combination of Fn and F7 keys. PROJECT window is the following:



- a. To display the contents from laptop to both screens, choose Duplicate option
- b. To display the contents from laptop to only desktop screen, choose Second screen only option.

4. The difference between HDMI port and USB port is given in the following table:

Characteristic	HDMI port	USB port
Number of devices	HDMI port supports one device at time	USB port can support one device to 127 devices at time
Transport of power	HDMI does not transport electricity	USB port transports both data and electricity at the same time

Lesson 3: Laptop comparison with desktop

(motherboard, processor, expansion capabilities and power management)

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Students have knowledge and skills about uses and components of a laptop acquired from previous lesson “LAPTOP COMPUTER FUNDAMENTALS”. Activity 1.3. must be done in computer lab into Groups. Students use laptops and internet so that they can do Activity 1.3. The target of this activity is to introduce to students Laptop comparison with desktop

b. Teaching resources:

- Laptops and desktops in computer lab
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- Teacher forms groups of students: 6 students for one group
- Teacher distributes tasks to groups. Every group must do one question from the Activity1.3
- Teacher provides internet and laptop and let students finds answers to Activity 1.3
- Students groups work independently
- Teacher asks each group secretary to takes short note about their findings
- Each group representative presents the findings of the whole group

- Students react on the finding/ answers from other groups.
- Teacher comments on all presentations by correcting false answers and completing the incomplete answers.
- Referring to notes in students' book, teacher summarizes the contents and gives examples that should be done by students.
- Teacher asks students to do Application activity 1.3
- All questions of Application activity must be done by all groups which did Activity 1.3.
- Each group does the Application activity 1.3. independently.
- Teacher walks around each group and see the work of the group.
- Teacher gives feedback to every group

Answers to learning activity 1.3

1. The following table shows how Desktop and Laptop manage power

Laptops	Desktop
Laptop takes electricity from the battery and can use direct power source	Desktops remain plugged into a power source

2. The laptop and desktop computer specifications (Motherboard, Processor, RAM, Hard Disk, Expansion capabilities and Power Management) are discussed in Students Book.

d. Answers to application activity 1.3

1. The following are steps to set your laptop in order to turn off the display
 - After 3 minutes when powered by battery
 - After 5 minutes when plugged in
- a. Open Control Panel window

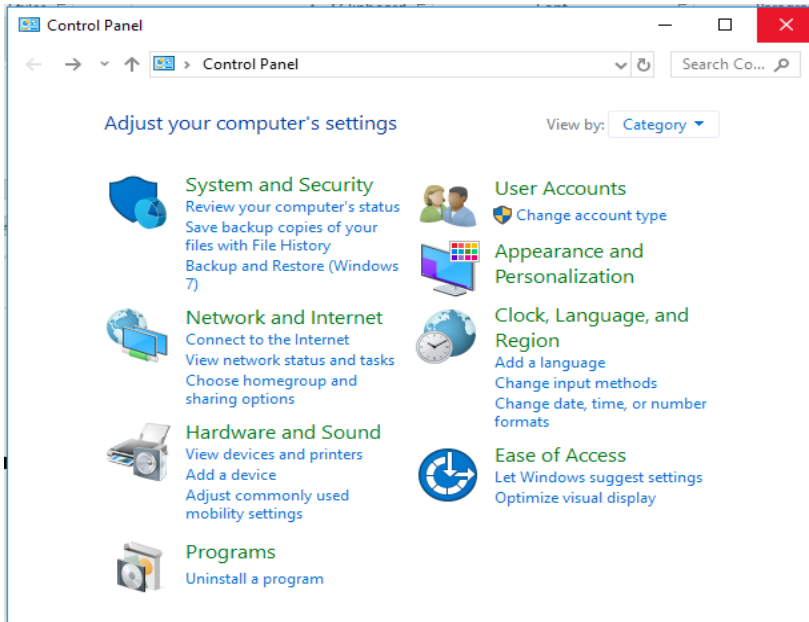


Figure 1.2: Control Panel Window

b. Open Hardware and Sound window

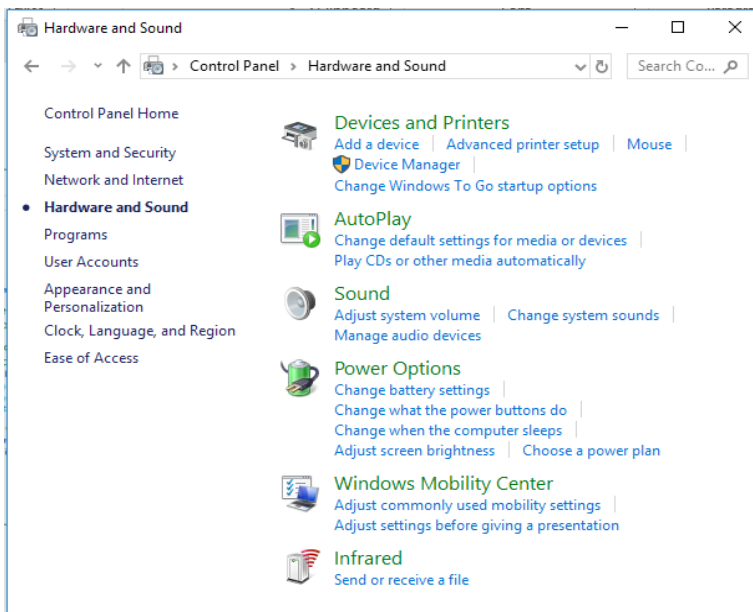


Figure 1.3: Hardware and Sound Window

c. Open Power Option window

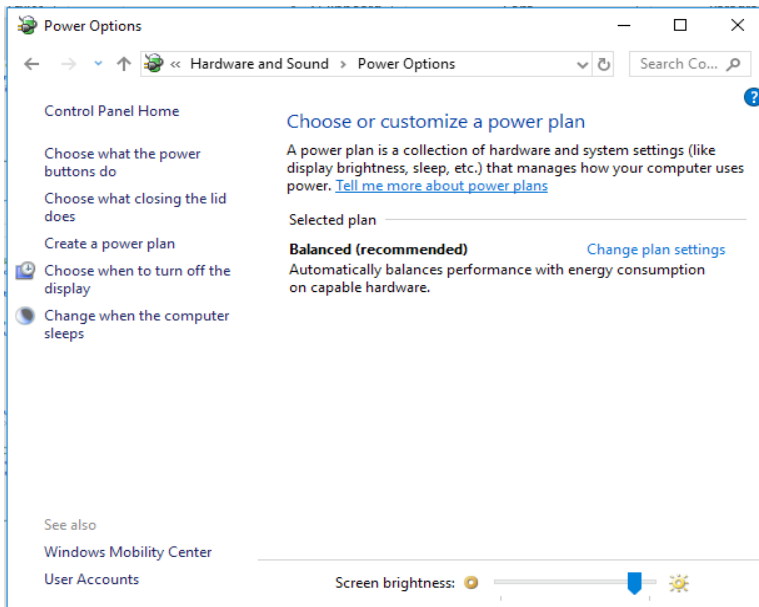


Figure 1.4: Power option Window

d. Open Create a Power Plan window

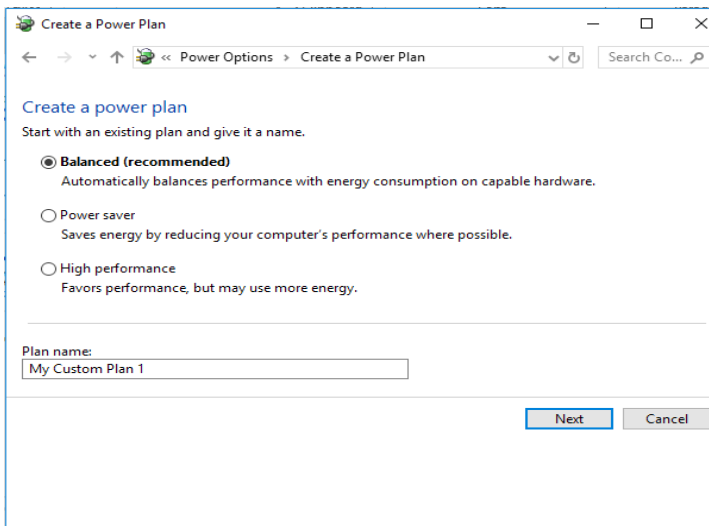


Figure 1.5: Create a Power Plan Window

- e. Select Power saver and click Next button to open Edit Plan Settings and then set
- 3 minutes when powered by battery
 - 5 minutes when plugged in

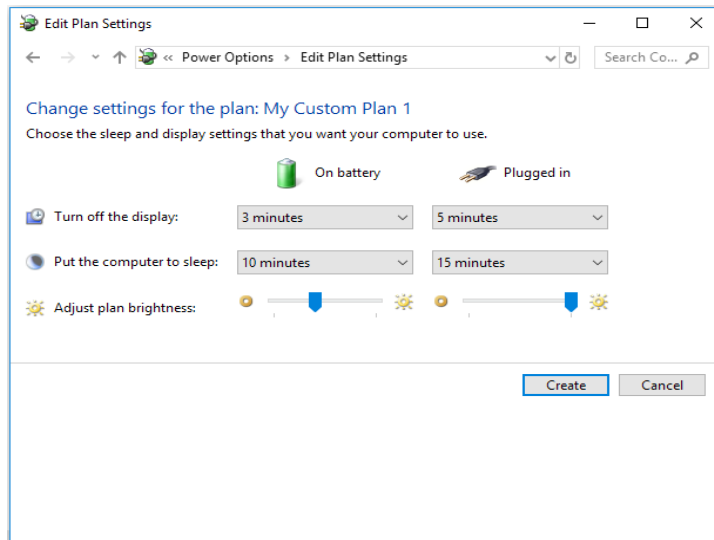


Figure 1.5: Edit Plan Settings Window

- f. Click Create button
2. Laptop computers lab does not need large cooling devices comparing to desktop computers lab because:
- Laptop processors use less power
 - Laptop processors create less heat so Processors don't require large cooling devices
 - Desktop processors create great heat quantity
 - Desktop processors require large cooling devices
3. The similarities and differences between desktop and laptop computers are discussed here below:
- The similarities:

Most of the functions that a desktop can perform can also be performed by a laptop. The similarities between Laptop and Desktop Expansion Components are in the following table

Components	Laptops		Desktop	
	Integrated	External Port	Integrated	External Port
External monitor		√		√
Printer		√		√
Mouse		√		√
External drives		√		√
Ethernet NIC	√	√	√	√
Wireless NIC	√	√	√	√
CD/DVD Drives		√		√
Drive controllers	√		√	

- The differences about Laptop and Desktop Expansion Components in table below:

Components	Laptops		Desktops
	PC Card	Integrated	Adaptor Card
Keyboard		√	
Ethernet NIC	√		√
Wireless NIC			
Drive Controllers			√

- The differences between laptop and desktop components

Feature/Component	Laptop	Desktop
Motherboard form factor	Specialized components (specific form factors)	Standardized components (Universal form factors)
Processor	Processors use less power	Processors use great electricity quantity
	Processors create less heat	Processors create great heat quantity
	Processors don't require large cooling devices	Processors require large cooling devices

Power management	laptop takes electricity from the battery	Desktops remain plugged into a power source
Expansion capability	Expansion devices are attached to laptop devices with USB ports, parallel ports, and PC Cards.	A desktop attaches these devices with USB ports and parallel ports.
RAM slot type	SODIMM	DIMM
Physical Size of Hard Disk	2.5-inch drives	3.5-inch drives

Lesson 4: Smartphones, pdas, tablets

Duration: 1 period: 40 minutes

a. Prerequisites/Revision/Introduction:

Students have knowledge and skills about description of types of portable devices acquired from first lesson of this unit "PORTABLE DEVICES". Activity 1.4 introduces to students SMARTPHONES, PDAS, TABLETS. This activity is done in groups. Students discuss other portable devices other than laptop which are used by teachers and students to access materials on Internet in the school and then they discuss common uses and features of those devices.

b. Teaching resources:

- Laptops, Smartphones or PDAs or tablets in computer lab
- Internet and textbooks to facilitate research

c. Learning activities:

- Guidance
- Teacher forms and organizes students in groups
- Teacher distributes tasks to groups
- Every group must do activity 1.4. independently
- Teacher asks each group secretary to takes short note about their findings

- Each group representative presents the findings of the whole group
- Students react on the finding/ answers from other groups.
- Teacher comments on all presentations by correcting false answers and completing the incomplete answers.
- Referring to notes in students' book, teacher summarizes the contents and gives examples that should be done by students.
- Teacher brings smartphones or iPads
- Teacher connects smartphones or iPads to internet
- Teacher asks students to do Application activity 1.4.
- One student of the group sends an email message to another student of the same group
- Each group does the Application activity 1.4 independently.
- Teacher walks around each group and see the work of the group.

Answer to learning activity 1.4.

1. Portable devices other than laptops that can be used in a school that can allow teachers and students to access materials on internet are Smartphones, PDAs or tablets
2. The common uses and features of Smartphones, PDAs or tablets are discussed in student book.

d. Answers to application activity 1.4.

1. The following are steps to download and install Google chrome using Smartphone or a Tablet or iPad
 - Open Play Store application
 - Search Google Chrome application by typing Google Chrome in search bar (Google Play)
 - Choose Google Chrome application by touching its icon
 - Click/touch INSTALL button
 - Click/touch PROCEED and wait for application setup downloading and installation completed.
 - Click/touch OPEN then press ACCEPT&CONTINUE button
2. Here below are steps guiding each group to do the second question:

- One student of the group opens his/her email account using smartphone or iPad
 - Click/touch write new message (nouveau message) icon
 - Type a receiver email address in text box
 - Write object of your email message
 - Type a message in message window
 - When you finish typing a message then click/touch Send/Envoyer button
 - The receiver opens his/her email account
 - The receiver reads the message and then
 - Click//touch Repondre/Respond// Reply button
 - Type the message in message window and then
 - Click/touch Send/Envoyer button
3. Steps to guide the third question are the following:
- Open Play Store application
 - Search Polaris Office application by typing Polaris Office in search bar (Google Play)
 - Click/touch INSTALL button
 - Click/touch PROCEED and wait for application setup downloading and installation completed.
 - Click/touch OPEN then press ACCEPT&CONTINUE button

Polaris Office is a free office service that runs on platforms such as Android, iOS, Windows and mac OS. It is capable of editing Microsoft Office file formats (doc/docx, hwp, ppt/pptx, txt, xls/xlsx) and viewing PDF files.

All files saved in Polaris Office are synchronized with other connected devices, and thus documents are automatically updated to the latest version. Moreover, Polaris Office has an agent program that allows uploading and downloading documents from a desktop computer to a mobile device.

Lesson 5: Laptop and portable devices cleaning procedures

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Activity 1.5 Introduces to students LAPTOP AND PORTABLE DEVICES CLEANING PROCEDURE. This activity is done in groups. Students discuss how they can prevent laptop to be damaged and different laptop parts which can be cleaned.

b. Teaching resources:

- Laptops, Smartphones or PDAs or tablets in computer lab
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- Teacher forms and organizes students in groups of four students.
- Teacher distributes tasks in groups
- Some groups work on three first questions and other groups works on remaining questions of activity 1.5
- Every group must do its task independently
- Teacher asks each group secretary to takes short note about their findings
- Teacher invites group representatives of 2 groups which worked on three first questions and 2 group representatives of 2 groups which worked on three last questions to present the answers to their respective groups.
- Students react on the finding/ answers from other groups.
- Teacher comments on all presentations by correcting false answers and completing the incomplete answers.
- Teacher summarizes the contents referring to notes in student's book
- Teacher provides laptops connected to internet to facilitate research for question 2 in Application activity.
- Teacher asks every group to do application activity 1.5
- Teacher walks around each group and see the work of the group.
- Teacher gives guides and gives comments every group.

Answers to learning activity 1.5

1. If a drink was spilled into the keyboard of a laptop, it can result in physical damage (include both electrical and physical damage). It depends a lot on the type of liquid, the quantity and how quickly you react. If a keyboard does not want to do anything, it's often easier to replace it than to clean it, if the rest of the laptop still works.

2. The given figure shows that laptop is in poured (spilled) tea on table. This can result in electrical damage.

- A good first response to this situation is to disconnect the laptop immediately from the electrical outlet, if it's not plugged into the mains, remove the battery as quickly as possible.
- Second response, clean your laptop using a dry cloth.

3. If the laptop and water are in contact:

Remove the laptop from any residual liquid. This will both minimize your laptop's exposure to more liquid and decrease the risk of electrical shock

4. Different laptop parts that can be cleaned are discussed in student's book

5. After cleaning a laptop, you keep waste products in a proper way in order to keep properly our environment

d. Answers to application activity

- Laptop keyboards take in a lot of dirt, dust and grime.

Follow the steps below while cleaning a laptop keyboard:

- Turn off your laptop
- Before you start cleaning your laptop's keyboard, make sure it is unplugged and powered off.
- Remove the mouse, any discs or CDs, USB drives and anything else that is protruding from your machine
- Blow compressed air between the keys; you can use a hair-dryer to blow it away.
- If you are still having problems, remove your laptop keys. So far, we have avoided doing this because it is time-consuming, annoying and easy to get wrong.
 - Research your laptops brand name and see if you do have keys that can actually be taken off
 - Be careful, because the keys are often held on by fragile plastic tabs. Gently pop them off and store them somewhere safe.
 - Run your wet-wipes over the bare key-board. After soaking them in anything that evaporates (rubbing alcohol and hydrogen peroxide) so that you do not get moisture under the keyboard.
 - You can also wash the keys, but this makes losing keys easier.

Follow the steps below:

Step 1: Shut down your laptop and unplug it from its power source. If you can, remove the battery just to play safe.

Step 2: Spray or apply the cleaning fluid onto a microfiber cloth. Make sure that the cloth is damp, but not wet.

Step 3: Gently rub the cloth over the affected area. Rub in small circles to avoid streaks and avoid heavy pressure as that can damage the display.

Step 4: Repeat as necessary, making sure not to drip any fluid onto your laptop's display or keyboard.

Step 5: When finished, wait for the display to dry completely before closing the lid or powering on your laptop.

Summary of the unit

Portable devices are computing devices designed to be held and used in the hands. Portable devices are becoming an increasingly important part of personal computing as the capabilities of devices like laptops, tablets and smartphones continue to improve. In this unit we discussed laptop and other portable devices, their similarities, differences, common uses, features and their cleaning procedures.

- ***Types of portable devices***

1. *Laptops*
2. *Smartphones*
3. *Mobile phones*
4. *Personal Digital Assistants*
5. *Tablets*

- ***The components of a laptop***

Components may be located in different places on different models.

a. The external components of a laptop

There are status indicators, ports, slots, connectors, bays, jacks, vents, and a keyhole on the exterior of the laptop

b. The internal components of a laptop

They are central circuit board(motherboard) makes up a complex electronic system, Random Access memory(RAM), etc.

- Laptop comparison with desktop (Motherboard, Processor, Expansion capabilities and Power Management)

Feature/Component	Laptop	Desktop
Motherboard form factor	Specialized components(specific form factors)	Standardized components (Universal form factors)
Processor	Processors use less power	Processors use great electricity quantity
	Processors create less heat	Processors create great heat quantity
	Processors don't require large cooling devices	Processors require large cooling devices
Power management	laptop takes electricity from the battery	Desktops remain plugged into a power source
Expansion capability	Expansion devices are attached to laptop devices with USB ports, parallel ports, and PC Cards.	A desktop attaches these devices with USB ports and parallel ports.
RAM slot type	SODIMM	DIMM

- Laptop and portable devices cleaning procedures

It is important to keep a laptop clean and to ensure that it is being used in the most optimal environment possible. It is very important to use the right products, cleaning materials and procedures when cleaning a laptop. Always read all warning labels on the cleaning products.

The LCD screen, keyboard, ventilation, touchpad etc. They are different parts of a laptop that need to be cleaned. We have to remove dirty and dust from your computer so that it cannot be damaged.

Additional Information

This section provides additional content for the teacher to have a deeper understanding of the topic.

Describe how to troubleshoot laptops and portable devices

When troubleshooting problems with laptops or portable devices, you should determine if a repair is cost-effective. To determine the best course of action, the cost of the repair should be compared to the replacement cost of the laptop or portable device less the salvage value.

Since many portable devices change rapidly in design and functionality, portable devices are often more expensive to repair than to replace. For this reason, portable devices are usually replaced while laptops can be replaced or repaired.

Follow the steps outlined in this section to accurately identify, repair, and document the problem.

Troubleshooting Process	
Step 1	Gather Data from the Customer
Step 2	Verify the Obvious Issues
Step 3	Try Quick Solutions
Step 4	Gather Data From the Computer
Step 5	Evaluate the Problem and Implement the Solution
Step 6	Close with the Customer

Figure 1.7: Troubleshooting Process

End unit assessment

This part provides the answers to end unit assessment activities designed in integrative approach to assess the key unit competence with cross reference to the textbook. The teacher's guide suggests additional questions and answers to assess the key unit competence.

6. Discuss the advantages and disadvantages of each type of computer below:
 - Laptop computer
 - Tablet
 - Smartphone

Answer:

Type	Advantages	Disadvantages
Laptop computer	It's portable due to small size and weight Battery can be recharged Can connect wireless to internet No loose cables. All components connect together	Limited battery life Laptops are difficult to repair and upgrade Can be stolen or lost Some users find it difficult to use pointing device
Tablet computer	High definition antiglare display Wireless, 3G/4G & Bluetooth connection Data can be backed up or synchronized with other devices Touch screen technology Battery life longer than a mobile phone	Limited memory compared to laptops Expensive to use 3G/4G internet Typing can be more difficult compared to a normal keyboard Not all files are compatible with tables.
Smart Phones	Small in size and easier to carry around Wireless or 3G/4G Connectivity Touch screen technology	Small screens make it difficult to read Battery life is short Could be misplaced or stolen Limited storage/memory compared to other

7. Describe what is used for standalone and networked laptop computer.

Answer:

Standalone laptop	Networked laptop
Can be used for either personal or work use.	Connect to internet
Completing work	Share resources
Communication	Share files
Gaming	Share drives
	Central storage
	Online gaming

8. Compare smartphone features and cell phone features

Answer:

Feature	Smartphone	Cell phone
Operating system	Yes	No
Wireless Fidelity	Yes	No
Expandable memory	Yes	No
QWERTY Keyboard	Yes	No
GPS	Yes	No
Internet access	Yes	No
High resolution display	Yes	No
Media players	Yes	No
Camera	Yes	No
Sensor	Yes	No
Touch Technology	Yes	No
SIM Card function	Yes	yes
Bluetooth	Yes	yes
Battery Type	Yes	yes

9. Is a Laptop hardware maintenance difficult comparing to a desktop computer maintenance? Explain

Answer:

Yes, Laptop hardware maintenance is difficult comparing to a desktop computer maintenance because Laptop components are proprietary, so you may not be able to use components made by one laptop manufacturer to repair a laptop made by another manufacturer which makes that technicians may have to obtain certification for each laptop manufacturer they support. Desktop components are standardized.

10. Give a clear difference between VGA and HDMI connectors.

Answer:

HDMI (High-Definition Multimedia Interface) connector transports both sound and video data while VGA (Video Graphic Array) connector carries video data only.

Note that both connectors transport any other type of data.

11. Explain how you can care your laptop.

Answer:

- Always place your laptop on a level surface.
- Wash your hands before using the computer.
- Fluids are the number one enemy of electronic items so it is best not to eat or drink while working on the laptop.
 - If liquid spills on the keyboard, turn the keyboard upside down to drain for at least 12 hours before powering on again.
- Never put personal data or programs that can't be easily recovered on your laptop.
 - Your laptop may, someday, unexpectedly require service. Your personal data will not be protected if this happens and you could lose your data.
- Don't save passwords on your laptop.

Use a password that is easy for you to remember (but not easy for someone else to guess)

12. Exchange a track of music from one device to another. What do you use? Are there other possibilities?

Answer:

To exchange a track of music from one device to another, we can use Bluetooth

There other three possibilities of transferring music from one device to

another:

- a. Transfer Music using Google Play Music
- b. Transfer Music from Android to Android device with iMusic
- c. Transfer Music from Android to Android Using Near Field Communication (NFC)

Consolidation, Remedial and extended activities**Consolidation activities**

Suggestion of questions and answers for deep development of competences.

13. Describe parts of Ipad that need cleaning

Answer:

The main part of Ipad to be cleaned is LCD screen

Remedial Activities:

Suggestion of Questions and Answers for remedial activities for slow learners.

14. What is the disadvantage of a cell phone?

Answer:

One major disadvantage of a cell phone is its negative health effects (sleeplessness, eye cancer, infertility, cardiac problems, and chronic fatigue).

15. What is Ipad?

Answer:

An iPad is a tablet computer designed and marketed by Apple Inc.

Extended activities: Suggestion of Questions and Answers for gifted and talented students.

16. Comparing to Apple's iOS, Android OS, Windows Phone OS and BlackBerry OS. Which is most useful operating system? Explain Why
17. What are the features of Android operating system?

Answer:

Phones operating on the Android platform are currently the most prevalent type of smartphone, followed by iPhones and Blackberry devices.

Demographically, Android phones are especially common among young adults and African-Americans, while iPhones and Blackberry devices are most prevalent among college graduates and the financially well-off.

1. Features of Android OS

Android is an open source operating system and middleware framework for smart devices such as phones and tablets.

These features include hardware features such as audio, Bluetooth, camera, network, microphone, GSM, NFC, and sensors such as accelerometer, barometer, compass, gyroscope, and Wi-Fi.

2.1. Key unit competence

To be able to utilize complex data structure in algorithm

2.2. Prerequisite knowledge and skills

To learn this unit, students have learnt simple data structure in the senior 4. Knowledge and skills learnt in previous unit are useful for this unit.

2.3. Cross-cutting issues to be addressed

- Peace and value education: Students must be aware of ordering the data according to position as well as area.
- Financial education: Students must be aware that sorting and search as well as mathematical calculation take into consideration available financial means.
- Standardization culture: To be covered through the explanation of search and sort roles avoid action that are against Rwandan culture such as obeisance
- Gender

2.4. Guidance on the introductory activity

Instruction to do the introductory activity

- Teacher organizes students in group of 3 or 5 in order to do introductory activity.
- Students elect the group leader and secretary.
- In respective groups, students read the scenario and observe the figure in the students books, and respond asked answers
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on the answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Students have not learnt abstract data structure and answers from may be biased.
- The introductory goal is to give students idea of dimensional array , queue ,stack and list

- Two dimensional array is achieved in the picture, where there is two line in front of tellers and queue is achieved on how client form a line in front of tellers, stack on how money is arranged and distributed by teller to client.

2.5. List of lessons

#	Lesson title	Learning objectives (from the syllabus including knowledge, skills and attitudes):	Number of periods
1	Introductory activity	Introduce data structure and algorithms	1
2	Declaration and Accessing array elements Two dimensional Arrays	Identify the use of two-dimension array in algorithm	2
3	initialization Two dimensional Arrays	Use Two-dimension array in algorithm	2
4	Abstract data structure	Identify and explain abstract data structures	2
5	Search using complex data structure (list ,Queue ,Stack ,Tree)	Write an algorithm that require the use of complex data structures	2
6	Sorting using complex data structure (list ,Queue ,Stack ,Tree)	Write an algorithm that require the use of complex data structures	2
7	Quadratic equation and summing a list of numbers	Identify appropriate steps to resolve a complex mathematical problem Design an algorithm and flowchart to resolve complex mathematical problem	2
8	factorial , Fibonacci series and palindrome functions	Identify appropriate steps to resolve a complex mathematical problem Design an algorithm and flowchart to resolve complex mathematical problem	2
9	Euclid's GCD (greatest common denominator)	Identify appropriate steps to resolve a complex mathematical problem Design an algorithm and flowchart to resolve complex mathematical problem	2
	Assessment		1

Lesson 1: Two dimensional array

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction

Learning activity 2.1 is used to introduce the two dimensional array. In doing the learning activity 2.1, students are going to discover the basic of two dimensional arrays:

- Array name here represented by table name,
- Array indexes which are represented by intersection of rows and columns.
- Finally, be able to identify an element of array using its index (row and column).

b. Teaching resources:

- Textbooks to facilitate the students
- Internet, Projector , computer

c. Learning activities:

Guidance on activity

- Teacher organizes students in group in order to do learning activity2.1.
- Students elect the group leader and secretary.
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Students reform the group and do the learning activity 2.2
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do application activity2.1, and application activity 2.2

- Students do application activity 2.1 and application activity 2.2

Answers to learning activity 2.1.

a. Suggest a name for the above table?

1. Student Marks

a. How many rows and columns in the above table?

2. 4 rows and 3 columns

a. Identify the location of the value 95 in the above table?

3. 95 is located at the 3rd row, 2nd column, it can be written as [3][2]

d. Answers to application activity 2.1

1. 4 rows and 4 columns

2. var population [4][4]

3. population[4][4] {

$i_0 j_0$	$i_0 j_1$	$i_0 j_2$	$i_0 j_3$
$i_1 j_0$	$i_1 j_1$	$i_1 j_2$	$i_1 j_3$
$i_2 j_0$	$i_2 j_1$	$i_2 j_2$	$i_2 j_3$

Lesson 2: Two dimensional array initialization

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Learning activity 2.2 is used to introduce the two dimensional array initialization. The purpose of this activity to show learner how data is represent inside the computer memory when values has been assigned to the array. Students get the picture from the given table to explain how the initialization is achieved in two dimensions with the help of the learning activity 2.2. Students draw a table that represent the above students' marks and derive and represent a matrix with its indexes.

b. Teaching resources:

Students' books

c. Learning activities:

Guidance activity

- This lesson can be conducted in the classroom.
- Teacher ask students to form pairs to do the Learning Activity 2.2
- Students elect the group leader and secretary in order to perform Learning Activity 2.2
- Teacher walk around and see if students are doing Learning Activity 2.2 in their respective group.
- Students present their answers to the rest of class.
- Students react on answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarize the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 2.2
- Teacher do Application activities 2.2

Answers to learning activity 2.2.

READ marks [1][2] ;

WRITE marks[1][2] ;

What do you think about the above statements?

READ marks [1][2] means that we are going to assign/ read the value at the position of row 1 and column 2

WRITE marks[1][2] ; means that we are going to print/ write the value at the position of row1 and column 2

d. Answer to application activity 2.2.

Solution:

a. int T[2][3];

b. 2 rows

c. 3 columns

d. 6 elements

e. T[1][0],T[1][1],T[1][2];

f. T[0][2],T[1][2];

g. T[0][1]=0;

h. for(int i=0;i<2;i++) for(int j=0;j<3;j++) T[i][j]=1

i. or for(int i=0;i<=1;i++) for(int j=0;j<=2;j++) T[i][j]=1

j. for(int i=0;i<2;i++)

k. for(int j=0;j<3;j++)

```

l. cin>>T[i][j];
m. for(int i=0;i<1;i++)
n. for(int j=0;j<3;j++) cout<<T[i][j];

```

ANSWER

ACTIVITY 2.2. ANSWERS

NAMES/SUBJECTS	MATHEMATICS	PHYSICS	COMPUTER
NIYIBIZI	90	30	70
UWERA	93	69	57
UMULISA	90	91	70
KWIZERA	93	95	80

APPLICATION ACTIVITY 2.2. ANSWERS

1. Give the size of the above array

```
int marks [2][7];
```

2. Initialize the above array

```
Int studentMarks[2][7]={1,2,3,13,17,34,19,54,23,11,45,31,65,26}
```

1	2	3	13	17	34	19
54	23	11	45	31	65	26

Answers to application activity 2.2

- a) 2 rows and 7 columns
- b) Var a[2][7] as integer

Lesson 3: Abstract data structure

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

The activity must be done in the library where it is possible. Teacher arranges the books by using the following way:

- One group of books should be arranged in the form of link,
- Second group of books should be arranged in the form of queue,
- Third group of books should be arranged in the form of stuck and last group of books arranged in the form of tree

- Students in the school library observe each group of books and make short notes on how each group of books is arranged. The objective is to make students able to understand how the data are arranged in the computer memory.

b. Teaching resources:

Projector, computer, library and books.

c. Learning activities:

Guidance on activity

- Introduction of lesson and the learning activity 2.5 must be done in the library.
- The rest of the lesson can be conducted in the class room.
- Teacher asks students to form the groups of 5 or 6 to do the Learning Activity 2.5
- Students elect the group leader and secretary in order to perform Learning Activity 2.5
- Teacher walks around and sees if students are doing Learning Activity 2.5 in their respective group.
- Students present their answers to the rest of class.
- Students react on answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarize the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 2.4
- Teacher gives the instructions on how to do Application activities 2.4

Answer to activity 2.4

Teacher organize the books referring to the activity 2.4

List 2) queue 3)stack 4) tree

ANSWERS TO APPLICATION ACTIVITY 2.5

Figure A represents a list of data

Figure B represents a queue of data

Figure C represents a stack

Figure D represents a tree

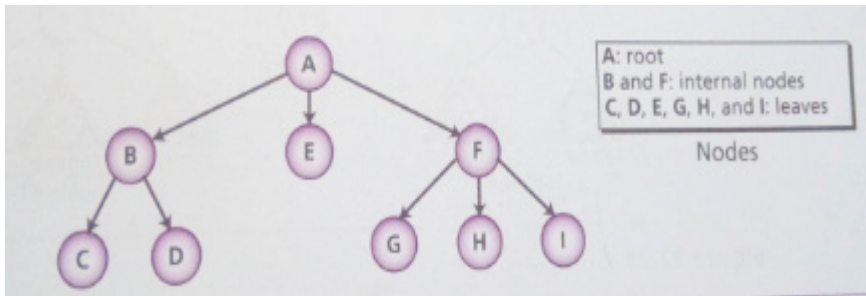
Students observe and differentiate the schema a, b, c, and d and they answer questions. Teachers gives instruction to students on how the data have been entered to the table.

The objective is to make students able to understand how data should be arranged in the different way.

What is abstract data structure?

Abstract Data structure is a mathematical model of a data structure that specifies the type of data stored, the operations supported on them and the types of parameters of the operations

1. With example compare list and tree
2.
 - List is a collection of data in which each element contains the location of the next element- that is, each element contains two parts: data and link.
 - The data parts holds the value information: the data to be processed. The link is used to chain the data together, and contains a pointer (an address) that identifies the next element in the list. While
 - A node that is directory accessible (through a single arco from a given node is called the child: the node from which the child is directly accessible is called a parent. Node with a common parents are called siblings . descendents of a node are all nodes that can be reached by that node , and a node from which all descendents can be reached is called an ANCESTOR



3. Discuss operations in :

- a. Queue

A queue is a linear list in which data can only be inserted at one end , called the REAR, and deleted from the other end , called the FRONT. These restrictions ensure that the data mis processed through the queue in the order in which it is received. In an other words, a queue is a first in, first out(FIFO) structure

- b. Stack

A stack is a restricted linear list in which all additions and deletions are made at one end, the top.

If we insert a series of data items into a stack and then remove them, the order of the data is reversed. Data input as 5, 10, 15, 20, for example would be removed as 20, 15, 10, and 5. This reversing attribute is why. Stacks are known as Last in, First out (LIFO) data

structures.

Lesson 4: Searching using complex data structure.

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Learning activity 2.5

Learning activity 2.5 is used to introduce the searching using complex data structure lesson. The purpose of this activity to show learner how to search a number in that series of numbers when the number is found in the series.

b. Teaching resources:

Students' books.

c. Learning activities:

Guidance activity

- This lesson can be conducted in the classroom.
- Teacher asks students to form a group of 5 students to do the Learning Activity 2.5
- Students elect the group leader and secretary in order to perform Learning Activity 2.5
- Teacher walks around and see if students are doing Learning Activity 2.5 in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarize the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 2.5
- Students do Application activities 2.5

Answer to activity 2.5

The purpose of this activity is to introduce the searching using complex data structure lesson. Students study series of numbers in order to search a number in that series of numbers when the number is found in the series, students give its position in series. Students write down all the steps used to search a number until it is reached.

```
int A[10] = {10, 8, 2, 7, 3, 4, 9, 1, 6, 5};
```

For example: step1= 10, step2= 8, step3= 2, step4= 7

The position is i_4

d. APPLICATION ACTIVITY 2.7 ANSWERS

int A[11] = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10}; and value to be searched is VAL = 9

Analyse the bellow stpes

The algorithm proceed in the following manner:

- BEG = 0, END = 10, MID = $(0 + 10)/2 = 5$
Now, VAL = 9 and A[MID] = A[5] = 5
- A [5] is less than VAL, therefore, we now search for the value in the second half of the array. So, we change the values of BEG and MID.

Therefore:

Now, BEG = MID + 1 = 6, END = 10, MID = $(6 + 10)/2 = 16/2 = 8$
VAL = 9 and A[MID] = A[8] = 8

- A[8] is less than VAL, therefore, we now search for the value in the second half of the segment. So, again we change the values of BEG and MID.

Therefore:

Now, BEG = MID + 1 = 9, END = 10, MID = $(9 + 10)/2 = 9$
Now, VAL = 9 and A[MID] = 9.

Note:

- The algorithm will terminate when A[MID] = VAL. When the algorithm ends, we will set POS = MID. POS is the position at which the value is present in the array.
- However, if VAL is not equal to A[MID], then the values of BEG, END, and MID will be changed depending on whether VAL is smaller or greater than A[MID].
- If $VAL < A[MID]$, then VAL will be present in the left segment of the array. So, the value of END will be changed as $END = MID - 1$.
- If $VAL > A[MID]$, then VAL will be present in the right segment of the array. So, the value of BEG will be changed as $BEG = MID + 1$.

Lesson 5: Sorting using complex data structure

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

b. Teaching resources:

Students' books.

c. Learning activities:

Guidance on activity

- This lesson can be conducted in the classroom.
- Teacher asks students to form a group of 5 students to do the Learning Activity 2.6
- Students elect the group leader and secretary in order to perform Learning Activity 2.6
- Teacher walks around and see if students are doing Learning Activity 2.6 in their group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarize the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 2.6
- Students do Application activities 2.6

Answer to activity 2.6

The purpose of this activity is to introduce the sorting using complex data structure lesson. Students observe two figures, the figure (a) shows unordered people and the figure (b) shows ordered people. This is what students have to discover. The objective of the learning activity 2.6 is to give students concept of how data can be ordered according on any order.

d. Answers to application activity 2.7

1. By using the bubble sort algorithm, write program to sort an integer array of 10 elements in ascending.

```
/* C++ Program - Bubble Sort */
#include<iostream.h>
#include<conio.h>
void main()
{
    clrscr();
    int n, i, arr[50], j, temp;
    cout<<"Enter total number of elements :";
    cin>>n;
    cout<<"Enter "<<n<<" numbers :";
    for(i=0; i<n; i++)
    {
        cin>>arr[i];
```

```

    }
    cout<<"Sorting array using bubble sort technique...\n";
    for(i=0; i<(n-1); i++)
    {
        for(j=0; j<(n-i-1); j++)
        {
            if(arr[j]>arr[j+1])
            {
                temp=arr[j];
                arr[j]=arr[j+1];
                arr[j+1]=temp;
            }
        }
    }
    cout<<"Elements sorted successfully..!\n";
    cout<<"Sorted list in ascending order :\n";
    for(i=0; i<n; i++)
    {
        cout<<arr[i]<<" ";
    }
    getch();
}

```

Suppose you are doing a sequential search of the ordered list [3, 5, 6, 8, 11, 12, 14, 15, 17, 18]. How many comparisons would you need to do in order to find the key 13?

A) 10 B) 5 C) 7 D) 6

C Correct! Since 14 is greater than the key value 13 you can stop.

3. Suppose you are doing a sequential search of the list [15, 18, 2, 19, 18, 0, 8, 14, 19, 14]. How many comparisons would you need to do in order to find the key 18?

A) 5 B) 10 C) 4 D) 2

D Correct! In this case only 2 comparisons were needed to find the key.

Lesson 6: Quadratic equation and summing a list of numbers

Duration: 2 Periods: 80 minutes

a. Prerequisites/Revision/Introduction:

- quadratic equation and series in mathematics ,
- Introduce the lesson using what students/learners have seen in lesson 2.6

b. Teaching resources:

Students' books.

c. Learning activities:

Guidance on activity

- This lesson can be conducted in the classroom.
- Teacher begins the lesson by assigning Learning Activity 2.11 first to the students and then after students do learning activity 2.12
- Teacher asks students to form a group of 5 students to do the Learning Activity 2.11 and learning activity 2.12
- Students elect the group leader and secretary, immediately start doing Learning Activities 2.11.
- Teacher walks around and see if students are doing Learning Activity 2.11 in their respective group.
- Students present their answer to the rest of class.
- Students react on answers from other groups.
- Teacher corrects false answers and completes the incomplete answers to answers to learning activity 2.11.
- Teacher asks students to go back in groups , do learning activity 2.12
- Teacher walks around and see if students are doing Learning Activity 2.11 in their respective group.
- Students present their answer to the rest of class.
- Students react on answers from other groups.
- Teacher corrects false answers and completes the incomplete answers to answers to learning activity 2.12.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarize the contents (Note in students book) and gives examples: should be done by students
- Teacher gives the instructions on how to do Application activities 2.7
- students do Application activities 2.7

Answer to activity 2.11

This activity must be done in the classroom. Students are given the algorithm and pseudo code to resolve the quadratic equation. Steps are not complete in given algorithm and pseudo code, students have seen quadratic equation in mathematics and they can complete missing steps. Teachers instructs students to study given algorithm and pseudo code and complete missing steps.

answer to activity 2.12

This activity is conducted in the classroom and Students in groups analyse the pseudo

code give in the activity and predict the result. The activity introduce student in recursive function and the given pseudo code give the simplest form of the recursive function.

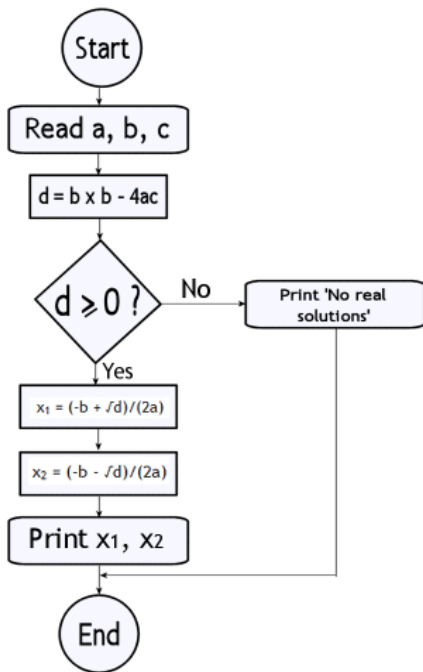
d. APPLICATION ACTIVITY 2.7 ANSWERS

Using the algorithm to solve quadratic equation. Draw the flowchart to solve quadratic equation

ALGORITHM TO SOLVE QUADRATIC EQUATION

1. integer a,b,c;
2. float d,r1,r2,r3,r4,r;
3. print 'Enter values of a,b,c of a quadratic equation:';
4. read a,b,c;
5. value of a,b,c is transferred to function 'quad'and body of function is:
6. $d = b^2 - 4ac$;
7. if($d < 0$)
8. print 'Value of Discriminant is negative';
9. else
10. if($d = 0$)
11. print 'Roots are real'

12. $r = -b/2a$;
13. print 'First and Second root of equation:',r;
14. else
15. $r1 = -b + \sqrt{d}$;
16. $r2 = 2a$;
17. $r = r1/r2$;
18. $r3 = -b - \sqrt{d}$;
19. $r4 = r3/r2$;
20. print 'First root of equation: ', r;
21. print 'Second root of equation: ', r4;



Lesson 7: Factorial, fibonacci series and palindrome functions

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

- Factorial number in mathematics
- Introduce the lesson using what students/learners have seen in lesson 2.15

b. Teaching resources:

- Classroom, students' books.

c. Learning activities:

- This lesson can be conducted in the classroom.
- Learning Activity 2.15 ,2.16 & 2.17 should be done in consecutive order
- Teachers give a reasonable time for each learning activity
- Teacher asks students to form a group of 5 students to do the
- Students elect the group leader and secretary in order to perform Learning Activity 2.15 ,2.16 & 2.17 consecutively
- Teacher walks around and see if students are doing Learning Activity in their respective group.
- Students present their answer to the rest of class.

- Students react on answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarize the contents (Note in students book) and gives examples: should be done by students
- Teacher gives the instructions on how to do Application activities 2.8,2.9 and 2.10
- Students do Application activities 2.8,2.9 and 2.10

Answer on activity 2.15

This activity must be done in the classroom. Students are given the pseudo code of Fibonacci series function. Steps of Fibonacci series function are complete in given pseudo code, students have seen Fibonacci series function in mathematics and they can derive the general for Fibonacci series function.

Answer on activity 2.16

This activity must be done in the classroom. Students are given the pseudo code of Fibonacci series function. Steps of Fibonacci series function are complete in given pseudo code, students have seen Fibonacci series function in mathematics and they can derive the general for Fibonacci series function.

Answer on activity 2.17

this activity must be done in the classroom. Students brainstorm word in Kinyarwanda which do not change when its letters are reversed. From palindrome words found by students, teacher can explain what a palindrome function is.

d. APPLICATION ACTIVITY 2.8 ANSWERS

1. Analyse the above pseudo code answer following question:

- Predict the result of each pseudo code
- What do you think of each concept used
- Differentiate of both pseudo code

1. Algorithm for calculate factorial value of a number:

[algorithm to calculate the factorial of a number]

step 1. Start

step 2. Read the number n

step 3. [Initialize]

$i=1, fact=1$

step 4. Repeat step 4 through 6 until $i=n$

step 5. $fact=fact*i$

step 6. $i=i+1$

step 7. Print $fact$

step 8. Stop

[process finish of calculate the factorial value of a number]

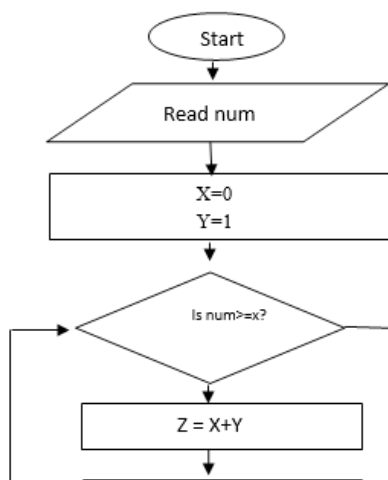
Application activity 2.8 answers

we all know fibonacci sequence (for eg 1,1,2,3,5,8,13,.... sequence in which next no is addition of previous 2 fibonacci numbers) so we will try to write algorithm to generate fibonacci sequence .

F1=1st number, F2=2nd number -->F3=f1+f2=1+1=2 F4=f2+f3=1+2=3 F5=f3+f4=2+3=5, and so on. f1 f2 f3 f4 f5 f6 f7..... 1 2 3 5 8 13 21.....

In algorithm:

1. Assign sum=0, A=0, B=1, i=1
2. Get the no. of terms upto which u want to generate the Fibonacci no, i.e., n.
3. Add A and B to get the next Fibonacci number
4. Assign the value of B to A i.e. A=B
5. Assign the value of sum to B i.e. B=sum
6. Write the value of su to get next Fibonacci number in the series.
7. increment i with 1 i.e. $i=i+1$ and repeat step 3,4,5,6 with the last value of $i=n$ (n is the no. of terms which u wnt to generate Fibonacci no. series.)
8. Stop



Algorithm to check Palindrome

A **palindrome** is a word, phrase, number, or other sequence of characters which reads the same backward or forward.

```
function isPalindrome (text)
  if text is null
    return false
  left ← 0
  right ← text.length - 1
  while (left < right)
    if text[left] is not text[right]
      return false
    left ← left + 1
    right ← right - 1
  return true
```

Palindrome Example:

CIVIC
LEVEL
RADAR
RACECAR
MOM

Complexity:

The first function **isPalindrome** has a time complexity of $O(n/2)$ which is equal to $O(n)$

Lesson 8: Euclid's gcd

(Greatest Common Denominator)

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

- Introduce the lesson using what students/learners have seen in lesson 2.15

b. Teaching resources:

- Classroom, students' books. Internet

c. Learning activities:

- This lesson can be conducted in the classroom.
- Teacher asks students to pairs in order to do the Learning Activity 2.16
- Teacher walks around and see if students are doing Learning Activity 2.16 in their pairs.
- Students present in pairs their answer to the rest of class.
- Students react on answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarize the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 2.16

Answer of activity 2.16

this activity must be done in the classroom. Students find the the greatest common divisor of two positive integers. Students do it manually and write down steps. From

the used steps students generate the algorithm to find greatest common divisor.

Below are steps used:

First let me show the computations for

- Divide 210 by 45, and get the result 4 with remainder 30, so $210=4\cdot 45+30$.
- Divide 45 by 30, and get the result 1 with remainder 15, so $45=1\cdot 30+15$.
- Divide 30 by 15, and get the result 2 with remainder 0, so $30=2\cdot 15+0$.
- The greatest common divisor of 210 and 45 is 15.

Suggested general algorithm:

1. **Step 1:** Input Two positive integers, a and b.
2. **Step 2:** If $a < b$, exchange a and b.
3. **Step 3:** Divide a by b and get the remainder, r. If remainder =0, report b as the GCD of a and b.
4. **Step 4:** Replace a by b and replace b by r. Return to the previous step.
5. **Step 5:** Output the greatest common divisor, g, of a and b.

d. Application activity 2.10 answers

The teacher instructs students to do this application activity by the use of the internet or any available learning resource

3.1. Key Unit Competence

To be able to explain principles, standards and purposes of computer network

3.2. Prerequisite knowledge and skills

Students have learnt some concepts of computer network in O level. They ideally have some knowledge and skills related to computer hardware and computer software.

3.3. Cross-cutting issues to be addressed

- **Financial Education:** to be covered when explaining students cost related to network design and implementation while choosing network devices , transmission medium and peripherals to be used in the computer network.
- **Standardization Culture:** to be covered when explaining the standard required in choosing network devices, transmission medium and peripherals to be used in the computer network.
- **Inclusive Education:** students with and without disabilities participate and learn together in the same classes.
- **Peace and Values Education:** students must be aware of internet based crimes like hacking and prevent accessing people’s data without permission.

3.4. Guidance on the introductory activity

Instruction to do the introductory activity

- This activity take place in the computer lab (where students can access the Internet) and each student must have a computer connected to the Internet where it is possible.
- Each student chooses a partner to make a pair. One is going to be the sender another the receiver. The sender must send a brief email to the receiver. “Computer Network “as an email subject and the email body contains names of previous units already covered in computer science. After the reception of the email, the receiver replies to the email. After the sender receives the reply of his email help students to answer questions in the activity.
- Guide students to list all possible elements that make this communication possible

Source: the source is the person attempting to share information. .

Message: the message is simply the information you want to communicate.

Encoding: encoding is the process of assembling the message (information, ideas and thoughts) into a representative design with the objective of ensuring that the receiver can comprehend it.

Channel: an encoded message is conveyed by the source through a channel. There are numerous channel categories: verbal, non-verbal, personal, non-personal, etc.in this case channel is the email.

Decoding: this is refer to listening, and reading carefully.

Receiver: the message is delivered to the receiver.

Feedback: a better word might be “reaction” or “responses.”

- Guide students to identify devices and transmission medium used to facilitate sending and reception of the email. These devices and transmission medium are: computers, laptops, smartphones, UTP cables, Access Point, Switch, Hub, Multipurpose device, browser. All Rwandan schools do not have same resources; give to your students what is available at your school.
- Guide students in discussion by explaining to students that without the school computer network which is connected to other computer networks this communication won't be possible.
- Let student express themselves about the use of emails in question 5&6 &7. Remember our goals/objective is to introduce student in computer network. Therefore do not spend much time on email concept instead spend time on technology behind it.

3.5. List of lessons

#	Lesson title	Learning objectives (from the syllabus including knowledge, skills and attitudes):	Number of periods
1	Introductory Activity	<ul style="list-style-type: none"> Introduce the unit title 3: introduction to computer network 	1
2	Fundamental Of Computer Network	<ul style="list-style-type: none"> Identify properties ,advantage / disadvantages and types of computer network 	2
3	Computer Network Concept And Technology	<ul style="list-style-type: none"> Differentiate network concepts and technology Identify network concepts and technology 	2
4	Local AreaNetwork	<ul style="list-style-type: none"> Identify different Local Area Network Compare Client - Server and Peer 2 Peer networks 	2
5	Physical Components	<ul style="list-style-type: none"> Install NIC card ,configure it Connect USB modem to computer and install it 	2
6	Network Devices	<ul style="list-style-type: none"> Explain functions of hub and switch and give difference between them Install and configure hub /switch and connect hosts to them 	3
7	Network Transmission Medium	<ul style="list-style-type: none"> Identify Network medium UTP and Coaxial cable as guided media, Radio waves as unguided media Make straight cable and crossover using untwisted pair cable (UTP) Identify Network medium Wi-Fi ,Bluetooth ,infrared as unguided media Configure a computer as host for Internet Connection Sharing (ICS) 	4
8	IP Address	<ul style="list-style-type: none"> Differentiate static IP address and dynamic IP address 	2
9	Data And device Sharing	<ul style="list-style-type: none"> Create a working group ,join ,change working group, and share files and network peripherals Explain advantage and disadvantage of using working group 	4
10	LAN Topology	<ul style="list-style-type: none"> Differentiate LAN topologies and technologies used 	3
	Assignment		1

Lesson 1: Introduction to computer network concept

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Introduce this lesson by explaining, by the help of students, that for a computer to work all its components have to be properly connected.

b. Teaching resources:

- Computer lab any room which has networked computers
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance on Activities

- Teacher organizes students in group in order to do learning activity.
- Students elect the group leader and secretary.
- Learners observe networked computers in computer lab and do Learning Activity 3.1, Application Activity 3.2 , Application Activity 3.3
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activity 3.1, Application activity 3.2 and Application activity 3.3
- Students do Application activity 3.1, Application activity 3.2 and Application activity 3.3

Answer of activity 3.1

Learning activity 3.1 is used to introduce the lesson. Students visit the school computer lab or any room which has networked computers. Students observe networked computers and they respond to the questions in the activity. Answers from students may be biased, from them teacher explain to students and introduce the lesson using technical explanations.

Answer of Activity 3.2

1. Let students discuss advantages and disadvantage of computer network in their school, community and common computer network advantages and disadvantage. The advantages and disadvantage of computer network are discussed in Students Book.
2. i&ii) printing 100 pages to be distributed to every student. Sharing notes with students is less costly.

Answers of Activity 3.3

Teacher brings at least 2 smartphones with compatible Bluetooth connectivity or teacher can have a smartphone and computer. If students have Laptops in the lab ask them to activate Bluetooth and choose a classmate to pair. Teacher activates Bluetooth for all devices and pair them through Bluetooth and start exchanging files (Music, Pictures and other) using Bluetooth. After the completion of the exchange, teacher asks students to turn off Bluetooth.

d. Answer of Application Activity 3.1

1. The answer depends on how the computer lab is designed, the objective of this question is to let student identifying the location of different network devices such as switch, hub, Access point and transmission Medias.
2. Students may not able to answer this question but the target is to let students brainstorm how they can rearrange school lab. Some of students may draw other may write down how they can rearrange the school computer lab.

Answer of Application Activity 3.2

1. Consequences when a shared resource is disconnected from the network are:
 - Shared resource can't be access by the network users
 - Cause delay of the work
 - Lose of money
2. Computer network is used in different area in today such as: Banking, Medicine, Education, Business and many others. Students can give more than what is here, teacher uses its own judgment.

Answers of Application Activity 3.3

1. There are benefits of using a LAN, individuals need to communicate with a resource on another LAN network, outside of the local network within the home, school campus, or organization. This is done using the Internet. In order to achieve you contact the ISP and subscribe to these services.
2. Most of students will answers that their school network is LAN because it serves only their school.

3. Refer to the diagram available in the Students Books and explanation to respond to this question.

4.

Radio waves	Wireless
Millions of interconnected network	WAN
Sharing resources	Advantages of Computer network
Hacking attacks	Disadvantages of Computer network
Bandwidth and Latency	Qualities of Computer network Performance

Lesson 2: Computer network concept and technology

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Students get prerequisites from Computer network and Data communication topic area of the O-level curriculum. The previous lesson “**FUNDAMENTAL OF COMPUTER NETWORK**”

b. Teaching resources:

- Computers in the computer lab, smartphones , other devices with Bluetooth
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance:

- This lesson can be conducted inside or outside of the computer lab.
- Teacher asks students to form pairs to do the Learning Activity 3.4
- Teacher walks around and sees if students are doing Learning Activity 3.4 in pairs.
- Students present their answers to the rest of class.
- Students react on the finding/ answers from other pairs.
- Teacher asks students to form pairs to do the Activity 3.5
- Students elect the group leader and secretary in order to perform Activity 3.5.
- Teacher walks around and sees if students are doing Activity 3.5 in their respective group.

- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 3.4 and Application activities 3.5 and
- Students do Application activity 3.4 and Application activity 3.5

Answers of activity 3.4:

Students investigate why a network can be very slow while it was not before

Activity 3.5

- Intranet refers to a private LANs and WANs that belongs to an organization. It is designed to be accessible only by the organization's members, employees and others who have authorization usually only accessible from within the organization.
- Extranet provides secure and safe access to individuals, staff working outside of the organization by using secure connections to the internal network. Extranet is accessible from outside the organization.

d. Answers Application Activity 3.4

1. There are several cause of network latency, here are main causes: bad made cables, malfunctioning of network devices, wireless interference and weather.
2. data bandwidth is measured in bits per second
3. Download speed (download bandwidth) is the rate at which data is transferred from the Internet to the user's computer. The upload speed (upload bandwidth) is the rate that data is transferred from the user's computer to the Internet.
4.
 - TV :simplex
 - Radio : simplex
 - Walkie –Talkie :half- duplex
 - Phone : Full duplex
 - Computer: Full duplex

Answers of Application Activity 3.5

General supply Ltd users can access data according to their roles in the organization:

- **Employees** use an intranet because they will have access from the inside of General supply Ltd.

- **Suppliers and Sellers** use Extranet to access data from General supply Ltd because extranet allows the outside users to access data.
- **Buyers and Clients** use Internet to access data from General supply Ltd, they only access public data.

Lesson 3: Local areanetwork

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Students get prerequisites from Computer network and Data communication topic area of the O-level curriculum. The previous lesson “**Computer Network Concept and Technology**”

b. Teaching resources:

- Computer lab, browser , Ping command
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance about learning activity

- This lesson can be conducted in the computer lab.
- Teacher asks students to form pairs to do the Learning Activity 3.6
- Students elect the group leader and secretary in order to perform Learning Activity 3.6
- Teacher walks around and sees if students are doing Learning Activity 3.6 in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities3.6

Guidance on Activity 3.6

Learning activity 3.6 introduces the lesson. Teacher ask students what they have learnt in previous lessons 1 and 2. From answers given by students , Teacher introduce the activity , the objective of the activity is to give students the factors that make a computer network be considered as PAN, LAN, MAN, WAN. These factors are: Area

covered, number of users and service offered. Students answers questions 1, 2 and 3 basing on their observations.

d. Application activity

Answers of Application Activity 3.6

Respond to the following questions by True or False

SN	QUESTIONS	Answer
1	Peer to Peer network is only implemented by computers which run same operating system	No
2	In Server-Client network ,Server respond to service only requested by the Client	Yes
3	Limit number of hosts in the Peer to Peer network are 10 computers	Yes
4	Client requests only the service available on the server in Server-Client network	Yes
5	Peer to Peer network is more secure than Server-Client network	No
6	There is a dedicated computer in Peer to Peer network	No
7	In Client- Server network, both client and server must run the same Operating System.	No

Lesson 4: Physical components

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Students get prerequisites from Computer network and Data communication topic area of the O-level curriculum. The previous lesson “**Local Area Network**”

Introduce the lesson using what students have learnt in lesson 3.

Students form group of 5 in doing learning activity 3.7. Students have to identify computer network components available in the school. Students describe the function of each device they have identified.

b. Teaching resources:

- Laptop, Smartphone, Computer, NIC ,wireless NIC
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance on activity 3.7

- This lesson can be conducted in the computer lab.
- Teacher asks students to form pairs to do the Learning Activity 3.7
- Students elect the group leader and secretary in order to perform Learning Activity 3.7
- Teacher walks around and sees if students are doing Learning Activity 3.7 in their respective group.
- Students present their answers to the rest of class.
- Students react on answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 3.6

d. Application activity

- **Step 1:** Shut down your Computer and disconnect it from the power source
- **Step 2:** Remove the case cover. Then remove the cover of the available slot.
- **Step 3:** Install NIC in proper slot and secure it
- **Step 4:** Replace the case cover.

Note: A wireless NIC has an antenna connected to the back of the card or attached with a cable so that it can be positioned for the best signal reception. You must connect and position the antenna.

Lesson 5: Network device

Duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

- Introduce the lesson using what students have seen in lesson 3.

b. Teaching resources:

- Computer lab, browser, switch, hub, access point and bridge
- Internet and textbooks to facilitate research

c. Learning activities:

- This lesson can be conducted in the computer lab.

- Teacher asks students to form pairs to do the Learning Activity 3.8
- Students elect the group leader and secretary in order to perform Learning Activity 3.8
- Teacher walks around and sees if students are doing Learning Activity 3.8 in their respective group.
- Students present their answers to the rest of class.
- Students react on answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 3.9

Guidance on doing Activity 3.8

This activity must be done in the computer lab or in any room where there are networked computers. Students observe the connection between network devices and they answer questions. Teachers gives instruction to students on how to do this activity limit instruction only on Hub, Switch, and Access Point. The objective is to make students be able to describe the exchange of the data from host A to Host B.

d. Answers of Application Activity 3.9

1. What is the range of an access point?

Answer: The range of an access point is 30 meters

2. Discuss how a switch performs micro-segmentation?

Answer: Micro-segmentation refers to the process of segmenting a collision domain into various segments. Micro-segmentation is mainly used to enhance the efficiency or security of the network. The micro-segmentation performed by the switch results in the reduction of collision domains. Only two nodes will be present as a result of the collision domain reduction

3. Explain why Switch is much preferred than a HUB

Answer: A switch is effectively a higher-performance alternative to a hub. For a network with more computers switch is preferable because it's built in MAC table. Technically speaking, hubs operate using a broadcast model where message is received on one port is generated and send to all ports of the hub and switches operate using a virtual circuit where received on one port is directly sent to its destination. Therefore, switch is much intelligent that a hub.

4. What is the difference between Access Point and Bridge?

Answer: A wireless access point is a device that extends a wired network, into the wireless space, it has an Ethernet port to connect to the wired network, and radio

transceivers to connect to wireless devices while a network bridge joins two otherwise separate computer networks to enable communication between them and allow them to work as a single network.

5. Discuss the purpose of switching table in the switch?

The switch make a forwarding decision based on the destination host's MAC address. The switch essentially forwarded the frame from one port's ingress queue to another port's egress queue. To perform this forwarding decision, a switch consults its MAC address table.

Lesson 6: Network transmission medium

Duration: 4 periods: 160 minutes

a. Prerequisites/Revision/Introduction

- Students get prerequisites from previous lessons of unit 3

b. Teaching resources:

- This lesson can be conducted in the computer lab.
- Teacher ask students to do the Learning Activity 3.8 individually
- Teacher walks around and sees if students are doing Learning Activity 3.8.
- Students present answers to the rest of class.
- Students react on answers.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students

c. Learning activity

- The teacher instructs learners to do learning activity 3.9
- Learners label all components of the drawn network
- Learners exchange their drawings to evaluate them
- At the end of the lesson the teacher gives instructions on how to do application activities

d. Guidance on application activities

Application activity 3.10

All instructions to make a straight cable are given in the Students Book, in order to conduct the activity you need a space, it can be conducted in the computer lab or in any other room where students can have space. Make groups of 3 or 5 and make sure each

student participated. Make sure you have enough: Unshielded twisted pair (UTP) patch cable, modular connector, Crimping tool, Cable tester.

Application activity 3.11

Using cables that students have made they are going to be used in order to check if you are connected to wired network. All instructions to get connected to a wired network are given in the Students Book.

Guidance on application activity 3.12

All instructions to connect to wireless network are given in the Students Book. This activity requires the availability of a wireless network.

Guidance on application activity 3.13

To do this activity, you need a good internet, in case you do not have a fast internet Download Google map application on your phone and Computer or visit www.map.google.com. Students can do the activity using website, phone application or using program.

Lesson 7: IP Address

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

- Previous lessons under unit 3 can serve as prerequisites to this lesson

b. Teaching resources:

- Computer lab,
- Internet and textbooks to facilitate research

c. Learning activities:

- Teacher organizes students in group in order to do learning activity 3.9.
- Students elect the group leader and secretary.
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answers to the rest of class.
- Students react on answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students

- Teacher gives the instructions on how to do Application activity 3.14, Application activity 3.15.
- Students do Application activity 3.14, Application activity 3.15.

Answers to learning activity 3.10a

Students narrate what they see in the image given in the student book

d. Application activity

Answers of Application activity 3.14, Application activity 3.15 are corrected in student book

Lesson 8: Data and device sharing

Duration: 4 periods: 160 minutes

a. Prerequisites/Revision/Introduction:

- This lesson 7 is practical, teacher is advised to conduct it in the computer lab where it is possible. Use existing infrastructures available in your school.

b. Teaching resources:

- Computer lab,
- Internet and textbooks to facilitate research

c. Learning activities:

- This lesson can be conducted in the computer lab.
- Teacher asks students to form pairs to do the Learning Activity 3.10
- Teacher walks around and see if students are doing Learning Activity 3.10 in their respective pairs.
- Students present their answer to the rest of class.
- Students react on answers from other pairs.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarize the contents (Note in students book) and gives examples that should be done by students
- Teacher give the instructions on how to do Application activities3.16, Application activities3.17, Application activities3.18, Application activities3.19,
 - Students do Application activities3.16, Application activities3.17, Application activities3.18, Application activities3.19,

Answer to learning activity 3.10b

With the assistance of the teacher, learners share folders and discuss how resources

are shared on a computer network

d. Application activity

Answers of Application activity 3.16, Application activity 3.17, Application activity 3.18, Application activity 3.19 are corrected in student book

Lesson 9: Network Topology

Duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Teacher introduces this lesson using what students/learners have seen in lesson 2. During this lesson students must be in the computer lab where they observe devices that make their school network.

b. Teaching resources:

- Computer lab, browser, switch, hub, access point and bridge, cables, access point
- Internet and textbooks to facilitate research

c. Learning activities:

- This lesson can be conducted in the computer lab.
- Teacher asks students to do the Learning Activity 3.8 individually
- Teacher walks around and sees if students are doing Learning Activity 3.8.
- Students present answers to the rest of class.
- Students react to answers.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in student book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 3.20.
- Students do Application activities 3.20.

Answer to learning activity 3.11

In doing learning activity 3.11 students draw a peer-to-peer network. This peer-to-peer network to draw should be made of a switch, 8 computers, one printer which has a NIC card and a printer.

d. Application activity

Answers for the application activity 3.20

Question 1:

Network devices: are physical devices which are required for communication and interaction between devices on a computer network

Network peripheral: is a device that is connected to a computer on the network and is not directly connected to the computer network.

Computer peripherals: a computer peripheral is a device that is connected to a computer but is not part of the core computer architecture.

Question 2:

Possible topologies to be used on this situation are: Ring and Star topologies.

Draw Ring and Star topologies for the arrangement of computers.

3.6. Unit summary

Computer network has a structural view, it means computers are connected together to share services and resources. Computers are connected on the network using cables as guided media and radio waves as unguided media. In this unit we discussed coaxial cable and twisted pair cable for guided media and infrared, Bluetooth and wireless fidelity for unguided media.

They are different types of computer networks classified according to size which are:

- PAN :Personal Area Network
- LAN : Local Area Network
- MAN : Metropolitan Area Network
- WAN :Wide Area Network

Simplex, half duplex and full duplex are three kinds of communication mode in computer networking. These communication modes provide pathways to convey information.

Every computer on the network needs two addresses in order to communicate with other computers MAC and IP address. MAC address is embedded on the NIC of the computer and IP address is assigned to the host either static or dynamic.

They are two category of LAN network:

- The Client-Server network data management is centralized.
- Peer-to-Peer network each user has his/her own data and applications.

Network Topology refers to the layout of a network and how different nodes in a network are connected to each other and how they communicate. There are four main

topologies used in LANs: bus, ring, star and mesh. The most widely used are:

- Bus topology it is the most used and employed in LAN architecture. All devices are connected to a central cable, called the bus or backbone. This topology is relatively inexpensive and easy to install for small networks.
- Ring topology each device is connected directly to two other devices, one on either side of it, to form a closed loop. This topology is relatively expensive and difficult to install, but it offers high bandwidth and can span large distances.
- Star topology all devices are connected directly to a central computer or server. Such networks are relatively easy to install and manage
- Mesh topology can be either a full mesh or a partial mesh. In the former, each computer is connected directly to each of the others.

3.7 End unit assessment:

This part provides the answers of end unit assessment activities designed in integrative approach to assess the key unit competence with cross reference to the textbook.

The teacher's guide suggests additional questions and answers to assess the key unit competence.

1. Define a computer network? What is the purpose of computer network?
 - **Answer:** A computer network is a collection of computers connected together for the purpose of sharing resources. The most common resource shared are connection to the Internet , printer folder and file
2. Discuss advantages and disadvantage of using computer network
 - **Answer:** Advantages of Computer Network
 - It enhances communication and availability of information.
 - It allows for more convenient resource sharing.
 - It makes file sharing easier.
 - It is highly flexible.
 - It is an inexpensive system.
 - It increases cost efficiency.
 - It boosts storage capacity.

Disadvantages of Computer Network

- It lacks independence.
- It poses security difficulties.
- It lacks robustness.
- It allows for more presence of computer viruses and malware.
- Negative usage promotes negative acts.

- It requires an efficient handler.
 - It requires an expensive set-up.
3. Using a clear example, differentiate MAC address and IP address?
- Answer:
 - A Media Access Control address (MAC address) is a unique identifier assigned to a network interface card (NIC) by its manufacturer. The network interface card is used to connect to the Ethernet network. Each NIC has its own unique MAC address. The MAC address works as a serial number as each MAC addresses corresponds to a specific NIC.
 - The IP address is a number that is assigned to each device, such as a computer, a printer, etc. It describes where on the Internet your computer is located. An IP address is required by any device that participates in a computer network that uses the Internet Protocol for communication. The IP address has two main purposes: host or network interface identification and location addressing.
4. Discuss and compare various type of computer networks?
- Answer:
 - LAN and WAN are the most popular network types.
 - Wireless Local Area Network is a LAN based on wireless network technology
 - Metropolitan Area Network is a network spanning a physical area larger than a LAN but smaller than a WAN.
 - Campus Area Network is a network spanning multiple LANs but smaller than a MAN, such as on a university or local business campus.
 - Storage Area Network: connects servers to data storage devices.
5. Discuss different factors that must be considered before making a choice for the network topology?
- Answer:
 - **Money:** Bus topology may be the least expensive way to install a network because you do not have to purchase central devices.
 - **Length of cable needed:** The bus topology uses shorter lengths of cable.
 - **Future growth:** Thestar topology expands the network is easily used for future growth because it is simple to add a central device.
 - **Cable type:** The most common used cable in schools is unshielded twisted pair, which is most often used with star topologies.
6. What do you understand by network subnet?
- Answer:
 - Network Subnet is logical division of the network and it is the strategy used to partition a single physical network into more than one smaller logical sub-

network.

7. Draw a Client-Server network diagram and explain the role of each component of the client server network?

• Answer:

- Client (which can be a laptop, desktop, a smartphone): uses the network as a way to connect with and speak to the server. The client uses the network to send request to the server and to receive answer from the server.
- Server fetches the request from the client and serves according to the client's request.

8. What are similarities and difference between bus topology and tree topology

Answer:

BUS Topology	TREE Topology
<p>Bus topology is a network type in where every computer and network device is connected to single cable.</p>	<p>It has a root node and all other nodes are connected to it.</p>
<p>Features of Bus Topology</p> <ul style="list-style-type: none">• It transmits data only in one direction.• Every device is connected to a single cable	<p>Features of Tree Topology</p> <ul style="list-style-type: none">• Ideal if workstations are located in groups.• Used in Wide Area Network.
<p>Advantages of Bus Topology</p> <ul style="list-style-type: none">• It is cost effective. Cable required is least compared to other network topology.• Used in small networks.• It is easy to understand.• Easy to expand joining two cables together.	<p>Advantages of Tree Topology</p> <ul style="list-style-type: none">• Extension of bus and star topologies.• Expansion of nodes is possible and easy.• Easily managed and maintained.• Error detection is easily done.
<p>Disadvantages of Bus Topology</p> <ul style="list-style-type: none">• Cables fails then whole network fails. If network traffic is heavy or nodes are more the performance of the network decreases.• Cable has a limited length. It is slower than the ring topology.	<p>Disadvantages of Tree Topology</p> <ul style="list-style-type: none">• Heavily cabled.• Costly: If more nodes are added maintenance is difficult. Central hub fails, network fails.

9. With a clear example, differentiate hub and switch in LAN?

Answer:

- A hub is a device that connects multiple Ethernet devices on one network and

makes them act together as a single network. A hub does not gather information and input in one port results as an output in all ports on the network. A switch is a networking device that performs the same job as the hub but are considered as a more intelligent hub as it gathers information about the data packets it receives and forwards it to only the network that it was intended for.

10. What do you understand by transmission medium? Discuss various transmission medium used in computer network

Answer:

Transmission media is a pathway that carries the data or information from sender to receiver

Types of transmission media

Transmission media is broadly classified into two groups:

- Wired or Guided Media: are the cables that are tangible or have physical existence and are limited by the physical geography. Example guided media are: Twisted pair cable, co-axial cable and fiber optical cable.
- Wireless or Unguided Media are the ways of transmitting data without using any cables. These media are not bounded by physical geography. Example of unguided media are: Radio wave, Infrared, Bluetooth.

3.8 Consolidation, Remedial and extended activities

Consolidation activities: Suggestion of questions and answers for deep development of competences.

1. What is the maximum length allowed for a UTP cable?

Answer: A single segment of UTP cable has an allowable length of 90 to 100 meters. This limitation can be overcome by using repeaters and switches.

2. What is the job of the Network Layer under the OSI reference model?

Answer: The Network layer is responsible for data routing, packet switching and control of network congestion. Routers operate under this layer.

3. What is the purpose of cables being shielded and having twisted pairs?

Answer: The main purpose of this is to prevent crosstalk. Cross-talks are electromagnetic interferences or noise that can affect data being transmitted across cables.

4. How can you identify the IP class of a given IP address?

Answer : By looking at the first octet of any given IP address, you can identify whether it's Class A, B or C. If the first octet begins with a 0 bit, that address is Class A. If it begins with bits 10 then that address is a Class B address. If it begins with 110, then it's a Class C network.

3.8.1 Remedial Activities:

1. What is the disadvantage of a star topology?

One major disadvantage of star topology is that once the central hub or switch get damaged, the entire network becomes unusable.

2. What is DHCP?

DHCP is short for Dynamic Host Configuration Protocol. Its main task is to automatically assign an IP address to devices across the network. It first checks for the next available address not yet taken by any device, then assigns this to a network device.

3. What is the number of network IDs in a Class C network?

For a Class C network, the number of usable Network ID bits is 21. The number of possible network IDs is 2 raised to 21 or 2,097,152. The number of host IDs per network ID is 2 raised to 8 minus 2, or 254.

4. What is Ping?

Ping is a utility program that allows you to check connectivity between network devices on the network. You can ping a device by using its IP address or device name, such as a computer name.

5. What is DNS?

DNS is Domain Name System. The main function of this network service is to provide host names to TCP/IP address resolution.

3.8.2 Extended activities:

1. What is point to point connection?

Answer :

- It provides a dedicated link between two devices. The entire capacity of the link is reserved for transmission between the two devices
- Example: when we change the TV channels by remote control we establish a point to point connection between remote control and TV control system.

2. What is multipoint connection?

Answer: In multipoint connection more than two specific devices share a single link. Here the capacity of the channel is shared either separately or temporally.

3. What are the types of network errors?

Answer: Errors can be categorized as a single-bit error or burst error. A single bit error has one bit error per data unit. A burst error has two or more bits errors per data unit.

4.1. Key Unit Competency

To be able to identify concepts of database and differentiate database models

4.2. Prerequisite knowledge and skills:

Students have learnt some concepts of computer Introduction in s4. They ideally have some knowledge and skills related to computer hardware and computer software and computer functions.

4.3. Cross-cutting issues to be addressed:

- Financial Education: Practical exercises that involve business issues
- Standardization culture: While developing a database, a customer gives system requirements to developer. It is a good practice to initiate a learner to meet customer's expectation while developing databases and meet all agreements as signed in contract.
- Inclusive education: All students must get involved in class activities regardless of any kind of disability they may present.
- Gender education: All students must get involved in class activities regardless of gender

4.4. Guidance on the introductory activity

(with cross referencing to the Student book + answers)

Instruction to do the introductory activity

- Teacher instructs students to go to page where figure 4.1 is in textbook.
- The teacher asks students to do the introductory activity in their respective groups.
- The teacher let the students work independently on the activity.
- The teacher moves around to see how students are working and ask some questions to boost the students.
- The teacher invites representatives of groups to presents their findings.
- The teacher asks students to evaluate findings.

- The teacher tells the students that in the coming lessons they will have complete answers.

4.5. List of lessons including assessment

#	Lesson title	Learning objectives:	Number of periods
1	Database concepts	And Describe key terms and Identify Areas where database is used	3
2	Database approaches	Explain two database approach (TFPS & DBMS) Identify Advantage and challenges	3
3	Database access levels and users	Independence, access level and user management	2
4	Data independence	Differentiate between logical independence and physical independence	2
5	Data models	Differentiate among database models	2

Lesson 1: Definitions of key terms

Duration: 2 periods: 120 minutes)

a. Prerequisites/Revision/Introduction:

- Introduce this chapter by letting students in their groups discuss about the answers from interview of questions given in activity 4.1
- Teacher introduces the lesson by reviewing the presentation and reach findings of the students.

b. Teaching resources:

- Computer lab any room internet and textbooks to facilitate research

c. Learning activities:

Guidance on Activities

- Teacher organize students in groups (according to class size, number of girls and boys) in order to do learning activity 4.1
- Students elect the group leader and secretary.

- Students analyze and do Learning Activity 4.1
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the half correctly answers
- Teacher summarizes the contents (Note in students' book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activity 4.1 and Application and activity 4.1
- Student do Application 4.1 and activity 4.1

Answer of Activity 4.1

Let students discuss on answers from interview are based to the following questions:

- Why is it necessary to collect data?
- When data of student will be information?
- What is example of full information in your report
- There are also school partners which are need student's information?
- Teacher supervise the students to conduct these questions with activity 4.1
- Teacher uses the example from the students to explain piece of information(**data**), full information, (**data after to be processed**) and database (**Organized collection of related data**)
- By start this Q(d), introduce where database is used (look at student book note: **Different database applications**)

d. Answer of application activity 4.1

The target of this activity is to introduce to students the concept of database (data, information and database)

Ask student to organize data in table as a hard copy or soft copy (spreadsheet).

1. Data collected in the table

NAME	MATH/40	C++/40	ICT/20	ENGLISH/20
KANEZA	39	37	20	15
CYUSA	40	35	18	17
KEZA	35	38	19	16
NTWARI	35	35	16	16
MUTESI	37	37	20	20

2. Calculate total marks (data in processing)

NAME	MATH/40	C++/40	ICT/20	ENGLISH/20	TOTAL/120
KANEZA	39	37	20	15	111
CYUSA	40	35	18	17	110
KEZA	35	38	19	16	108
NTWARI	35	35	16	16	102
MUTESI	37	37	20	20	114

3. Calculate the percentage (data in processing)

NAME	MATH /40	C++/40	ICT /20	ENGLISH /20	TOTAL /120	PERCENTAGE
KANEZA	39	37	20	15	111	92.5
CYUSA	40	35	18	17	110	91.66667
KEZA	35	38	19	16	108	90
NTWARI	35	35	16	16	102	85
MUTESI	37	37	20	20	114	95

4. Arrange their marks by largest to lowest order (result needed)

NAME	MATH /40	C++ /40	ICT /20	ENGLISH /20	TOTAL /120	PERCENTAGE
MUTESI	37	37	20	20	114	95
KANEZA	39	37	20	15	111	92.5
CYUSA	40	35	18	17	110	91.667
KEZA	35	38	19	16	108	90
NTWARI	35	35	16	16	102	85

Help students to reflect on the database definition to decide that result table is considered as simple database

Answer of application activity 4.2

Let students work independently in groups on other database aspects (like: Government Organizations, Social Media, Sports, Personal Cloud Storage, E-commerce (then Teacher reach findings of the students from student book, their own knowledge and research.

- Social Gaming:** Gaming done across social networks is extremely data intensive. Gathering individual player information from around the globe and serving it to players on demand requires a high availability database software
- Personal Cloud Storage:** If you save photos or documents to your Smartphone or tablet, it's likely your data is stored in "the cloud," a large, central storage environment with a small portion dedicated just to you. Syncing this data across your devices requires powerful databases able to call up your data at a moment's notice, wherever you are.

3. Sports: Fan participation in national sports doesn't just utilize the power of the database, it depends upon it. From fantasy football leagues to March Madness brackets, they all depend on huge databases full of player statistics, game performances, injury reports, and more, all calculating the odds of a win on a weekly basis.

4. Government Organizations: Government organizations around the world are constantly collecting data for research, defense, legislation, and humanitarianism purposes, to name a few. This data is collected, stored and analyzed using powerful and far-reaching database services.

5. Social Media: Every social media platform stores reams of user information in databases used to recommend friends, businesses, products, and topics to the end user. This cross-referencing of data is immensely complex and uses highly reliable and capable database software, including for example, MySQL which is used in Facebook data centers.

6. E-commerce: Any online organization that sells its products or services uses databases to organize their products, pricing information, user purchase history and then recommend other potential products to customers.

Lesson 2: Database Approaches

Duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

- Students get prerequisites from previous lesson “**Database concepts**”
- Activity must be done in group and students gather ideas on DATABASE APPROACHES.

b. Teaching resources:

- Internet and textbooks to facilitate research

c. Learning activities 4.2

Guidance on Activities

- This lesson can be conducted inside or outside of the class room.
- Teacher asks and help students to form small group to do the Learning Activity 4.2
- Students elect the group leader and secretary.
- learners analyze and do Learning Activity 4.2
- Teacher walks around and sees if students are doing Learning Activity 4.2
- Students present their answer to the rest of class.

- Students react on the finding/ answers from others.
- Teacher corrects false answers and completes the half correctly answers
- Teacher summarizes the contents (Note in student’s book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 4.2 and Application activities 4.3
- Student do Application activities 4.2 and Application activities 4.3

Answers activity 4.2

1. Mr.mugabo can improve its shop management by using computerized database system (database approach)
2. The approach of database which are replacing manual database system, are (TFPS & DBMS). Add information about the Manual database and computerized database system (TFPS & DBMS)
3. c) Student must understand why Mr.Mugabo will be able to maintain the clean around the his environment

d. Answers of application activity 4.3

1. **Consider the result from Analyze of students.**
2. Some critics on these information representations
 - Information for restaurant is represented well more than the two last
 - The information are separately
 - Duplication of information is very easy etc
 - Three employees and work on the same information
3. **Solution to minimize the cost of information at Lycee de Kigali is to relate all information from those three departments in the same relation (table) as the following:**

Name	Address	salary	Date of birth	Restaurant bill	Dispensary bill
------	---------	--------	---------------	-----------------	-----------------

Note: To minimize cost is issue of financial education (emphasis on it)

Answers of Application Activity 4.4

1. Teacher allows the students to find the comparison of DBMS vs File Processing System (with definition, Advantages and Challenges).

File based system	Database system
The data and program are inter-dependent.	The data and program are independent of each other.
File-based system caused data redundancy. The data may be duplicated in different files	Database system control data redundancy. The data appeared only once in the system.
File –based system caused data inconsistency. The data in different files may be different that cause data inconsistency.	In database system data always consistent. Because data appeared only once.
The data cannot be shared because data is distributed in different files.	In database data is easily shared because data is stored at one place.
In file based system data is widely spread. Due to this reason file based system provides poor security.	It provides many methods to maintain data security in the database.
File based system does not provide consistency constrains.	Database system provides a different consistency constrains to maintain data integrity in the system.
File based system is less complex system.	Database system is very complex system.
The cost of file processing system is less then database system.	The cost of database system is much more than a file processing system.
File based system takes much space in the system and memory is wasted in this approach.	Database approach store data more efficiently it takes less space in the system and memory is not wasted.
To generate different report to take a crucial decision is very difficult in file based system.	The report can be generated very easily in required format in database system. Because data in database is stored in an organized manner. And easily retrieve to generate different report.
File based system does not provide concurrency facility.	Database system provides concurrency facility.
12. File based system does not provide data atomicity functionality.	12. Database system provides data atomicity functionality.

13. The cost of file processing system is less than database system.	13. The cost of database system is more than file processing system.
14. It is difficult to maintain as it provides less controlling facility.	14. Database provides many facility to maintain program.
15. If one application fail it does not affect other files in system.	15. If database fail it affects all application that dependent on database
16. Hardware cost is less than database database system	<ul style="list-style-type: none"> 16. Hardware cost is high in database than file system.

2) Some DBMS existing

MYSQL:

MySQL is an open source SQL database, which is developed by a Swedish company – MySQL AB. MySQL is supporting many different platforms including Microsoft Windows, the major Linux distributions, UNIX, and Mac OS X. MySQL has free and paid versions, depending on its usage (non-commercial/commercial) and features. MySQL comes with a very fast, multi-threaded, multi-user and robust SQL database server.

MSSQL Server:

- MS SQL Server is a Relational Database Management System developed by Microsoft Inc. Its primary query languages are:
 - T-SQL
 - ANSI SQL

ORACLE:

It is a very large multi-user based database management system. Oracle is a relational database management system developed by 'Oracle Corporation'. Oracle works to efficiently manage its resources, a database of information among the multiple clients requesting and sending data in the network. It is an excellent database server choice for client/server computing. Oracle supports all major operating systems for both clients and servers, including MSDOS, NetWare, UnixWare, OS/2 and most UNIX flavors

MS ACCESS:

This is one of the most popular Microsoft products. Microsoft Access is entry-level database management software. MS Access database is not only inexpensive but also a powerful database for small-scale projects. MS Access uses the Jet database

engine, which utilizes a specific SQL language dialect (sometimes referred to as Jet SQL). MS Access comes with the professional edition of MS Office package. MS Access has easy to-use intuitive graphical interface.

- 1992 - Access version 1.0 was released.
- 1993 - Access 1.1 released to improve compatibility with inclusion the Access Basic programming language.
- The most significant transition was from Access 97 to Access 2000
- 2007 - Access 2007, 2010, a new database format was introduced ACCDB which supports complex data types such as multi valued and attachment fields.

Lesson 3: Database access levels and users

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

- Students get prerequisites from the previous lesson “DATABASE APPROACHES”
- Teacher asks students what they have learnt in previous lessons 1 and 2. From answers given by students, Teacher introduces the activity 4.3. The objective of this activity is to give students the factors that make a database to be managed. These factors are: abstract levels, Types of users and responsibilities offered.

b. Teaching resources:

- Computer lab, Internet and textbooks to facilitate research

c. Learning activities 4.3

- This lesson can be conducted in the computer lab, class room or outside.
- Teacher asks students to form groups to do the Learning Activity 4.3
- Students elect the group leader and secretary in order to perform Learning Activity 4.3
- learners think and do Learning Activity 4.3
- Teacher walks around and sees if students are doing Learning Activity 4.3 in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the half correctly answers
- Teacher summarizes the contents (Note in student’s book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 4.3

- Student does Application activity. 4.3

Answers activity 4.3

Let student discuss on what they have observed

Facilitate them to link their ideas with the objectives of this activity.

- Understand: **Internal, External and conceptual.**
- **About End user, database designer and Database Administrator)** and intervene where necessary for more explanations.

Note: on the DB users (address the gender and inclusive education)

d. Answers of application activity 4.5

1. With answers from students presentation Assign each user from the hierarchy what is supposed to do and compare these hierarch with real database users (Administrators, designer and end user)
 - HIDDEN: Visitors
 - READ: students
 - READ,WRITE: Teacher
 - READ,WRITE,UPDATE: DOS
 - READ, WRITE, UPDATE, DELETE: Headmaster
2. **Responsibilities of DBA:** Responsible
 - For authorizing access to the database,
 - For coordinating and monitoring its use,
 - Acquiring software and hardware resources,
 - Controlling its use and monitoring efficiency of operations.

Lesson 4: Data independence

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

- Students get prerequisites from the previous lesson “DATABASE ACCESS LEVELS AND USERS” using what students have learnt in lesson 3. Students can identify and describe themselves forms of data independence the available in the database system.

b. Teaching resources:

- Computer, internet and textbooks to facilitate research

c. Learning activities

- This lesson can be conducted in the computer lab, class room or outside.
- Teacher asks students to form groups to do the Learning Activity 4.4
- Students elect the group leader and secretary in order to perform Learning Activity 4.4
- Teacher walks around and sees if students are doing Learning Activity 4.4 in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the half correctly answers
- Teacher summarizes the contents (Note in student's book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 4.4
- Students do Application activity. 4.4

Learning Activities 4.4

Consider the result from students in their group and explain the **Data independence** (logical and physical) which is the ability to modify a scheme definition in one level without affecting a scheme definition in a higher level is called data independence.

d. Application Activity 4.6

1. Logical and physical independence

Logical data independence: the capacity to change the conceptual schema without having to change external schema or application programs ex: Employee (E#, Name, Address, Salary) A view including only E# and Name is not affected by changes in any other attributes.

Physical data independence: the capacity to change the internal schema without having to change the conceptual (or external) schema - internal schema may change to improve the performance (e.g., creating additional access structure) - easier to achieve logical data independence, because application programs are dependent on logical structures.

2. Difference between data dependence and data independence

Structural dependence: access to a file dependent on its own structure–All file system programs must be modified to conform to a new file structure

Structural independence: change files structure without affecting data access

Data dependence: data access changes when data storage characteristics change

Data independence: data storage characteristics do not affect data access

Lesson 5: Data Models

Duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

- Introduce the lesson using what students have seen in lesson 4.

b. Teaching resources:

- Computer, internet and textbooks to facilitate research

c. Learning activities:

- This lesson can be conducted in the computer lab, class room or outside.
- Teacher asks students to form groups to do the Learning Activity 4.5
- Students elect the group leader and secretary in order to perform Learning Activity. 4.5
- Teacher walks around and sees if students are doing Learning Activity 4.5 in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the half correctly answers
- Teacher summarizes the contents (Note in student's book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 4.5
- Students do Application activity. 4.

Activities 4.5

Introduce this lesson by assigning students the following test questions in their respective groups:

Identify common data models (Hierarchical model, Network model, Relational model)

Define common data models

Relational Model: A relational database is a collection of relational tables.

The following is a graphical representation of entities and their relationships in a database structure.

Hierarchical Model: The hierarchical model organizes its data using a tree structure. The root of the tree is the parent followed by child nodes. A child node

cannot have more than one parent, though a parent can have many child nodes.

Network Model: In the network model, entities are organized in a graph, in which some entities can be accessed through several paths.

d. Application Activity 4.7

Relational database model

- The logical view of the relational database is facilitated by the creation of data relationships based on a logical construct known as a relation.
- Because a relation is a mathematical construct, end users find it much easier to think of a relation as a table. A table is perceived as a two-dimensional structure composed of rows and columns.
- A table is also called a relation because the relational model's creator, E. F. Codd, used the term relation as a synonym for table. You can think of a table as a persistent representation of a logical relation, that is, a relation whose contents can be permanently saved for future use.

As far as the table's user is concerned, a table contains a group of related entity occurrences, that is, an entity set (*discussed later in next unit*). For example, a STUDENT table contains a collection of entity occurrences, each representing a student. For that reason, the terms entity set and table are often used interchangeably.

4.6. Unit summary

Databases are used in applications or devices with software that stores and retrieves information. As you know; the underlying architecture of the platform includes a database where your data is stored. This means that all of the information you enter is stored in that database and then retrieved from the database whenever you view it within your app.

This is the first unit which introduce a database course that is why it called

“Introduction to Database”

In this unit, you learned:





- The difference between data and information
- What a database is, the various types of databases, and why they are valuable assets for decision making
- The importance of database design
- How modern databases evolved from file systems
- About flaws in file system data management
- The main components of the database system

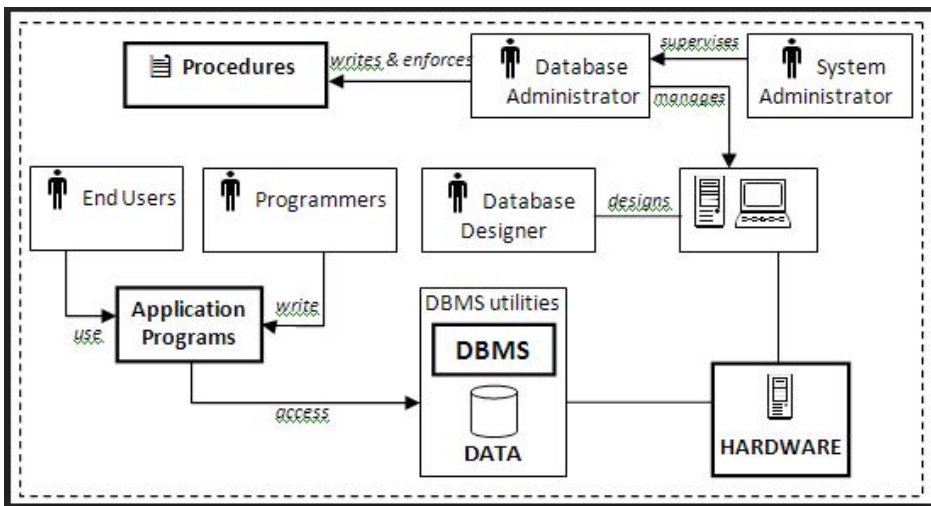
- The main functions of a database management system (DBMS)
- **Data are raw facts.** Information is the result of processing data to reveal its meaning. Accurate, relevant, and timely information is the key to good decision making, and good decision making is the key to organizational survival in a global environment.
- **Data are usually stored in a database.** To implement a database and to manage its contents, you need a database management system (DBMS). The DBMS serves as the intermediary between the user and the database. The database contains the data you have collected and “data about data,” known as metadata.
- **Database design defines the database structure.** A well-designed database facilitates data management and generates accurate and valuable information. A poorly designed database can lead to bad
- Decision making, and bad decision making can lead to the failure of an organization.
- **Databases evolved from manual and then computerized file systems.** In a file system, data are stored in independent files, each requiring its own data management programs. Although this method of data management is largely outmoded, understanding its characteristics makes database design easier to comprehend.
- **Some limitations of file system** data management are that it requires extensive programming, system administration can be complex and difficult, making changes to existing structures is difficult, and security features are likely to be inadequate. Also, independent files tend to contain redundant data, leading to problems of structural and data dependence.
- **Database management systems** were developed to address the file system’s inherent weaknesses. Rather than depositing data in independent files, a DBMS presents the database to the end user as a single data repository. This arrangement promotes data sharing, thus eliminating the potential problem of islands of information. In addition, the DBMS enforces data integrity, eliminates redundancy, and promotes data security.

4.7. Addition of information

Components of DBMS

DBMS have several components, each performing very significant tasks in the database management system environment. Below is a list of components within the database and its environment.

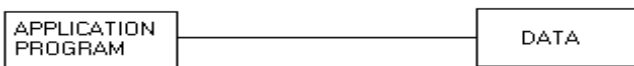
	Software	This is the set of programs used to control and manage the overall database. This includes the DBMS software itself, the Operating System, the network software being used to share the data among users, and the application programs used to access data in the DBMS.
	Hardware	Consists of a set of physical electronic devices such as computers, I/O devices, storage devices, etc., this provides the interface between computers and the real world systems.
	Data	DBMS exists to collect, store, process and access data, the most important component. The database contains both the actual or operational data and the metadata.
	Procedures	These are the instructions and rules that assist on how to use the DBMS, and in designing and running the database, using documented procedures, to guide the users that operate and manage it.



DATA INDEPENDENCE: The ability to modify a schema definition in one level without affecting a schema definition in the next higher level is called Data Independence.

It is independence between the programs and the data.

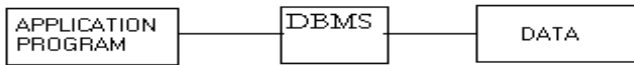
HOW IT WORKS



AP are based on Data and its Structures and Hence DO NOT PROVIDE DATA INDEPENDENCE

In the **conventional data processing** application programs, any change of data structure or format would require appropriate changes to the application programs. If major changes were to be made to the data, the application programs may need to be

In a **database system**, the DBMS provides the **interface** between the application programs and the data.



DBMS Act as INTERFACE between AP and Data and Hence PROVIDE DATA INDEPENDENCE

In DBMS when changes are made to the data representation, the **metadata** maintained by the DBMS is changed but the DBMS continues to provide data to application programs in the previously used way. The DBMS handles the task of transformation of data wherever necessary.

LEVELS

- Physical Data Independence
is ability to modify the physical schema without causing application programs to be rewritten.
- Logical Data Independence
is ability to modify the logical schema without causing application programs to be rewritten.

IMPORTANCE

Data independence plays **crucial role** in database environment like:

1. Improve performance.
Change in data structure does not require change in application program. Hide implementation details from the users. Allow users to concentrate on the general structure, rather than on low-level implementation details.
2. Standards can be enforced.
3. Security can be improved.
4. Integrity can be improved.
5. Better service to the users.
6. Cost of developing and maintaining systems is lower.
7. Flexibility in system improvement.
8. Inconsistencies can be reduced.

In essence, Integrity, consistency, security and availability can be ensured.

4.8. End unit Assessment Answer

1. What is the purpose of managing information?

The purpose of management information systems, including **decision support systems**, is to guide the decision-making process. Specifically, MIS combines people, computer hardware, software and communication devices to collect, store and convert raw data into useful information, which subsequently is communicated to the right people precisely when needed.

2. The difference between file processing system and database approach is as follow

Traditional File Processing System (TFPS): This is an approach which was used earlier, prior to DBMS. With this approach, users had to write their application programs to store data in form of files on the computer permanent storage device (Hard Disk).

A user must have knowledge of programming languages but this is not easy for a common computer user, even an experienced programmer would find it difficult to write a program each time a new database was to be created. Each application program written by a user had to define and manage its own data. **While**

The Database Management system (DBMS) is a referred to as a software system that is used to store, access, manage, organize, maintain, modify and delete data from databases. Database Management System (DBMS) also provides security features that protect against unauthorized users trying to gain access to confidential information and prevent data loss in case of a system crash. Some of the most popular software includes, **Microsoft Access, Oracle, Microsoft SQL Server, MySQL.**

MySQL is, one of the most popular database management systems used by online entrepreneurs. **Discuss the concept of data independence and explain its importance in Database environment.**

DATA INDEPENDENCE: The ability to modify a schema definition in one level without affecting a schema definition in the next higher level is called Data Independence. It is independence between the programs and the data.

IMPORTANCE: Data independence plays **crucial role** in database environment.

- Improve performance.
- Change in data structure does not require change in application program.
- Hide implementation details from the users.
- Allow users to concentrate on the general structure, rather than on low-level implementation details.
- Standards can be enforced.
- Security can be improved.
- Integrity can be improved.

- Better service to the users.
- Cost of developing and maintaining systems is lower.
- Flexibility in system improvement.
- Inconsistencies can be reduced.

In essence, Integrity, consistency, security and availability can be ensured.

Discuss the uses of databases in business environment.

Using Databases to Improve Business Performance and Decision-Making

Businesses use their databases to:

- Keep track of basic transactions
- Provide information that will help the company run the business more efficiently
- Help managers and employees make better decisions

4.9. Additional activity

4.9.1 Remedial

1. Define a database (result: look at key terms in text book of student)
2. With different examples, distinguish data and information (result: look at key terms in text book of student)
3. Differentiate DBMS to TFPS (result: look at database approach in text book of student)

4.9.2 Consolidation

1. List the advantages of DBMS in school, in bank, and in hospital (result: look at database Applications in text book of student)
2. Differentiate logical to physical independence in database. (result: look at Data independence in text book of student)
3. At your school as any example, explain physical independence

4.9.3 Extended

1. Describe the purpose of conceptual level (look at database access in text book of student)
2. Databases touch all aspects of our lives. justify this statement (database applications in text book of student)

Term	Date	Subject	Class	Unit No	Lesson No	Duration	Class size
Term 1	14 /02/ 2018	Computer Science	S5	3	1 of 9	80 minutes	40
Type of Special Educational Needs to be catered for in this lesson and number of learners in each category				slow learners and low vision students			
Unit title		Introduction to Database					
Key Unit Competence:		To be able to identify concepts of database and differentiate database models					
Title of the lesson		DEFINITIONS OF KEY TERMS					
Instructional Objective		After to follow discussions about definitions of key terms , students will be explain database and their role in our society perfectly					
Plan for this Class (location: in / outside)		This class will be held in class room and students will be organize in small groups					
Learning Materials (for ALL learners)		Computer lab Internet and textbooks to facilitate research					
References							
Timing for each step		Description of teaching and learning activity				Generic competences and cross cutting issues to be addressed + a short explanation	
	In computer laboratory, Learners will be asked to search on the internet what is Database and how a database is used in different areas						
	Teacher activities	Learner activities					

<p>Introduction</p> <p>15 minutes</p>	<p>Teacher Provide objective of the lesson to Learners</p> <p>-Describe key terms</p> <p>-Identify Areas where database is used</p> <p>Teacher give the instruction on how to perform the Learning Activity</p> <p>Teacher asks students to form groups of 5 students</p>	<p>Learners Listen and note the objectives of the lesson</p> <p>Students follow instructions</p> <p>students form groups of 5 students</p> <p>Students elect the chair and secretary of the group</p>	
<p>Development of the lesson</p> <p>(Harmonization and summary)</p> <p>50 minutes (task 1: 20 minutes, task 2: 20 minutes, task 3:10 minutes)</p>	<p>Teacher monitors the work in groups</p> <p>Teacher walks around to monitor what students are doing.</p> <p>Teacher see and how students are progressing towards the required knowledge</p> <p>Teacher corrects false answers</p> <p>Teacher completes the half correctly answers</p> <p>Teacher summarize the contents</p> <p>Teacher gives examples: should be done by students</p>	<p>Students work in formed groups</p> <p>Students work on the activity</p> <p>Group 1or 2 presents their answers on the on that activity.</p> <p>Other group reacts on answers of that group representing</p> <p>note down important points</p> <p>which summarized by the teacher</p>	

<p>Conclusion: (Assessment) 15 minutes</p>	<p>Teacher asks students to form groups of 2 students to perform the application Activity</p> <p>Application activities</p> <p>Remedial questions 4.1.1</p> <p>Compensation questions</p> <p>Extension questions</p>	<p>students form groups of 2 students and do the Application activity 4.1.1</p> <p>Students work individually on the Application activity 4.1.1</p> <p>In pairs students do the Application activity 4.1.1</p> <p>Individually students do the Application activity 4.1.1</p>	
<p>Teacher self-evaluation</p>	<p>To be completed by the teacher after the lesson</p>		

5.1. Key unit competence

To be able to define conceptual, logical and physical levels of a database with database creation and manipulation

5.2. Prerequisite/ Knowledge/skills

Students should ideally have some knowledge and skills related to database approaches (TFPS and DBMS), database models; data independence and view of data (see Unit 4).

5.3. Cross-Cutting Issues to be addressed

Financial Education: Students should do analysis of financial benefits of having a well-designed database compared to traditional file processing system. *(Integrate this issue after completing the unit)*

Standardization Culture: Well-designed database always present accurate information which is easy to retrieve. *(Integrate this issue during teaching)*

Inclusive Education: All students (students with and with no disabilities) should be involved in the database design lessons. *(Integrate this issue during teaching)*

Peace and Values Education: Students should be sensitized that relationship among different classes (in diversity) makes beauty. *(Integrate this issue during teaching entity relationship model)*

Gender education: Both (girls and boys) are involved in all learning and application activities in a class. *(Integrate this issue during teaching)*

5.4. Introductory Activity

Guidance On introductory activity

- This activity takes place in the computer lab or in classroom where each student should carefully read and analyze the scenario.
- Ask students to do the introductory activity in pair of 2 and let them do it independently.
- After some times (e.g. 15 minutes) move around in the class to see how students are working and assist them where it is necessary like helping slower learners to

understand very well scenario.

- Check the students' answers and provide to them feedback based on their answers and ideas.

Answers to introductory activity

1. The used approach was not well designed due to the following reasons:
 - Insertion anomaly
 - Data redundancy which leads to duplication of information and lack of data consistency
 - Update anomaly
 - Data isolation issues
 - Lack of flexibility
 - Lack of data security
 - Data dependence issue
2. Difficulties each department may encounter are: Retrieving information from different files and matching them would mean an increased burden. For example, suppose employee details such as firstname, lastname, emailid are stored only in employee_details file and not in payroll file. If we need to access payroll along with firstname of the employee, we have to retrieve details from two files overhead.
3. Efficient approach to suggest to Chief Executive Officer of AMAHORO Ltd is well-designed approach known as **database system**.

5.5. List of lessons

#	Lesson title	Learning objectives	Number of periods
1	Introductory activity		1
	Database design levels	Describe each levels of database design	3
	Conceptual level	Have a good understanding on design levels to make a functional database	
	Logical level		
	Physical level		
2	Database design steps	Enumerate database design steps starting from Investigation up to Data base management	1

3	Relational model	Identify important Entities and their Attributes from a given real life situation	
3A	Introduction	<p>Create a database with several table</p> <p>Describe table, record, field, cell, value, domain, Null, field data types and field size, constraints, table structure, degree, ,cardinality, candidate key, primary key ,alternate key, composite key ,foreign key, Relationship in tables, base table, base key, foreign table, foreign key, referential integrity rule</p> <p>Create a relationship between different tables</p>	2
3B	Queries in design view	Create queries using Design View	3
	Dynamic queries using parameter	Appreciate use of design view to graphically create new queries	1
4	Entity relationship model	<p>Identify important Entities and their Attributes from a given real life situation</p> <p>Draw an Entity and their associated attributes</p> <p>Draw an Entity Relationship Diagram</p> <p>Create a relationship between different tables</p>	4
5	Database optimisation through normalisation	<p>Describe meaning and steps of Normalization and various Normal form (1NF, 2NF,3NF, 4NF)</p> <p>Create a relationship between different tables</p> <p>Have a good understanding on design levels to make a functional database</p>	2
5A	1NF,2NF		
5B	3NF,4NF		4

Lesson 1: Database design levels

a. Prerequisites/Revision/Introduction

- Students should remember different database models but emphasizing more on Entity relationship and relational model. (See Unit 4)
- Teacher should help students to understand that data in relational model is implemented using practical applications (DBMS applications) such as MySQL, DB2, MS Access, SQL, etc.

b. Teaching resources

- Computer laboratory with Internet and MS Access
- Whiteboard/blackboard
- Marker/chalk
- Projector
- Textbooks to facilitate research

c. Learning activities

Guidance on activities

- Ask students to do the learning activity 5.1 in group of 3 and let them do it independently.
- Move around in the class to see how students are working, assist students where it is necessary like helping slower learners to understand very well problem
- To plan a session for students to present their responses
- Let students discuss their answers, then correct false answers and complete the partially answers and provide feedback.
- Summarise the content to teach based on the answers and ideas from students.

Answers to learning activity 5.1.

Teacher		
Attributes	Data Type	Reason for Choice
TeacherId	Numeric or alphanumeric	Numeric- can be sorted on numerical order integer, float, double, etc Alphanumeric-can be given a fixed length- Not used for calculation can include other characters besides digits for example +,() (char/varchar)
FirstName	alphanumeric àText/char/varchar	Can be sorted in alphabetical order
SurName	alphanumeric àText/char/varchar	Can be sorted in alphabetical order
Salary	Numericàfloat	Salary can contain floating point
Qualification	alphanumeric àText/char/varchar	Can be sorted in alphabetical order
Address	alphanumeric àText/char/varchar	Address can contain text, symbols and numbers.
Contact	Alphanumericà char/varchar	Contain can contain number and special symbols like +,()

Combination		
Attributes	Datatype	Reason
CombinationId	Numeric or alphanumeric	Numeric- can be sorted on numerical order (integer) Alphanumeric contains can contain number and text (char)
Combination Name	alphanumeric (Text/char/varchar)	It can contain texts and numbers It can be sorted in alphabetical order

Student attributes

Student		
Attributes	Datatype	Reason
StudentId	Numeric or Alphanumeric	Numeric- can be sorted on numerical order àinteger Alphanumeric Contain can contain number and text (char/varchar)
FirstName	alphanumeric àText/char/ varchar	It can contain texts and numbers It can be sorted in alphabetical order
SurName	alphanumeric àText/char/ varchar	It can contain texts and numbers It can be sorted in alphabetical order
Address	alphanumeric àText/char/ varchar	It can contain texts and numbers It can be sorted in alphabetical order

Subject attributes

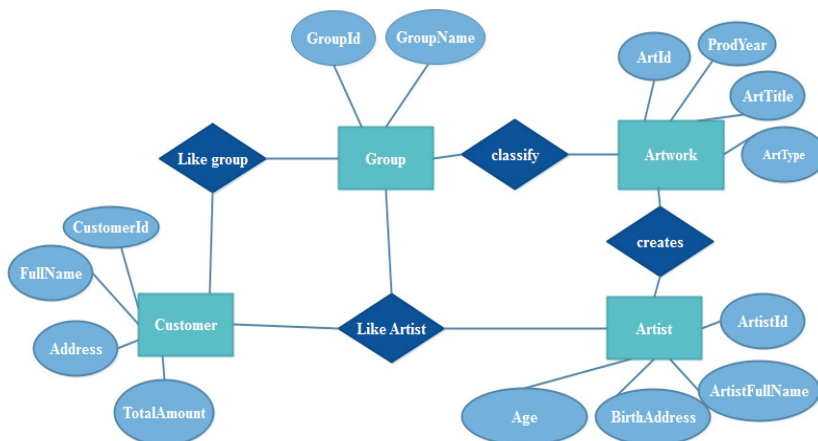
Subject		
Attributes	Datatype	Reason
SubjectId	Numeric or alphanumeric	Numeric- can be sorted on numerical order (integer) Alphanumeric contains can contain number and text (char/varchar)
SubjectTitle	alphanumeric (Text/char/ varchar)	It can contain texts and numbers It can be sorted in alphabetical order

2. Logical relationships between entities

- Teacher-Student → Teacher teaches Student
- Teacher-Subject → Subject is taught by Teacher
- Teacher-Combination → Teacher teaches in Combination
- Student-Subject → Student learns Subject

d. Answers to application activity 5.1

1



Lesson 2: Database design steps

a. prerequisites/Revision/Introduction

- Teacher should use the software life cycle (waterfall model) to explain the iterative steps of database design.

b. Teaching resources

- Computer laboratory with Internet
- Whiteboard/blackboard
- Marker/chalk
- Projector
- Notebooks/blank papers
- Textbooks to facilitate research

c. Learning activities

Guidance on learning activity

- Explain that database design is part of software development.
- Ask students to do the learning activity 5.2 in groups and let them do it independently.
- Move around in the class to see how students are working, assist students where it is necessary like helping slower learners to understand very well problem
- Plan session for students to present their responses

- Check the students' answers then correct false answers and complete the partially answers and provide feedback.
- Summarise the content to teach based on the answers and ideas from students.

Answers to learning activity 5.2.

1. Refer student book.
2. **Automation:** Computerized financial activities eliminate many of the burden and time-consuming issues associated with file based approach.

For example, once receipts are generated automatically making work less time-consuming.

Accuracy: The financial management system should be designed to be accurate. Once the data is entered into computerised system, all operations including additions, comparisons, subtractions, are done automatically by software. This minimizes error usually done in counting.

Data Access and sharing: Once all employees in the financial institutions use same computerised system; it becomes much easier for them to access information outside of their office securely. This is possible if an online **management system is being used.**

Reliability: Because the calculations and operations are so accurate, the financial statements prepared by computers are highly reliable.

Speed: Using software, the entire process of preparing reports and statements become faster. Managers do not have to wait for hours and days to prepare and write reports on papers.

Security: Once all information are stored in computers, it is safe from disasters such as fires, floods or malwares. Here the system can quickly restore on other computers in case of disasters.

Cost-effective: Using computerised management system in financial institutions is more efficient and effective than paper based accounting approach thus work will be done faster and less time consuming.

Visuals: Using computerized system helps users to view data in different format for example viewing data using tables and different types of **charts.**

d. Answer of Application activity 5.2.

- It clears database objectives and stabilizes its requirements
- It measures database progress.
- It helps in management and quick manipulation of data.
- Missing requirement can be easily identified.
- It encourages innovation and flexible design of database

Lesson 3: Relational model

LESSON 3 A: INTRODUCTION

a. Prerequisites/Revision/Introduction

Teacher should remind students the logical level of database design.

The way in which information is organized and stored can have a deep effect on how easy and efficient is to access and manage. Possibly the simplest and most useful way to organize information is to store it in tables. The relational model is centred on two-dimensional tables known as “relations”. Important part of the database design is to relate their attributes and relationship among them.

b. Teaching resources

- Computer laboratory with Internet
- Whiteboard/blackboard
- Marker/chalk
- Projector
- Notebooks/blank papers
- Textbooks to facilitate research

c. Learning activities

Guidance on learning activities

- Emphasize on the similarities between the following key terms: relations vs. object, records vs. row, value vs. cell and attribute vs. column
- Ask students to do the learning activity 5 individually and let them do it independently.
- Move around in the class to see how students are working, assist students where it is necessary like helping slower learners to understand very well problem
- Check the students’ answers then correct false answers and complete the partially answers and provide feedback.
- Summarize the content to teach based on the answers and ideas from students.

Answers to learning activity 5.3.

The properties to find in student object arranged in Tabular form 4x10

SN°	Student Id	First Name	Last Name	Age	Class	Combination	Admission Date	Contact	Address

d. Answers to application activities 5.3.

1.

Fields for a patient:	Fields for a doctor:
<ul style="list-style-type: none"> • PatientId • FirstName • FamilyName/SurName • DOB • DateofAdmission • Consultant • WardNumber • BedNumber 	<ul style="list-style-type: none"> • DoctortId • FirstName • FamilyName/SurName • Qualification • Birthdate • Department • OfficeNumber

2.

EmpId	EmpSname	EmpF-name	EmpLoca-tion	EmpJob-Code
1011	RUKUNDO	Jean Claude	Kigali	12
1013	NYIRAMANA	Sylvane	Huye	19
1014	UWIMANA	Yvette	Muhanga	29
1021	KAGABO	Peter	Musanze	13

i) Components of employee table are : Records,Columns,Cells/values,

ii) Domain of EmpId = {1011,1013,1014,1021}

iii) They are records 4 records

iv) They are 5 attributes

Fields	Datatype
EmpId	Numericàinteger
EmpSname	Text/Char

EmpFname	Text/Char
EmpLocation	Text/Cahr
EmpJobCode	NumericalInteger

Lesson 3b: Queries in design view+ dynamic queries using parameter

a. prerequisites/Revision/Introduction

- Students should know relational model having tables, fields and records and how to do analysis and choose specific data type for each field.
- Microsoft Access, graphical user interface is application software to use in this lesson.

b. Teaching resources

- Computer laboratory with Internet and Microsoft Access
- Whiteboard/blackboard
- Marker/chalk
- Projector
- Notebooks/blank papers
- Textbooks to facilitate research

c. Learning activities

- Emphasise on design view of MS Access
- Ask students to do the learning activity 5.4 individually and let them do it independently.
- Move around in the class to see how students are working, assist students where it is necessary like helping slower learners to understand very well problem
- Check the students' answers then correct false answers and complete the partially answers and provide feedback.
- Summarize the content to teach based on the answers and ideas from students.

Answers to learning activity 5.4.

- Design view
- Advantages of design view over other views: enables designer to design and set up database graphically without knowing command. It is easy to learn, setup and configure different objects such as tables, queries, forms, etc.

d. Answers to application Activity 5.4.

1. **Output:** All Cities from America where Population is greater than 8 million.

Population
 Name_of_city
 Sao Paulo
 New York

Field:	Name_of_city	Country	Population	Area
Table:	WorldCities	WorldCities	WorldCities	WorldCities
Sort:				
Show:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Criteria:			> 13	
or:				= 1590

Lesson 4: Entity relationship model

a. prerequisites/Revision/Introduction

- Teacher should remind students conceptual level exists in database design and help them review it.

b. Teaching resources

- Computer laboratory with Internet
- Whiteboard/blackboard
- Marker/chalk
- Projector
- Notebooks/blank papers
- Textbooks to facilitate research

c. Learning activities

- Help students to clearly understand two concept: Entity/object and Relationship along with the degree of relationship in real life.
- Ask students to do the learning activity 5.5 individually and let them do it independently.
- Move around in the class to see how students are working, assist students where it is necessary like helping slower learners to understand very well problem
- Let students present their responses

- Let students discuss their answers, then correct false answers and complete the partially answers and provide feedback.
- Summarise the content to teach based on the answers and ideas from students.

Answers to learning activity 5.5.

Teacher-Student: Teacher teaches Student, Student is taught by Teacher, One teacher can teacher many students → One to Many relationship

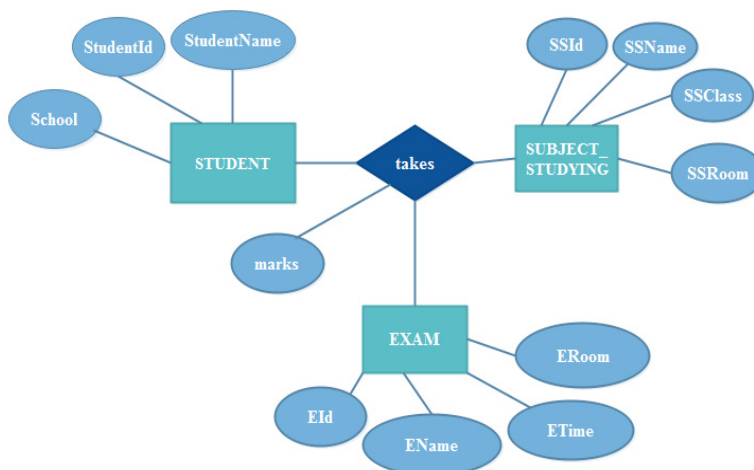
Teacher-Combination: Teacher teaches in combination, one teacher can teach in many combinations → One to many relationship

Student-Combination: Students belongs to combination, many students belong to one combination → Many to One Relationship

Teacher-Subject: Teacher teaches Subject; one teacher can teach one subject → one to one relationship or one teacher can many subject → one to many relationships.

d. Answers to application activity 5.5. Sub question 3

Sub question 1 and 2 learners have to be guided with teacher



Lesson 5: Database optimisation through normalisation

a. prerequisites/Revision/Introduction

- The teacher should help students to review the relational database model.

b. Teaching resources

- Computer laboratory with Internet
- Whiteboard/blackboard

- Marker/chalk
- Projector
- Notebooks/blank papers
- Textbooks to facilitate research

c. Learning activity

- Focus more on functional dependency and referential integrity.
- Explain that the process of dividing big table into smaller tables is called normalization.
- Ask students to do the learning activity 5.6 individually and let them do it independently.
- Move around in the class to see how students are working, assist students where it is necessary like helping slower learners to understand very well problem
- Let students present their responses
- Let students discuss their answers, then correct false answers and complete the partially answers and provide feedback.
- Summarize the content to teach based on the answers and ideas from students.

Answers to learning activity 5.6.

1. Customer may order several items, we do not know how many order entries to allow.
2. It is not simple, it makes it difficult to implement the data in a relational database
3. It has many anomalies such as

Data separation anomaly → Group repeating

For example, 5 items might be ordered by one customer

The table represents a repeating group. This is very wasteful of space and would make the database perform very poorly

If there is a repeating group, the attributes cannot sensibly be put into one relational table.

A table must have single rows and atomic attribute values

- Data duplication may occur → For our case; field customer occurs 5 times in the table
- Data inconsistency
- Update anomaly
- Deletion anomaly

4. A complex relation/entity must be converted to simple entities before it can be implemented in the relational database. This conversion process is called normalisation

d. Answers to application activity 5.6

1. **1NF:** It contains no repeating attribute or groups of attributes. Intersection of each tuple and attribute contains only 1 value

CUSTOMER					
Number	Customer Name	District	Province	ProductId	Description
005	UWIMANA Yvonne	Gisagara	South	1	HP Laser Jet Printer
005	UWIMANA Yvonne	Gisagara	South	2	Hair Trimmer
005	UWIMANA Yvonne	Gisagara	South	3	HP ProBook4530s
008	KAGABO Peter	Rusizi	West	2	Hair Trimmer
008	KAGABO Peter	Rusizi	West	7	POSITIVO BGH Laptop
008	KAGABO Peter	Rusizi	West	7	POSITIVO BGH Laptop
014	RUKUNDO Paul	Nyarugenge	Kigali	5	Lenovo L430 Laptop
002	MUGABO Tom	Gisagara	South	7	POSITIVO BGH Laptop
002	MUGABO Tom	Gisagara	South	1	HP Laser Jet Printer
002	MUGABO Tom	Gisagara	South	2	Hair Trimmer

2NF

CUSTOMER			
CustomerNumber	CustomerName	District	Province
005	UWIMANA Yvonne	Gisagara	South
008	KAGABO Peter	Rusizi	West
014	RUKUNDO Paul	Nyarugenge	Kigali

002	MUGABO Tom	Gisagara	South
-----	------------	----------	-------

CUSTOMER_PRODUCT	
Customer Number	Product Id
005	1
005	2
005	3
008	2
008	7
008	7
014	5
002	7
002	1
002	2

PRODUCT	
Product Id	Description
1	HP Laser Jet Printer
2	Hair Trimmer
3	HP ProBook4530s
4	POSITIVO BGH Laptop
5	Lenovo L430 Laptop

3NF

CUSTOMER	
CustomerNumber	CustomerName
005	UWIMANA Yvonne
008	KAGABO Peter
014	RUKUNDO Paul
002	MUGABO Tom

LOCATION	
Province	District
South	Gisagara
West	Rusizi
Kigali	Nyarugenge

PRODUCT	
ProductId	Description
1	HP Laser Jet Printer
2	Hair Trimmer
3	HP ProBook4530s
4	POSITIVO BGH Laptop
5	Lenovo L430 Laptop

CUSTOMER_PRODUCT	
CustomerNumber	ProductId
005	1
005	2
005	3
008	2
008	7
008	7
014	5
002	7
002	1
002	2

i) There is a multivalued dependency on SubjectTitle

- SubjectTitle → Teacher
- SubjectTitle → BookTitle

ii) To eliminate this dependency, table SUBJECT is divided into two tables as below:

- SUBJECT_TEACHER
- SUBJECT_BOOK

4NF

SUBJECT_TEACHER	
SubjectTitle	Teacher
Mathematics	Eric
Mathematics	Bosco
Computer Science	Callixte
Physics	Peter

SUBJECT_BOOK	
SubjectTitle	Books
Mathematics	Mathematics fundamentals
Mathematics	Mathematics for computer scientists

Computer Science	Database System concepts
Physics	Physics for Rwandan Secondary Students

5.6. Summary of the Unit

Database design focuses on conceptual, logical and physical levels. Knowing logic of internals of relational database, entity relationship model and relationships among entities and data optimisation technique is required to design a database that overcomes update, insertion and delete anomalies.

This unit is consisted of:

- Database design levels
- Database Design Steps
- Entity relationship types
- Data optimization through normalization

5.7. Additional information

Software used to draw E-R Diagrams and relational model are Edraw Max and MySQLWorkBench 6.3 CE respectively.

5.8. Answers of End of unit

Question 1.

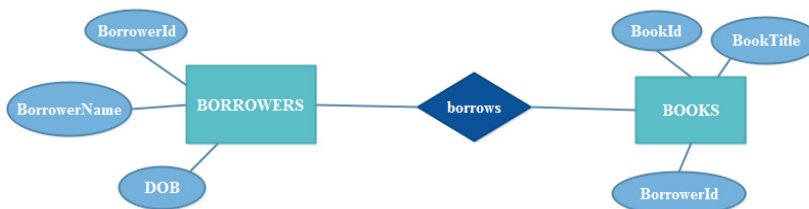
i) Borrowerid ,BookId are unique and stable

ii) BorrowerId

iii) BORROWERS candidate keys are: BookId, BookTitle BOOKS candidate keys are: BorrowerId, BorroweName-Assume that there is no borrowers having same name

iv) Relationship between BORROWERS and BOOKS is borrows

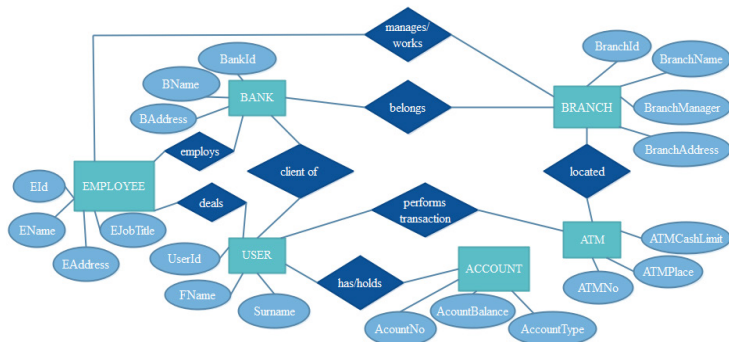
ER Diagram



v) Yes, table BOOKS exhibits referential integrity. Because BorrowerId appears in BOOKS entity is foreign key from reference table BORROWERS.

Question 2

ER diagram for Banking System with 6 Entities



Question 3

(i) Data type for each field:

PictureTitle → Text/Varchar

PictureArtist → Text/Varchar

PictureDescription → Text/Varchar

CatalogueNumber → Numeric(Integer)

PictureSize → Varchar

PicturePrice → Varchar

ArrivedDate → Date

Status → Text

(ii) The primary key is CatalogueNumber

(iii)

Field:	CatalogueNumber	PictureTitle	PictureArtist	PicturePrice	Status
Table:	PICTURE	PICTURE		PICTURE	PICTURE
Sort:					
Show:	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
Criteria:			= "GATOTO"		= "Unsold"
or:					

5.9 Additional activities

1.2.1. Remedial activities and answers

1. What are the database models that are used at conceptual level and logical level?

Answer:

Conceptual level we use ENTITY- RELATIONSHIP model (ERM) to represent all the data elements.

The logical level we use the RELATIONAL model.

2. Fill in the blanks:
 - produces a lower normal form.
 - A relational table must not contain.....groups.
 -refers to the level of database design which is concerned on how data will be encoded and stored. This level consists of practical applications.

Answer:

- a. Normalisation
 - b. Repeating groups
 - c. Physical
3. State database design steps.

Answer:

- Investigate the information.
 - Identify the objects.
 - Model the objects.
 - Identify the types of information for each object.
 - Identify the relationships between objects.
 - Database optimisation through normalisation
 - Data entry and manipulation
4. Differentiate entity and relationship.

Answer:

- Entity, defined as table/object that holds specific information (data). Student and Teacher are example of entities
- Relationships, defined as the associations or interactions between entities. For

example Student is taught by Teacher

5. Define the following terms:
 - b. Column
 - c. Record
 - d. Null
 - e. Degree

Answer

- a. **Column:** a database stores pieces of information or facts in an organized way. The principal storage units are called columns or fields or attributes.
- b. **Records:** each record/row represents a group of related data values. A row, or record, is also known as a tuple
- c. **Null value:** In many situations every row and column will contain data, but there cases where it makes sense for some columns to not contain a value because they are optional field.
- d. **Degree:** the degree is the number of attributes in a table

6. Suppose a student called UWIMANA work on his personal computer with Microsoft Office 2016 installed on it. She has created a database named SCHOOL using Microsoft Office Access 2016. This database contains three Access objects named Student, AllStudentsQuery, and StudentAddress. She wants to view these objects in the navigation pane. Which of the following options will you choose to accomplish the task?

- A. All Access Objects
- B. Navigate To Category
- C. Filter By Group
- D. Custom

Answer: A

1.2.5. Consolidation activities and answers

1. Based on the cardinality, explain the different types of relationships that can exist between entities.

Answer:

One-to one (1:1)

A single instance of an entity can relate to only one instance of the other entity. It is the relationship of one entity to only one other entity, and vice versa

Example: President-Country

Person-Passport

One-to-many (1: M)

An instance of one entity can relate to multiple instance of another instance. The relationship that associates one record of entity A to more than one record of entity B is called one-to-many relationship.

Example: 1 country can have many states.

Many-to-One Relationship Type (M: 1)

The relationship between EMPLOYEE and DEPARTMENT is an example of many-to-one relationship. Many employees can work in one department

Many-to-many (M: M): Multiple instances of an entity can relate to multiple instances of another entity.

Example: Many teachers can teach many students.

2. Each of the following is either an entity type and/or an entity. If it's an entity type, then provide examples of entities; if it's an entity, define a possible entity type.

- Toyota Fortuner
- Clothes
- Employee

Answer:

- **Toyota Fortuner** is an entity; *manufacturer* is a possible entity type.
- Clothes is entity type with entities: pants, trousers, suit, shirts, etc.;
- Employee is an entity type; KAGABO and UWIMANA are example of entities.

3. What is the cardinality and existence of each of the following relationships in just the direction given? State any assumptions you have to make.

- Husband to wife
- Car and steering wheel
- Student to degree
- Child to parent
- Player to team
- Student to course

Answer:

- Husband to wife → 1:1
- Car and steering wheel → 1:1
- Student to degree → 1:1

- Child to parent → 1:M
- Player to team → 1:M
- Student to course → M:M, 1:M

4. Which of the following data types is more commonly called Boolean?

- Yes/No
- Date/Time
- Hyperlink
- Attachment

Answer: A

EXTENDED ACTIVITIES AND ANSWERS

9. Consider the following table answer corresponding questions

EMPLOYEE							
EmpId	FullName	Designation	Salary	Doj	Dob	Country	City
101	KAREKEZI Ange	Accountant	240000	3/23/2003	1/13/1980	RWANDA	HUYE
102	GANZA Kevin	Head-IT	320000	12/2/2010	7/22/1987	UGANDA	KAMPALA
103	MUTONI Rehma	Customer Care	200000	6/24/2009	2/24/1983	BURUNDI	BUJUMBURA
105	NKUSI Anicet	Marketing Officer	310000	11/8/2006	3/3/1984	BURUNDI	BUJUMBURA
108	KARENZI Abdul	CEO	560000	12/29/2004	1/19/1982	RWANDA	KIGALI

- Identify the composite attribute and give reason
- Identify the primary key
- Which attribute could have a NULL value? Why?

Answer

- FullName → One Employee can have Firstname, Surname, MiddleName, NickName, etc.
- EmpId is primary key because it is stable attribute and unique.
- City, Country and Doj can be null because they are optional and they are not candidate keys

2. Consider the following table which holds information about employees and projects.

One employee can work on one or many projects and each project has a budget (in FRW) and time limit (in months) to be accomplished.

Assume EmpID and ProjectID are a composite PK.

EMPLOYEE_PROJECT			
EmpID	Budget	ProjectID	Period
E11	32,000,000	PR01	3
E11	40,000,00	PR02	5
E21	32,000,000	PR01	7
E21	27,000,000	PR03	8
E39	40,000,000	PR02	6
	17,000,000	PR04	

- i) Which normal form does table above belong to? and Why?
- ii) With examples, identify problems does table contain?
- iii) Explain the function dependency does exist in the table above?

Answer

i) 1NF, no repeating groups

ii) Anomalies are:

- Insertion anomaly
- Dummy value
- Deletion anomaly
- Update anomaly
- Data redundancy

iii) FD:

$$\{Budget, ProjectID, Budget\} \rightarrow EmpID$$

iv) How to avoid the anomalies?

The solution is to convert the table EMPLOYEE_PROJECT into higher normal by separating into two tables named PROJECT and EMPLOYEE as follow

PROJECT	
PK	<u>ProjectID</u>
	Budget

EMPLOYEE	
PK	<u>EmployeeID</u>
PK,FK	<u>ProjectID</u>
	Budget

PROJECT	
Project ID	Budget
PR01	32,000,000
PR02	40,000,000
PR03	27,000,000
PR04	17,000,000

EMPLOYEE		
EmpID	ProjectID	Period
E11	PR01	3
E11	PR02	5
E21	PR01	7
E21	PR03	8
E39	PR02	6

After separating data into two tables:

- No anomalies will be arisen if a budget is changed.
- No dummy values are needed for projects that have no employees assigned.
- If an employee's id is deleted, no important data is lost.

The following database stores information about bank, its customers and their loans.

Use it to answer asked questions.

LOAN			
LoanNumber	LoanType	BankBranch	Amount
C100001	Consumer loan	Musanze	1,000,000
AF100001	Asset Finance loan	Rubavu	54,000,000
MB120001	Microbusiness loan	Huye	3,000,000
AF100002	Asset Finance loan	Huye	124,000,000
MB120011	Microbusiness loan	Ngoma	800,000
MB120031	Microbusiness loan	Nyabihu	110,000
C100002	Consumer loan	Musanze	290,000

CUSTOMER			
CustomerID	CustomerName	LoanNumber	Address
10002	KAYIHURA	C100001	Musanze
10003	KAMALI	AF100001	Kicukiro
10004	UWAMALIYA	MB120001	Huye

10006	KUBWIMANA	AF100002	Ngoma
11006	MUKAMUSONI	MB120011	Rubavu
12006	AYINKAMIYE	C100002	Kicukiro
11016	MUKAMANA	MB120031	Musanze

- i) Find the names and address of all customers who have a loan from Musanze branch.
- ii) Find and show all customers who live in the same district as KAMALI.
- iii) Find and show customer id, names, Address, loan type and amount of customers who have loan type of "Asset Finance loan:
- iv) Consider the following query by example grid:

Field:	CustomerID	CustomerName	Address	BankBranch	Amount
Table:	CUSTOMER	CUSTOMER	CUSTOMER	LOAN	LOAN
Sort:					
Show:	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Criteria:					<3000000
or:					

What will be displayed?

Answers

- i) Query by example grid

Field:	CustomerName	Address	BankBranch
Table:	CUSTOMER	CUSTOMER	LOAN
Sort:			
Show:	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Criteria:			= "Musanze"
or:			

Output:

CustomerName

KAYIHURA

AYINKAMIYE

- ii) QBE grid

Field:	CustomerName	Address	
Table:	CUSTOMER	CUSTOMER	
Sort:			
Show:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Criteria:		= "Kicukiro"	
or:			

Output

CustomerName	Address
KAMALI	Kicukiro
AYINKAMIYE	Kicukiro

iii)

Field:	CustomerID	CustomerName	Address	LoanType	Amount
Table:	CUSTOMER	CUSTOMER	CUSTOMER	LOAN	LOAN
Sort:					
Show:	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Criteria:					
or:					

Output

Customer ID	Customer Name	Address	LoanType	Amount
10002	KAYIHURA	Musanze	Consumer loan	1000000
10003	KAMALI	Kicukiro	Asset Finance loan	54000000
10004	UWAMALIYA	Huye	Microbusiness loan	3000000
10006	KUBWIMANA	Ngoma	Asset Finance loan	124000000
11006	MUKAMUSONI	Rubavu	Microbusiness loan	800000
12006	AYINKAMIYE	Kicukiro	Consumer loan	290000
11016	MUKAMANA	Musanze	Microbusiness loan	110000

iv)

Customer ID	CustomerName	Address	BankBranch	Amount
10002	KAYIHURA	Musanze	Musanze	1000000
11006	MUKAMUSONI	Rubavu	Ngoma	800000
12006	AYINKAMIYE	Kicukiro	Musanze	290000
11016	MUKAMANA	Musanze	Nyabihu	110000

6.1. Key Unit Competence

To be able to apply pointers for dynamic memory allocation and structure as user defined data type in C ++ program

6.2. Prerequisite knowledge and skills

Students should have knowledge and skills related to introduction to C++ and Operating learnt in Senior 4 Unit-10: Introduction to C++ programming and Unit- 11: Expression and Operator in C++ language Unit-13: Function in C++ language. Unit-14: Array in C++ language.

6.3. Cross-cutting issues to be addressed

- **Inclusive Education:** covered when all students (students with and with no disabilities) take place and are involved in the same class.
- **Peace and Values Education:** during group activities debates, presentation, the teacher will encourage learners to help each other to respect opinions of colleagues
- **Gender education:** involve both girls and boys in all activities: No activity is reserved only to girls or boys. Teachers should ensure equal participation of both girls and boys during activities as well as during cleaning and tidying up related activities after computer lab activities.

6.4. Guidance on the introductory activity

Instruction to do the introductory activity

1. This activity takes place in the class where teacher organizes students into groups.
2. Ask students to do the introductory activity in their respective groups.
3. Move around to see how students are working.
4. Invites representatives of groups to presents their findings.
5. Ask the rest of the class to evaluate findings and some questions to boost the students.
6. Tell the students that they will have complete answers in the coming lessons.

Answers to Introductory Activity

- (Pointer)**: The label shown in the door of classroom represent the address of that class and direct the student (point them) to their appropriate classroom.
- (Memory)**: The figure showing the length of the classroom means that from one room to another there is 10 meter and one classroom can host 30 students. (e.g. 30 students are being allocated to B1 p2 classroom)
- (structure)**: The attribute of the entity students: Student First name, Student last name, Student Age, Student class, Student Father, Student Mother, ...
- (Declaration of pointer)**: `int *student [30];` /* Declares an array of pointers */
The pointers array has 30 elements; each element is a pointer to a variable with int type.
- (Memory Allocation)**: *Because there are increment of 30 students in senior 4, the school have to add one room in order to hold the new students allocated on it.*
- void* malloc (30)**: `malloc ()`: `void* malloc (size_t size)`;
Allocation of memory block: In C++ the function Malloc () Allocates requested size of bytes of memory and returns a pointer to the beginning of the block).

6.5. List of lessons

#	Lesson title	Learning objectives	Number of periods
1	Pointers in C++		
1A	Definition of Pointers Dereference and reference operators	Define, declare and use pointers in C++ programming language	2
	Declaration, initialization of pointer variable in C++		2
1B	Graphical representation of pointers for referencing memory allocation Incrementing and Decrementing Pointer in C++	Describe the use of pointers for dynamic memory allocation with graphical representation	2
1C	Arrays and Comparison of pointers in C++ Subtracting and Assignment of pointers in C++		Read and interpret a simple C++ program containing pointer and provide the intended results
1D	Pointers and function in C++		

2	Memory Allocation	Describe the use of pointers for dynamic memory allocation with graphical representation Appreciate the use of Pointers for dynamic memory allocation	3
3	C++ Structure		
3A	Definition of structure in C++ Initialization, Declaration of structure in C++	Define, declare and use structures in C++ programming language	2
3B	Calculate Memory consumption by structure Access members of a structure	Describe the use of Structure as user defined data type and its memory allocation	2
3C	Use of Structure Pointer to structure	Read and interpret a simple C++ program containing structure and provide the intended results	2
3D	Nesting structure Array of structure		2

Guidance on different lessons outlined above

Lesson 1: Pointers in c++

a. Prerequisites/Revision/Introduction:

For learners to well understand this lesson have to review the introduction on C++.

b. Teaching resources:

1. Computer lab
2. Some of the software that can be used are: DEV C++, Visual Basic, Turbo C++
3. Internet and textbooks to facilitate research

c. Learning activity

Guidance:

- Organizes students in group in order to do learning Activity 6.1,
- Elect the group leader and secretary.
- Teacher gives the instructions on how to do Learning Activity 6.1
- Teacher walks around and sees if students are doing activity in their respective group.
- Representatives of 3 or 4 groups present their answers to the rest of the class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Summarizes the contents and gives examples that should be done by students.

Answer of activity 6.1

Proposed discussion:

1. (Pointers)

- Kayiranga will take it and use it for submitting the work on time but in its place, he should leave a note to Iradukunda saying: “I took your Computer and C++ book for doing my work and I’m going to my home, I will return back when I am done, Thanks”.

This note is like a pointer because contains the address that will orient Kayiranga to the place where he will find his materials. The paper on which the note is written is like a pointer variable.

- When he comes back, he will know directly the address (where he can find his materials)

2. (pointer and Address)

- To get to the student number 5 from number 2 you increase by skipping two students.
- To get to the student number 8 from number 15 you decrease by skipping 7 students.

d. Application activity

Answers of application activity 6.1

Gives the instructions and requests students to do Application activity 6.1 in the groups as they have done on Learning Activity 6.1

Activity 1:

- Refer to Student Book (unit 6 section 6.1.1)
- Refer to Student Book (unit 6 section 6.1.2 and section 6.1.3)

Activity 2:

a. `i=π` b. `*pi=&i;` c. `pd=π` d. `pd=i;`

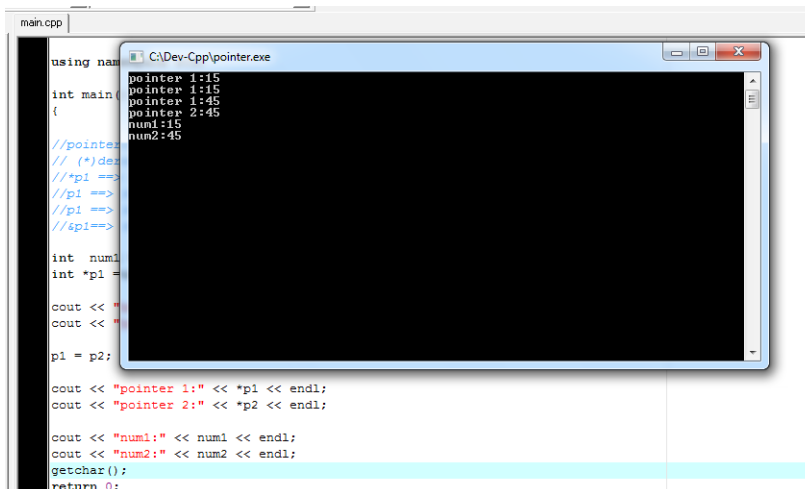
Activity 3:

- The pointer `p` should store the address of a variable, not a normal value.
- The pointer `p` should store the address of a pointer variable, not an address of a normal variable.
- The pointer `p` should store the address of a pointer variable, not a normal value.

Activity 4:

```
#include<iostream>
using namespace std;
//pointers -store the address of a variable
// (*)dereference operator
//*p1 ==> return value of the variable the pointer is pointing to
//p1 ==> return address of where variable is stored
//p1 ==> return address of pointer
//&p1==> returns address of pointer
int main()
{
int num1 = 15, num2 = 45;
int *p1 =&num1,*p2= &num2;
cout<< "pointer 1:" <<*p1 <<endl;
cout<< "pointer 1:" <<*p1 <<endl;
p1 = p2;
cout<< "pointer 1:" << *p1 <<endl;
cout<< "pointer 2:" << *p2 <<endl;
cout<< "num1:" << num1 <<endl;
cout<< "num2:" << num2 <<endl;
getchar();
return 0;
}
```

Output:



```
using namespace std;
int main()
{
    //pointer
    // (*d)
    // *p1 ==>
    // *p1 ==>
    // *p1 ==>
    // *p1 ==>
    // *p1 ==>

    int num1;
    int *p1;

    cout << "num1:" << num1 << endl;
    cout << "num2:" << num2 << endl;

    p1 = p2;

    cout << "pointer 1:" << *p1 << endl;
    cout << "pointer 2:" << *p2 << endl;

    cout << "num1:" << num1 << endl;
    cout << "num2:" << num2 << endl;
    getch();
    return 0;
}
```

The screenshot shows a code editor with a C++ program and its output. The program defines two integer variables, num1 and num2, and two pointers, p1 and p2. It prints the values of num1 and num2, then assigns p1 to p2. Finally, it prints the values of *p1 and *p2, which are the same as num1 and num2 respectively. The output window shows the following text:

```
pointer 1:15
pointer 1:15
pointer 1:45
pointer 2:45
num1:15
num2:45
```

Lesson 2: Memory Allocation

a. Prerequisites/Revision/Introduction:

Students get prerequisites from Unit-15 Senior four student book: Introduction to Operating System and pointer in C++.The target of this lesson is to introduce to students how memory is allocated to the different program during the execution.

b. Teaching resources:

- Computer lab
- Some of the softwares that can be used are: DEV C++, Visual Basic, Turbo C++
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- This activity takes place in the class where teacher organizes students into groups.
- Ask students to do the introductory activity in their respective groups.
- Move around to see how students are working.
- Invites representatives of groups to presents their findings.
- Ask the rest of the class to evaluate findings and some questions to boost the students.

Learning activity 6.2:Answers are used to introduce Memory Allocation.

- When an importer brings his/her goods to MAGERWA he/she is allocated a space in where to put those goods: this is a way Memory space is reserved for specific purposes. It is a process by which computer programs and services are assigned with physical or virtual memory space to be used by a program when it is executed.
- When he/she withdraws his/her goods from Magerwa, the occupied space is given to other customers for use: Once the program has finished its operation, the memory is released and allocated to another program or merged within the primary memory

d. Application activity 6.2

Activity 1:

Explain the memory allocation: Memory allocation is the process of setting aside sections of memory in a program to be used to store variables, and instances of structures and classes.

Static Memory: When you declare a variable or an instance of a structure or class. The memory for that object is allocated by the operating system. The name you declare for the object can then be used to access that block of memory.

Dynamic memory allocation is when an executing program requests that the operating system gives it a block of main memory. The program then uses this memory for some purpose

When you use dynamic memory allocation you have the operating system designate a block of memory of the appropriate size while the program is running.

For other clarification Refer to student book Memory Allocation section 6.2

Lesson 3: Structure in c++

a. Prerequisites/Revision/Introduction:

Students have knowledge and skills about Introduction to C++, Unit-5: Database design. The target of this activity is to introduce to students on how variables of different data types can be collected under a single name and to make students able to understand how the collected data are arranged in the computer memory.

b. Teaching resources:

- Computer lab
- Software editor: e.g. DEV C++, Visual Basic, Turbo C++
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- Organizes students in group in order to do learning Activity 6.1
- Elect the group leader and secretary
- Teacher gives the instructions on how to do Learning Activity 6.1
- Teacher walks around and sees if students are doing activity in their respective group
- Representatives of 3 or 4 groups present their answer to the rest of class
- Students react on the finding/ answers from other groups
- Teacher corrects false answers and completes the incomplete answers
- Summarizes the contents and gives examples that should be done by students.

Answer activity6.3

1. The data type attributes are:

```
    firstname: Char;  
    secondname:char  
    age: int  
    degree: char  
    salary: float.
```

2. It is easy because Arrays of structure are good for storing information of a single entity
3. If **employee** is considered as a single entity, how will it be declared in the program?

```
    struct employee  
    {  
        char firstname[20];  
        char secondname[20];  
        int age;  
        char degree [20];  
        float salary;  
    }
```

Answer of Application Activity 6.3

Activity:

- Refers to Student book section 6.3.1
- Emp.emName;

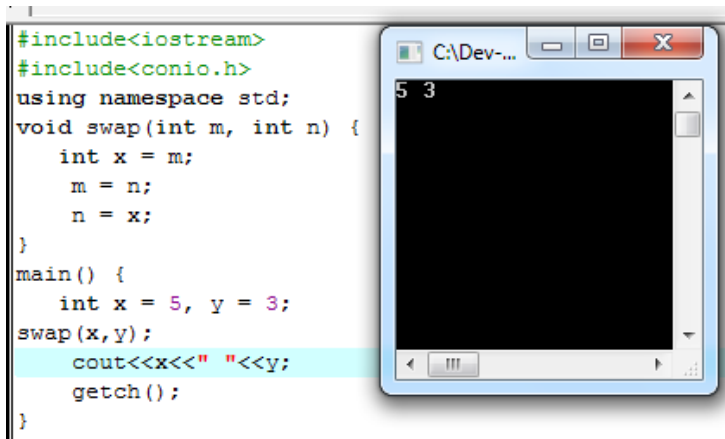
Activity 2:

```
#include <iostream>
#include <cstring>
#include <conio.h>
using namespace std;
struct student
{
int ID;
string name;
int Age;
};
int main(){
struct student st[4];
int i;
//taking values from user
for(i=0; i<4; i++)
{
cout<< "Student " <<i + 1 <<endl;
cout<< "Enter ID" <<endl;
cin>>st[i].ID;
cout<< "Enter name" <<endl;
cin>>st[i].name;
cout<< "Enter Age" <<endl;
cin>>st[i].Age;
}

for(i=0; i<4; i++){ //printing values
cout<< "Student " <<i + 1 <<endl;
cout<< "ID : " <<st[i].ID <<endl;
cout<< "Name : " <<st[i].name <<endl;
cout<< "Age : " <<st[i].Age <<endl;
}
getch();
return 0;
}
```

Activity 3: What is the output of the following program?

```
swap(x,y);
cout<<x<<" "<<y;
getch();
}
```



```
#include<iostream>
#include<conio.h>
using namespace std;
void swap(int m, int n) {
    int x = m;
    m = n;
    n = x;
}
main() {
    int x = 5, y = 3;
    swap(x,y);
    cout<<x<<" "<<y;
    getch();
}
```

The screenshot shows a C++ IDE with a code editor on the left and a console window on the right. The code defines a swap function and calls it in the main function. The console window displays the output "5 3".

Activity4:

- A -.
- B -->

Activty5:

Answers: Compile error; because Class member variables cannot be initialized

6.6. Summary of the Unit

In this unit, we discussed pointer, memory allocation and structures in C++.

In summary, structs are used to collect a number of related variables into one structure, thereby creating a new kind of data type. Variables in a struct are accessed with the dot operator “.”, and variables in a struct pointer are accessed with the membership access operator “->”.

A way of use pointers with structs is to create linked lists, which are structures that can hold any number of “links.” To create a new variable from an arbitrary pointer, use the new operator to allocate a piece of memory to point to. To free the memory again, use the delete operator with the pointer variable’s name. Once the program has finished its operation, the memory is released and allocated to another program or merged within the primary memory. Programs and services are assigned with a specific memory as per their requirements when they are executed.

6.7. Addition information

For more information about this unit, there is some site that contains the addition information that can be used for more explanation like www.cplusplus.com or www.tutorialpoint.com.

6.8. Answers of End Unit Assessment answers

This part provides the answers of end unit assessment activities designed in integrative approach to assess the key unit competence with cross reference to the textbook

Activity:

What would be printed from the following C++ program?

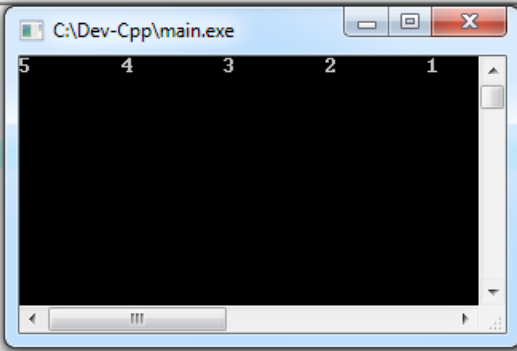
```
#include<iostream>
#include<conio.h>
using namespace std;
int main(){
int x[5]={1,2,3,4,5};
int *p=x;
int i;
for(i=0;i<2;i++)
{
int temp=*(p+i);
*(p+i)=*(p+4-i);
*(p+4-i)=temp;
}
for(i=0;i<5;i++)
cout<<x[i]<<"\t";
getch();
return 0;
}
```

```
#include<iostream>
#include<conio.h>
using namespace std;
int main(){
int x[5]={1,2,3,4,5};
int *p=x;
int i;
for(i=0;i<2;i++)
{
int temp=*(p+i);
*(p+i)=*(p+4-i);
*(p+4-i)=temp;
}

for(i=0;i<5;i++) cout<<x[i]<<"\t";

getch();

return 0;
}
```



The screenshot shows a window titled "C:\Dev-Cpp\main.exe" with a black background. The output of the program is displayed as five numbers: 5, 4, 3, 2, 1, each followed by a tab character. The numbers are aligned to the right of the line, with the number 5 on the far left and 1 on the far right.

Activity 2:

By accessing member of structure using C++ write a simple running program that will display the output of your birthday and today date.

```
#include <iostream>

using namespace std;

int main()
{
    struct birth
    {
        int day;
        int month;
        int year;
    } b1, b2;
    b1.day=23;
    b1.month=2;
    b1.year=2010;
    b2.day=15;
    b2.month=3;
    b2.year=2018;
    cout<< "My Birth day is:"<<b1.day<<"/"<<b1.month<<"/"<<b1.year<<"\n\n";
    cout<< "To day date is:"<<b2.day<<"/"<<b2.month<<"/"<<b2.year<<"\n\n";
    getchar();
    return 0;
}
```

Activity3:

Write a program that calculates the Roots of a Quadratic Equation $2x^2 + 6x + 4$ in C++ using pointers.

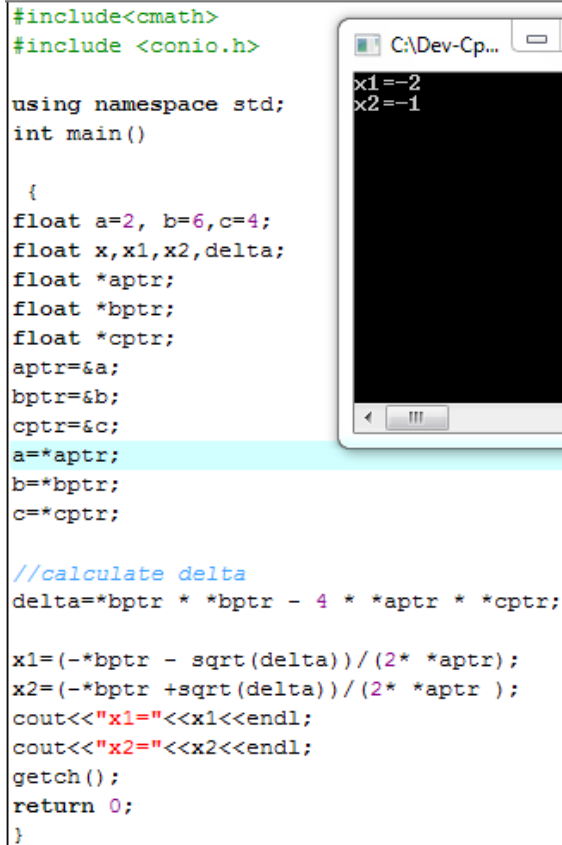
Answers:

```
#include <iostream>
#include <cmath>
#include <conio.h>
using namespace std;
int main()
{
    float a=2, b=6,c=4;
    float x,x1,x2,delta;
    float *aptr;
    float *bptr;
    float *cptr;
    aptr=&a;
    bptr=&b;
    cptr=&c;
```

```

a=*aptr;
b=*bptr;
c=*cptr;
//calculate delta
delta=*bptr * *bptr - 4 * *aptr * *cptr;
x1=(-*bptr - sqrt(delta))/(2* *aptr);
x2=(-*bptr +sqrt(delta))/(2* *aptr);
cout<<"x1="<<x1<<endl;
cout<<"x2="<<x2<<endl;
getch();
return 0;
}

```



The image shows a code editor window on the left and a console window on the right. The code editor contains the following C++ code:

```

#include<cmath>
#include <conio.h>

using namespace std;
int main()

{
float a=2, b=6,c=4;
float x,x1,x2,delta;
float *aptr;
float *bptr;
float *cptr;
aptr=&a;
bptr=&b;
cptr=&c;
a=*aptr;
b=*bptr;
c=*cptr;

//calculate delta
delta=*bptr * *bptr - 4 * *aptr * *cptr;

x1=(-*bptr - sqrt(delta))/(2* *aptr);
x2=(-*bptr +sqrt(delta))/(2* *aptr );
cout<<"x1="<<x1<<endl;
cout<<"x2="<<x2<<endl;
getch();
return 0;
}

```

The console window shows the output of the program:

```

x1=-2
x2=-1

```

6.9. Additional activities

6.9.1. Remedial Activities

1. Define a pointer, structure in C++ (Refer to teacher book section 6.1.1)
2. Give the general syntax of declaration / initialization of pointers and Structure (Refer to teacher book section 6.1.2;6.1.3 and 6.3.2;6.3.3)
3. With different examples, declaration / initialization pointers and Structure (Refer to teacher book section 6.3.1)

4. List types of operators used for accessing members of a structure (Refer to teacher book section 6.3.5)

6.9.2. Consolidation activities

1. After giving general syntax of different operators, use simple example to explain malloc, calloc, free and realloc functions(Refer to teacher book section 6.2.2)
2. Explain the operator New and Delete (Refer to teacher book section 6.2.2)

6.9.3. Extended

1. Using pointer in C++, Display month name according to the month number.

Answer:

```
#include<iostream>
#include<conio.h>
using namespace std;
int main()
{
    int n;
    int *nptr;
    nptr=&n;
    n=*nptr;
    cout<< "Month No:-> ";
    cin>>&nptr;
    switch(n)
    {
        case 1:
            cout<<"January\n";
            break;
        case 2:
            cout<<"February\n";
            break;
        case 3:
            cout<<"March\n";
            break;
        case 4:
            cout<<"April\n";
            break;
        case 5:
            cout<<"MAy\n";
            break;
        case 6:
            cout<<"June\n";
            break;
        case 7:
            cout<<"July\n";
            break;
        case 8:
            cout<<"August\n";
            break;
        case 9:
            cout<<"September\n";
            break;
        case 10:
            cout<<"October\n";
            break;
        case 11:
            cout<<"November\n";
            break;
        case 12:
            cout<<"December\n";
            break;
        default:
            cout<<"invalid Month number\nPlease try again ....\n";
            break;
    }
    getch();
}
```

2. An array stores details of 20 students (ID, name, marks in three subject). Write a program to create such an array and print out a list of students who have failed in more than one subject.

Answers :

```
#include<iostream>
#include<conio.h>
#include <stdlib.h>
using namespace std;
struct stud
{
int ID;
char name[50];
float mark1, mark2, mark3;
};
typedef stud S;
intmain()
{
S student[20];
for(int i =0 ; i< 2 ; i++)
{
cout<< "\n Enter Student ID : “;
cin>> student[i].ID;
cout<< “\n Enter Name : “;
cin>>student[i].name;
cout<< “\n Enter marks of three subjects :”;
cin>> student[i].mark1 >> student[i].mark2 >> student[i].mark3 ;
}
cout<< “\n STUDENTS FAILED IN MORE THAN 1 SUBJECT \n “;
cout<<”Student ID” << “\t” <<”Student Name”<< “\n”;
for(inti =0 ; i< 2 ; i++)
{
if(( student[i].mark1< 40 && student[i].mark2 < 40) ||
(student[i].mark2 < 40 && student[i].mark3 < 40) ||
( student[i].mark1 < 40 && student[i].mark3 < 40))
cout<< student[i].ID << “\t\t” << student[i].name << “\n”;
}
getch();
return 0;
}
```


7.1. Key Unit Competence

To be able to explain common concepts of Object Oriented Programming (OOP) and implement them in C++.

7.2. Prerequisite knowledge and skills

Learners should have knowledge and skills on basic C++ programming (senior 4 and senior 5) and be able to write and run some C++ programs.

7.3. Cross-cutting issues to be addressed

- **Standardization culture:** in all lessons make sure that learners follow standards of coding exposed by programmers in order to make a standard program.
- **Gender Education:** in all lessons make sure that if the school is mixed in terms of gender make sure that the groups are gender balanced and all are participating when they are working on given activities and other work assigned by the teacher.
- **Peace and values Education:** in all lessons make sure that learners share resources available in computer laboratory. They should also avoid stealing computer and its different components. They should maintain safety of computers in laboratory.
- **Inclusive Education:** in all lessons make sure that learners with disability are mixed and participate with their fellows without disability in the same groups for their assigned work.
- **Financial education:** through discussion, at the end of the unit allow learners to understand the contribution of Object Oriented Programming paradigms in software development in terms of reusability, reduced cost of software development.

7.4. Guidance on the introductory activity

Introduction to do the introductory activity

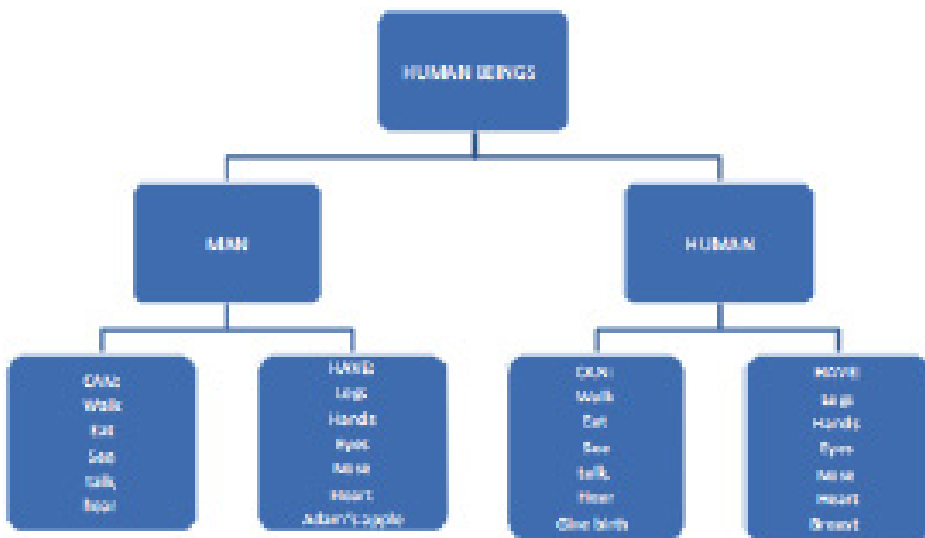
- This activity takes place in smart classroom where a group of four learners must log into a computer where it is possible or use student books. Ask learners to go to the page where is the introductory activity of **Unit 7** in textbook.
- Ask learners to answer the questions in the introductory activity in their

respective groups.

- Give time to the learners to work independently on activity.
- Move around to see how learners are working.
- Ask some questions to boost the learners.
- Guide the learners to well organize their findings.

Here are possible answers to the introductory activity,

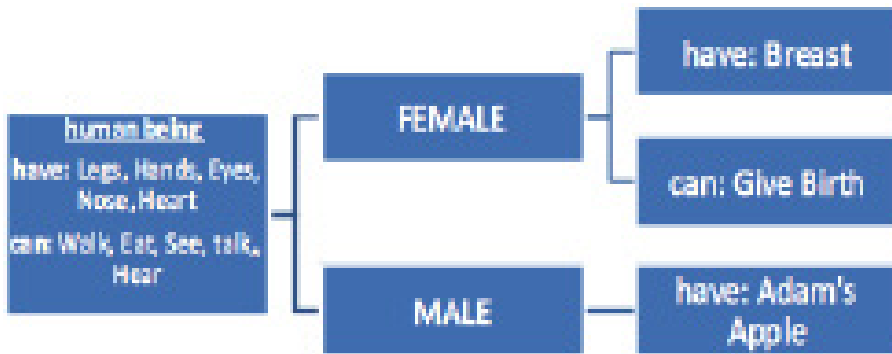
1. Human beings are categorized into two groups (Female and Male).
2. All Human and Man have two legs, two hands, two eyes, a nose, a heart, and so on.
3. Mans have Adam’s Apple but not female, Female have breast but not men.
4. Both Males and Females perform some common functions like walk, eat, see, talk, hear etc. but there are some specific functions for each group of Human Beings.
5. The diagram that illustrate the relationship among entities raised in scenario of human being:



6. Functions raised by question 3,4 and 5 are: Male and Female, entity male and female depends on Human being.
7. There is no need to repeat the properties and functions of human being entities to male and female because there some functions that are common to both like: Walk, Eat, See, talk, hear etc. And there are also the parts of body which are common to both like: legs, hands, eyes, nose, heart, etc. But there are some functions and parts which are particular to each. It is here that Object Oriented Programming

concepts involve.

8. New diagram of entities:



9. Let's discuss the answers given to the introductory activity

Class: Here we can take **Human Being** as a class. A class is a blueprint for any functional entity which defines its properties and its functions. Like Human Being, having body parts, and performing various actions.

Inheritance: Considering Human Being a class, which has properties like hands, legs, eyes etc. and functions like walk, talk, eat, see etc. Male and Female are also classes, but most of the properties and functions are included in Human Being, hence they can inherit everything from class Human Being using the concept of **Inheritance**.

Objects: My name is TUMUKUNDE, and I am an **instance/object** of class Female. When we say, Human Being, Male or Female, we just mean a kind, you, your friend, me we are the forms of these classes. We have a physical existence while a class is just a logical definition. We are the objects.

Abstraction: Abstraction means, showcasing only the required things to the outside world while hiding the details. Continuing our example, **Human Beings** can talk, walk, hear, eat, but the details are hidden from the outside world. We can take our skin as the Abstraction factor in our case, hiding the inside mechanism.

Encapsulation: To explain this concept with our example let's take an example of Our Legs that help us walk. Our hands, help us hold things. This binding of the properties to functions is called Encapsulation.

Polymorphism: Polymorphism is a concept, which allows us to redefine the way something works, by either changing how it is done or by changing the parts using which it is done. Both the ways have different terms for them.

If we walk using our hands, and not legs, here we will change the parts used to perform something. Hence this is called **Overloading**.

And if there is a defined way of walking, but I wish to walk differently, but using my legs, like everyone else. Then I can walk like I want, this will be called as **Overriding**.

7.5. List of lessons (including assessment)

#	Lesson title	Learning objectives	Number of periods
1	Introduction to Object Oriented Programming (OOP)	List and explain basic Object Oriented Programming concepts	3
2	Class definition in C++	Describe different Object Oriented Syntax applied in C++ program	2
3	Object in C++	Able to use Class and Object in programming	3
4	Data Encapsulation and Data Abstraction in C++	Describe class with data members and some function members defined inside and outside class definition.	3
5	Friends function in C++	Create objects in main program from a class and access object data and object functions, constructor, destructor and friend function.	3
6	Polymorphism in C++	Able to Apply the concepts of Polymorphism in C++	3
7A	Constructors in C++	Define and use constructor in C++	3
7B	Destructors on C++	Define and use destructor in C++	3
8A	Introduction to Inheritance in C++	Be able to define inheritance and appreciate the advantages of inheritance in C++.	3
8B	Multi-level Inheritance in C++	Derive a new class from base class in various mode of derivation: Public, protected and private in all forms of inheritance.	3
8C	Multiple inheritance in C++		3
8D	Hybrid inheritance		3
	Evaluation		1
		Total	36

Lesson 1: Introduction to Object Oriented Programming (OOP)

Duration: 3 Periods: 120 minutes

a. Prerequisites/revision/ introduction:

Learning activity 7.1 is used to introduce the lesson, through group work, learners discuss about the scenario given and the question accordingly.

b. Teaching resources:

- Computer lab/smart classroom
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- Ask Learners to open Internet or text books and start searching all possible answers about activity.
- Move around and see if learners are doing activity.
- Ask Group representatives to present their findings.
- Learners react on the findings presented by other groups
- Summarize the contents (Notes in learners' book)
- Give the guidance on how to do Application activity 7.1
- Learners do the Application activity 7.1

Answers of activity 7.1

1. Structure can be used to create that program because the structure in C++ is a collection of variables of different data types under a single name.
2. Refer to sub-unit 7.1.1 in learner's book that discusses about the concepts of Object Oriented Programming language.

d. Answer of application activity 7.1

1. **Ref:** sub unit 7.1 in learner's book, discusses about the concepts of OOP concepts.
2. **Ref:** sub unit 7.1 in learner's book, Advantages of Object Oriented Programming.
3. The features added to standard C++ to form Object Oriented programming are: Class, object, polymorphism, access specifier, encapsulation etc.

Lesson 2. Class Definition in C++

Duration: 2 Periods: 80 minutes

a. Prerequisites/revision/ introduction:

Learning 7.2 introduces the lesson. Teacher asks learners what they have learnt in the previous lesson 7.1. From the given answers by learners, teacher introduces the activity 7.2. The objective of activity 7.2 is to identify some key words and new way of programming introduced by Object Oriented programming.

b. Teaching resources:

- Computer lab /smart classroom
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- Organize learners in groups of two or three to work on activity
- Learners discuss on the program codes provided in activity 7.2 refer to the learner's book.
- Move around and see if learners are doing activity
- Learners present their answers
- Learners react on the findings presented by other groups
- Teacher summarizes the contents (Notes in learners' book)
- Guide learners on how to do Application activity 7.2
- Learners do the Application activity 7.2

Answers of Learning activity 7.2

1. New keywords are: class, public, private.
2. The part that body of class is defined inside the curly brackets and terminated by a semicolon at the end.
3. Data members of class test are: "a" of the type Integer and "b" of the type float.
4. Function members of class test are: number1() and number2()
5. Variable m1 is an object of class test and it is used when we want to call the member functions of our class.

d. Answers for Application activities 7.2

a. Errors:

- On line 6, Access specifier is ending with semi-colon, correct way is of writing that access specifier have to be **public**:
- On line 7, type is missing when declaring a function (**eg. Void set_values(int,int)**).
- On the last line, semi-colon (;) is missing to end class definition.

b.

```
#include <iostream>
using namespace std;
class Rectangle
{
    intwidth,height;
public:
    void set_values (int,int);
    intarea() {return width*height;}
};
```

Lesson 3: Object in c++

Duration: 3 Periods: 120 minutes

a. Prerequisites/revision/ introduction:

Learning activity 7.3 introduces the lesson. Teacher ask learners what they have learnt in the previous lesson 7.1 and 7.3 From the given answers by learners, teacher introduces the activity 7.3 which is related to what they are going to learn in lesson 7.3.

b. Teaching resources:

- Computer lab /smart classroom
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance:

- Organize learners in groups of two or three to work on activity.
- Learners discuss on the program codes provided in activity 7.3 refer to the learner's book.
- Move around and see if learners are doing activity.
- Learners present their answers.

- Learners react on the findings presented by other groups.
- Summarize the contents (Notes in learners' book).
- Guide learners on how to do Application activity 7.3
- Learners do the Application activity 7.3

d. Answers of activity 7.3

1.

```

#include<iostream>
#include<conio.h>
using namespace std;
class school
{
private:
    char school_name[10];
    char school_code[10];
    int number_of_learners,number_
of_teachers;
public:
    void read_school()
    {
        cout<<"enter
the school name, school code,
number of learners and number of
teachers"<<endl;
        cin>>school_
name>>school_code>>number_of_
learners>>number_of_teachers;
    }
    void print_school()
    {
        cout<<school_name<<"\t|
t"<<school_code<<"\t"<<number_
of_learners<<"\t|
t"<<number_of_teachers<<endl;
    }
};
int main()
{
    school a1[29];
    for(int a=0;a<5;a++)
    {
        a1[a].read_school();
    }
    cout<<"_____
_____ "<<endl;
    cout<<endl<<"SCHOOL NAME\t|tCODE\t
tLEARNERS\tTEACHERS"<<endl;
    cout<<"-----
"<<endl;
    for(int a=0;a<5;a++)
    {
        a1[a].print_school();
    }
    cout<<en
dl<<"-----";
    getch();
}

```

2.

Data member(s)	Member function(s)	Class(s)	Object(s)
School name	Read_school()	School	a1
Code of school	Print_school()		
Combination			
Number of learners			
Number of teacher			

Answer of application activity 7.3

1. Refer to learner's book **unit 7.3**

2.

```
#include<iostream>
using namespace std;
class person
{
    private:
        char
        fname[20],lname[20];
        int age;
    public:
        void getdata()
        {
            cout<<"enter the first name, last
            name and age";

            cin>>fname>>lname>>age;
        }
        void putdata()
        {
            cout<<"First
            name: "<<fname<<endl;
            cout<<"Last
            name: "<<lname<<endl;
            cout<<"age:
            "<<age<<endl;
        }
};
intmain()
{
    person a1;
    a1.getdata();
    a1.putdata();
    return 0;
}
```

3.

```
#include<iostream>
#include<conio.h>
using namespace std;
class temperature
{
    float f,c;
    public:
    float getdata()
    {
```

```
        cout<<"Enter Value for farenheit degree to
        find for celsius:- ";
        cin>>f;
        c = (f-32)/1.8;
        return(c);
    }
    void display(void)
    {
        float v;
        v=getdata();
        cout<<"CELSIUS DEGREE = "<<v;
    }
};
int main()
{
    temperature celsius;
    celsius.display();
}
```

4.

```
#include<iostream>
#include<conio.h>
using namespace std;
class result
{
    char name[14];
    char surname[29];
    float vb,cpp,wd,KINYARWANDA,sum,mean;
    double percent;
    public:
    void readident(void)
    {
        cout<<"Enter your name and
        surname:"<<endl<<"\n\n";
        cin>>name>>surname;
    }
    void readmarks(float a, float b, float c, float
    d)
    {
        vb=a;
        cpp=b;
        wd=c;
        KINYARWANDA=d;
    }
}
```

```

void calculate(void)
{
sum=vb+cpp+wd+KINYARWANDA;
mean=sum/4;
percent=sum*1.25;
}
void display(void)
{
cout<<"\n\n You are"<<" "<<name<<"
"<<surname<<"\n";
cout<<"Here are your results:\n\n"<<endl;
cout<<"1. Visual Basic:"<<vb<<endl;
cout<<"2. C++ Programming:"<<cpp<<endl;
cout<<"3. Web Design:"<<wd<<endl;
cout<<"4.
KINYARWANDA:"<<KINYARWANDA<<endl;
cout<<"5. Mean="<<mean<<endl;
cout<<"6. Percentage:"<<percent<<endl;
}
};
int main()
{
float e,f,g,h;
cout<<"\n\n Enter the
marks in VB, cpp, wd and in
KINYARWANDA:"<<endl<<"\n\n";
cin>>e>>f>>g>>h;
result *test;
test=new result;
test->readmarks(e,f,g,h);
test->readident();
test->calculate();
test->display();
delete test;
test=NULL;
getch();
}

```

5.

Lesson 4: Data Encapsulation and Data Abstraction in C++

Duration: 3 Periods: 120 minutes)

a. Prerequisites/revision/ introduction:

For the learners to well understand this lesson, they should have knowledge and skills of C++ programming especially the Lesson 1,2 and 3 of Object oriented programming (refer to learner’s book, Unit 7, sub-units 1,2 and three).

b. Teaching resources:

- Computer lab /smart classroom
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance:

- Organize learners in groups of three
- Learners discuss the possible answers on learning activity 7.4 (Ref to student book)
- Give time to the learners in order to let them work on a given activity.
- Move around checking if the learners are all active in their groups.
- Group representatives present their findings.
- All learners participate in open discussion on the findings presented by other groups
- Summarize the contents by reflecting to data encapsulation and data abstraction in C++.
- Guide learners on how they are going to do the application activity 7.4
- Learners do the activity.

Answers of activity 7.4

Answer: when driving a car, there are some mechanisms exposed to the driver in order to control its functionality like, breaks to stop the car, gear to control speed, buttons to control the radio set and air conditioners of the car but there are other parameters hidden where the driver cannot know how exactly gear box allows him to control speed of the car, how ignitions happens etc. this is what is reserved by Data encapsulation and Data abstraction. Where:

- **Data Abstraction:** data abstraction is a process of representing the essential features without including implementation details.
- **Data Encapsulation:** Data encapsulation, also known as data hiding, is the mechanism whereby the implementation details of a class are kept hidden from the user.

d. Answers of Application activity 7.4

1. **Data Encapsulation:** Data encapsulation is known as data hiding is the mechanism whereby the implementation details of a class are kept hidden from the user.
2. Refer to student notes sub unit 7.4 (data encapsulation and data abstraction).

3.

```
#include <iostream>
using namespace std;
class Adder {
public:
    Adder(int i = 0) {
        total = i;
    }
    // Abstracted part
    void addNum(int number) {
        total += number;
    }
    // Abstracted part
    int getTotal() {
        return total;
    }
private:
    // encapsulated part
    int total;
};
int main() {
    Adder a;
    a.addNum(10);
    a.addNum(20);
    a.addNum(30);
    cout << "Total " << a.
    getTotal() << endl;
    return 0;
}
```

Lesson 5: Friends function in c++

duration: 3 Periods: 120 minutes

a. Prerequisites/revision/ introduction:

For the learners to well understand this lesson, they should have knowledge and skills of C++ programming especially the Lesson 1,2 and 3 of Object oriented programming (refer to learner's book, Unit 7, sub-units 1,2 and three).

b. Teaching resources:

- Computer lab /smart classroom
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance:

- Organize learners in groups of three and introduce the learning activity 7.5 from learner's book.
- Learners discuss the possible answers on learning activity 7.5 (Referring to student book)
- Give time to the learners in order to let them work on a given activity.
- Move around checking if the learners are all active in their groups.
- Group representatives present their findings.

- All learners participate in open discussion on the findings presented by other groups
- Summarize the contents referring to the learner's book.
- Raise Financial education as cross-cutting issue relating it to the learning activity 7.5. where two schools share resources available.
- Guide learners on how they are going to do the application activity 7.5.
- Learners do the application activity 7.5.

Answers of activity 7.5

1. For G.S TUMURERE to access resources (books) from the library of G.S UMWANANKUNDI, both schools will sign the M.O.U(Memorandum Of Understanding) that let them share resources.
2. Let's explain the above relating it to friend function in C++, Friend function is the way that let a non-member function access an object's private or protected data. So it is with this context that a friend function has to be declared using keyword **friend** that can be considered as the **M.O.U** that two schools have to sign in order to create a good understanding among them to help G.S TUMURERE to access resources (**Books**) that is considered as object's private or protected data in the example given.

d. Answers of Application activity 7.5

1. Friend function is defined or declared using keyword 'friend' before the function prototype inside the class.
2. A non-member function cannot access an object's private or protected data. But, sometimes this restriction may force programmer to write long and complex codes. So, friend function is a mechanism built in C++ programming to access private or protected data from non-member functions.
3. Here is a simple C++ program that calculate them mean of two numbers entered by the user applying mean as a friend function.

```
#include<iostream>
#include<conio.h>
using namespace std;
class base {
int val1, val2;
public:
void get() {
cout<< "Enter two values:";
cin>> val1>>val2;
}
friend float mean(base ob);
```

```
};
float mean(base ob) {
return float(ob.val1 +
ob.val2) / 2;
}
intmain() {
base obj;
obj.get();
cout<< "\n Mean value is : "
<< mean(obj);
getch();
}
```

Lesson 6: Polymorphism in c++

Duration: 3 Periods: 120 minutes

a. Prerequisites/revision/ introduction:

For the learners to well understand this lesson, they should have knowledge and skills basic OOP principles of C++ like Class and Object. Learning activity 7.6 will help learners to well understand the meaning of Overloading.

b. Teaching resources:

- Computer lab /smart classroom
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance:

- Organize learners in groups and introduce the learning activity 7.6 from learner's book.
- Learners discuss the possible answers on learning activity 7.6 (Referring to student book)
- Give time to the learners and let them work on a given activity independently in their groups.
- Move around checking if the learners are all active in their groups.
- Group present the activity.
- All learners participate in open discussion on the findings presented by other groups.

- Summarize the contents using learners text book.
- Guide Learners on how they are going to do the application activity 7.6.
- Learners do the activity.

Answers of activity 7.6

1. At home Bosco will behave like a son,
2. In the market, he will behave like a customer,
3. At school Bosco will behave like a student.

d. Answers of Application activity 7.6

1. Answer: d

Explanation: It never increases function definition overhead, one way or other if you don't use polymorphism, you will use the definition in some other way, so it actually helps to write efficient codes.

- 2.

OPERATOR	OVERLOADED
+	Yes
?:	No
&	Yes
.*	No
-	Yes

3. Output:

GAKWAYA went to school He is back from school

4. Operators can be overloaded in a C++ program to carry out the same type of operations on objects. For example, when we overload a binary operator using a member function, only one object has to be passed to the overloaded operator function since the other object is assumed to be the object invoking the function. We can also use multiple overloading by combining more than one type of operator overloading.

Lesson 7A: Constructors

Duration: 3 Periods: 120 minutes

a. Prerequisites/revision/ introduction:

For the learners to well understand this lesson, they should have knowledge and basic skills on OOP principles of C++ like Class and Object. Learning activity 7.7 Part I will help

learners to well understand the meaning and the use of destructors in C++.

b. Teaching resources:

- Computer lab /smart classroom
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance:

- Organize learners in groups and introduce the learning activity 7.7 Part I from learner’s book.
- Learners discuss the possible answers on learning activity 7.7Part I (Referring to student book)
- Give time to the learners in order to let them work on a given activity.
- Move around checking if the learners are all active in their groups.
- Group present the activity.
- All learners participate in open discussion on the findings presented by other groups.
- Summarize the contents using learners text book.
- Guide Learners on how they are going to do the application activity 7.7 Part I
- Learners do the activity.

Answers of activity 7.7

- **Ref:** student book 7.8.1 (constructors)

d. Answers of Application activity 7.7 Part I

- Ref: student book 7.7.1 (characteristics of constructor)
- Ref: student book 7.7.1 (default constructor)

Lesson 7B: Destructors

Duration: 3 Periods: 120 minutes

a. Prerequisites/revision/ introduction:

For the learners to well understand this lesson, they should have knowledge and basic skills on OOP principles of C++ like Class and Object. Learning activity 7.7 Part II will help learners to well understand the meaning and the use of constructor in C++.

b. Teaching resources:

- Computer lab /smart classroom
- Internet and textbooks to facilitate research

c. Learning activities:**Guidance:**

- Organize learners in groups and introduce the learning activity 7.7 Part II from learner’s book.
- Learners discuss the possible answers on learning activity 7.7 Part II (Referring to student book)
- Give the time to the learners in order to let them work on a given activity.
- Move around checking if the learners are all active in their groups.
- Group present the activity.
- All learners participate in open discussion on the findings presented by other groups.
- Summarize the contents using learners text book.
- Guide Learners on how they are going to do the application activity 7.7 Part II
- Learners do the activity.

Answers of activity 7.7

1. **Ref:** student’s book 7.8.2 Destructors

d. Answers of Application activity 7.7 Part II

1. A C++ program that contains constructor and destructor

```
#include<iostream>
using namespace std;
class A
{
    public:
    A()//constructor
    {
    cout<< “Hello “;
    }
    ~A()//destructor
    {
    cout<< “welcome to the world of programming”;
    }
};
intmain()
{
    A obj1;
}
```

2. Example of a program that use constructor and destructor to prompt the user to enter two numbers and calculate the sum of those numbers

```
#include<iostream>
using namespace std;
class A
{
    private:
        inta,b,c;
    public:
        A()
        {
            cout<< "enter the value of a and b: "<<endl;
            cin>>a>>b;
        }
        ~A()
        {
            cout<< "the sum of a and b is: "<<a+b;
        }
};

intmain()
{
    A obj1;
    return 0;
}
```

Lesson 8A: Inheritance

Duration: 3 Periods: 120 minutes

a. Prerequisites/revision/ introduction:

For the learners to well understand this lesson, they should have knowledge and basic skills on OOP principles of C++ like Class and Object. Learning activity 7.8 Part I will help learners to well understand the meaning and the use of constructor in C++.

b. Teaching resources:

- Computer lab /smart classroom
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance:

- Organize learners in groups and introduce the learning activity 7.8 Part I from learner's book.
- Learners discuss the possible answers on learning activity 7.8 Part I in groups (Referring to student book)
- Give time to the learners and let them work on a given activity.

- Move around checking if the learners are all active in their groups.
- Group present the activity.
- All learners participate in open discussion on the findings presented by other groups.
- Summarize the contents using learners text book.
- Guide Learners on how they are going to answer the questions of application activity 7.8 Part I
- Learners do the activity.

Answers of Learning activity 7.8 PART I

Answer: In scenario 1 the father will be considered as base class and the child as derived class.

d. Answers of Application activity 7.8 Part I

Question 1: Application activity 7.8

Answer:

- The base class is School, the derived class is student
- DISP() will access m member from class Teacher and U member from class student
- Object of class student will access DISP(), INDATA() and OUTDATA()
- NO, because function OUT() is a member of class school and school is not accessible base class of teacher, so OUT() is not accessible.

Lesson 8B: Multi-Level Inheritance

Duration: 3 Periods: 120 minutes

a. Prerequisites/revision/ introduction:

For the learners to well understand this lesson, they should have knowledge and basic skills on OOP principles of C++ like Class and Object. Learning activity 7.8 Part II will help learners to well understand the meaning and the use of constructor in C++.

b. Teaching resources:

- Computer lab /smart classroom
- Internet and textbooks to facilitate research

c. Learning activities:

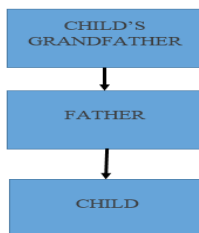
Guidance:

- Organize learners in groups and introduce the learning activity 7.8 Part II from learner’s book.
- Learners discuss the possible answers on learning activity 7.8 Part II in groups (Referring to student book)
- Give the time to the learners in order to let them work on a given activity.
- Move around checking if the learners are all active in their groups.
- Group present the activity.
- All learners participate in open discussion on the findings presented by other groups.
- Summarize the contents using learners text book.
- Guide Learners on how they are going to answer the questions of application activity 7.8 Part II
- Learners do the application activity.

Answers of activity 7.8 Part II

Question 2: activity 7.8

Answer:



d. Answers of Application activity 7.8 Part II

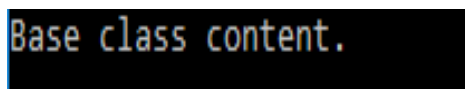
Question 2: Application activity 7.8

Answer:

```
#include <iostream>
using namespace std;
class A
{
    public:
    void display()
    {
        cout<<"Base class content.";
    }
};
class B : public A
```

```
{
};
class C : public B
{
};
int main()
{
    C obj;
    obj.display();
    return 0;
}
```

Output:



```
Base class content.
```

Lesson 8C: Multiple Inheritance

Duration: 3 Periods: 120 minutes

a. Prerequisites/revision/ introduction:

For the learners to well understand this lesson, they should have knowledge and basic skills on OOP principles of C++ like Class and Object. Learning activity 7.8 Part III will help learners to well understand the meaning and the use of constructor in C++.

b. Teaching resources:

- Computer lab /smart classroom
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance:

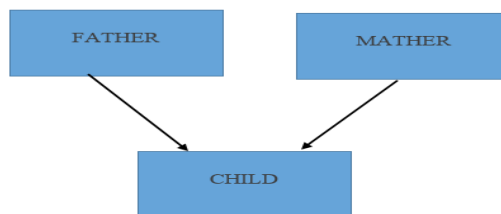
- Organize learners in groups and introduce the learning activity 7.8 Part III from learner's book.
- Learners discuss the possible answers on learning activity 7.8 Part III in groups (Referring to student book)
- Give time to the learners in order to let them work on a given activity.

- Move around checking if the learners are all active in their groups.
- Group present the activity.
- All learners participate in open discussion on the findings presented by other groups.
- Summarize the contents using learners text book.
- Guide Learners on how they are going to answer the questions of application activity 7.8 Part III
- Learners do the application activity.

Answers of Learning activity 7.8 Part III

Question 3: Learning Activity 7.8

Answer:



d. Answers of Application activity 7.8 Part III

Question 3: Application Activity 7.8

Answer:

```

20
10

```

Lesson 8D: Hybrid Inheritance

Duration: 3 Periods: 120 minutes

a. Prerequisites/revision/ introduction:

For the learners to well understand this lesson, they should have knowledge and basic skills on OOP principles of C++ like Class and Object. Learning activity 7.8 Part IV will help learners to well understand the meaning and the use of constructor in C++.

b. Teaching resources:

- Computer lab /smart classroom

- Internet and textbooks to facilitate research

c. Learning activities:

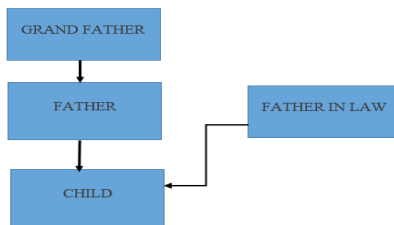
Guidance:

- Organize learners in groups and introduce the learning activity 7.8 Part IV from learner’s book.
- Learners discuss the possible answers on learning activity 7.8 Part IV in groups (Referring to student book)
- Give time to the learners in order to let them work on a given activity.
- Move around checking if the learners are all active in their groups.
- Group present the activity.
- All learners participate in open discussion on the findings presented by other groups.
- Summarize the contents using learners text book.
- Guide Learners on how they are going to answer the questions of application activity 7.8 Part III
- Learners do the application activity.

Answers of activity 7.8 Part IV

Question3: Learning Activity 7.8

Answer: Diagram that represent scenario 3 of learning activity 7.8



d. Answers of Application activity 7.8 Part IV

Question 4: Application activity 7.8

Answer:

```

class A
{
  .....
};
class B : public A
{
  .....
};
  
```

```

class C
{
    .....
};
class D : public B, public C
{
    .....
};

```

7.6. Summary of the Unit

- **A class** is a user defined data type used to implement an abstract object.
- **An object** is an instance of a class.
- **A class** having no objects is known as an Abstract Class.
- **A class definition** has members which could be data members or member functions.
- **A member function** is a function which is a part of a class. A member function has access to private members of a class which other external functions do not have.
- A class has 3 kinds of access specifiers, private, public, protected.
- **Private Members** are those members which can only be accessed by the member functions.
- **Public Members** are those members which can be accessed by any function in the entire program.
- The practice of wrapping up of data and functions together in a single unit is known as **Encapsulation**.
- **Data Abstraction** is defined as bringing the data down to its essentials.
- **The process of using an operator or a function** in different ways for different set of inputs given is known as **polymorphism**.
- **Constructors** are special member functions which can be included in the class for automatic initialization at the time of object creation.
- Constructors have the same name as that of the class they are initialized in. They also have no return type and are automatically called at the time of object creation.
- **A copy constructor** is an overloaded constructor function in which an object of the same class is/are passed as reference parameter(s).
- **The destructor** is the counterpart of the constructor. It is a member function that called automatically when a class object goes out of scope.
- **OOPS** has various advantages over procedural programming. OOPS has close relation between the real world objects and user created classes.
- **Compilers for Object Oriented programs** are able to detect conceptual errors

hence increasing program reliability.

- **Its various features like** encapsulation, Inheritance, data abstraction, polymorphism make it much more advantageous than procedural programming hence object oriented languages like C++, Java are experiencing a rapid increase in popularity among other programming languages.
- **Inheritance** is the concept of creating a new class, (derived class) from an already existing class (Base Class)
- **The derived class** can contain all the features of its base class and additional features of its own.
- **A derived class is declared** using the following format in C++:
 - Syntax:
 - `class derived_className: Access_specifier Base_className.`
 - **There are three type of access specifiers** ‘Public’, ‘Protected’ and ‘Private’.
 - **The ‘Public’** type access specifier allows minimum amount of data hiding to take place.
 - **The ‘Protected’** type access specifier provides levels of data protection between that of ‘public’ or ‘private’ type access specifiers.
 - **The members under the ‘Protected’** type access specifier can be passed on to the derived classes but cannot be accessed by objects of classes.
 - **The ‘Private’ type access specifier** provides highest level of data protection. Members under the ‘Private’ type access specifiers cannot be inherited by derived classes neither can they be accessed by objects of these classes.
 - **Constructors and Destructors of base classes** cannot be inherited by derived classes.
 - **Whenever an object of a derived class** is declared or initialized the default constructor for the base class is automatically called for.
 - **A class can be derived from one or more base classes.** When the derived class inherits its properties from a single base class it is defined as ‘Single Inheritance’ where as when a derived class derives its properties from more than one base class ‘Multiple Inheritance’ is said to be observed. The code for initiating multiple inheritances is given below:

```
class A
{
    ...
};
class B
{
    ...
};
class C : public A, public B // Multiple Inheritance
{
    ...
};
```

7.7. Addition information for teachers

- If there are student with vision impairment, you can use software like: JAWS(Job Access With Speech) and NVDA(Non vision Desktop Access).
- This book contains some exercises and answers about the unit, you can add others according to the unit progression.

7.8. End unit assessment answers

1. Ref: Student's book Unit 7.
2. Class definition begins with the keyword **class**. The body of class definition is delimited with braces (**{and}**). Class definition is terminated with a **semicolon**.

```
Class class_name
{
    Access_specifier:
    Member1;
    Access_specifier:
    Member2;
    ... ..
};
```

3.

```
#include <cstdlib>
#include <iostream>
using namespace std;
class rectangle
{
    int x,y;
public:
    void set_values(int,int);
    int area()
    {
        int res;
        res=x*y;
        return(res);
    }
};
void rectangle::set_values(int a, int b)
{
    x=a;
    y=b;
}
int main(int argc, char *argv[])
{
    int t,v;
    cout<<"enter values of a and b: "<<endl;
    cin>>t>>v;
    rectangle rect;
    rect.set_values(t,v);
    cout<<"area of rectangle is "<<rect.area()<<endl;
    system("PAUSE");
    return EXIT_SUCCESS;
}
```

4.

a. OUTPUT:

```
Balance110
Acc no.9
Balance111
Acc no.0
Balance110
Acc no.-10
```

b.

```
00
1010
55
```

```
#include <iostream>
class City {
public:
    int inhabitants,gpy; //growth per year
    City(inta,int b){
        inhabitants=a;
        gpy=b;
    }
};
int main () {
    City A(50,3),B(70,2);
    int i=0;
    begin:
        A.inhabitants+=A.gpy*A.inhabitants/100;
        B.inhabitants+=B.gpy*B.inhabitants/100;
        i++;
        if (A.inhabitants>B.inhabitants)
            std::cout<<"In "<<i<<"year(s), A will surpass
B\n";
        else goto begin;
    return 0;
}
```

5.

```
#include<iostream>
#include<conio.h>
using namespace std;
class student
{
private:
    int admno;
    char sname[20];
    float eng,math,science;
    float total;
    float ctotal()
    {
        return eng+math+science;
    }
public:
    void Takedata()
    {
        cout<<"Enter admission number ";
        cin>>admno;
```

```

        cout<<"Enter student name ";
        cin>>sname;
        cout<< "Enter marks in english, math, science ";
        cin>>eng>>math>>science;
        total=ctotal();
    }
    void Showdata()
    {
        cout<<"Admission number "<<admno<<"\nStudent name
"<<sname<<"\nEnglish "
        <<eng<<"\nMath      "<<math<<"\nScience
"<<science<<"\nTotal "<<total;
    }
};
int main ()
{
    student obj;
    obj.Takedata();
    obj.Showdata();
    getch();
    return 0;
}

```

6.

```

#include<iostream>
#include<conio.h>
using namespace std;
class BOOK
{
    int BOOKNO;
    char BOOKTITLE[20];
    float PRICE;
    void TOTAL_COST(int N)
    {
        float tcost;
        tcost=PRICE*N;
        cout<<tcost;
    }
public:
    void INPUT()
    {
        cout<<"Enter Book Number ";
        cin>>BOOKNO;
        cout<<"Enter Book Title ";
        cin>>BOOKTITLE;
        cout<<"Enter price per copy ";
        cin>>PRICE;
    }
    void PURCHASE()
    {
        int n;
        cout<<"Enter number of copies to purchase ";
        cin>>n;
        cout<<"Total cost is ";
        TOTAL_COST(n);
    }
};
int main()
{
    BOOK obj;
    obj.INPUT();
}

```

7.

```
        obj.PURCHASE();
        getch();
        return 0;
    }

#include<iostream>
#include<conio.h>
using namespace std;
class Distance
{
private:
    int feet;
    float inches;
public:
    void setdist(intft, float in)
    {
        feet=ft; inches=in;
    }
    Distance add(Distance);
    void disp();
};
Distance Distance::add(Distance D)
{
    Distance t;
    t.inches=inches + D.inches;
    t.feet =0;
    if(t.inches>=12.0)
    {
        t.inches-=12.0;
        t.feet++;
    }
    t.feet +=feet + D.feet;
    return t;
}
void Distance::disp()
{
    cout<<feet<<"\ "<<inches<<"\ " "<<endl;
}
intmain()
{
    Distance d1,d2,d3;
    d1.setdist(10,7.1);
    d2.setdist(23,5.5);
    d3=d1.add(d2);
    cout<<"\n distance 1 = ";d1.disp();
    cout<<"\n distance 2 = ";d2.disp();
    cout<<"\n distance 3 = ";d3.disp();
    getch();
    return 0;
}
```

8.

```
#include<iostream>
#include<conio.h>
using namespace std;
class time
{
private:
    int hours;
    int minutes;
```

```

public:
    void settime(int h, int m)
    {
        hours=h; minutes=m;
    }
    time sum(time);
    void showtime();
};
time time::sum(time TM)
{
    time t;
    t.minutes = minutes + TM.minutes;
    t.hours=t.minutes/60;
    t.minutes=t.minutes%60;
    t.hours += hours + TM.hours;
    return t;
}
void time::showtime()
{
    cout<<hours<<" hours and "<<minutes<<" minutes"<<endl;
}
intmain()
{
    time T1,T2,T3;
    T1.settime(2,45);
    T2.settime(3,30);
    T3=T1.sum(T2);
    cout<<"\n Time 1 : ";T1.showtime();
    cout<<"\n Time 2 : ";T2.showtime();
    cout<<"\n Time 3 : ";T3.showtime();
    getch();
    return 0;
}

```

9. Errors

a.

- Line 3 Colon(:) missing after key word private
- Line 7 Extra semicolon following function name header
- Line 13 Missing semicolon at the end of the class definition
- Line 15 The function should be declared with return type preceding the class name the correct code is: float circle::area().

b. Answer:

- None of the data members are accessible from objects belonging to class branch.
- The names of member functions which are accessible from objects belonging to class 'employee' are joining(), showdetail().
- The members accessible from objects belonging to class 'employee' are Data Members: eno, ename, salary, expense, noemployees Member Functions: register(), status(), enter(), show(), joining(), showdetails().

7.9. Additional activities

7.9.1. Remedial activities

Question 1: What is a class and are the private members of class accessible to the object?

Answer: A class is a user defined data type used to implement an abstract object, giving you the capability to use object oriented programming with C++. No the private members of a class are not accessible to the object.

Question 2: What are the differences between the following?

1. Object oriented programming and procedural programming
2. Public and private members of a class

Answer:

1. In object oriented programming the stress is given on the object, whereas in procedural programming the stress is given on the subject.
2. The public members are accessible to objects of a class whereas private member are not accessible outside the class or to objects of the class.

Question 3:

Define the following terms:

- | | |
|----------------------|------------------------|
| a) OOP | f) Abstraction |
| b) Object | g) Friend function |
| c) Class | h) Constructor |
| d) Class declaration | i) Default constructor |
| e) Private section | |

Answers:

a) OOP : Object oriented programming enables the programmers to group together data and code that uses data into discrete units. In OOP the stress is given on the object in spite of procedure.

b) Object: An object is a self-contained abstraction of an item. An instance of a class.

c) Class: A class is a user defined data type used to implement an abstract object. It contains members of three types: private, public and protected. By default, the data members of the class are private. Classes enable the programmer to model objects with attributes and behaviors. Class types can be defined in c++ using the key word 'class' and 'struct', but key word class is normally used for this purpose.

d) Class declaration: The class is declared with a keyword class

```
class class_name
{
private:
data_members;
member_functions;
public:
data members;
member_functions;
};
```

e) Private section: Private members are available to only members of class and not accessible to the objects or functions outside the class. The default access mode for classes is private so all members after the class header and before the first member access specifier are considered to be private.

f) Abstraction: The class members, which are private, remain hidden from the outside world, the public members form the interface by providing the essential and relevant information to outside world. Thus only the essential features are represented to outside world without including the background details, which is called abstraction.

g) Friend Function: A function outside of a class can be defined to be a friend function by the class. By doing so the class gives the friend function, free access to the private members of the class.

h) Constructor: A constructor is a special initialization function that is called automatically whenever instance of the class is declared. The name of the constructor is same as that of class and it returns no value.

i) Default constructor: A default constructor is one, which accepts no parameters:

```
class student
{
private:
introllno;
public:
student() //Default constructor
{
rollno=1;
} };
```

Question 4: Is data hiding same as encapsulation?

Answer:

No. Data hiding is the property of a program where vital data remains safely hidden from functions which do not use or manipulate them. On the

other hand, encapsulation is the mechanism through which data hiding is achieved.

7.9.2. Consolidation activities

Question 1: Write a program to edit the existing class definition for ‘class product’ to include tax in the listed price and then calculate and display the net price including tax for the following spare parts:

id no=1013 price=1000.0

id no=2314 price=550.0

Note: Vat is 18% of the listed price

```
#include<iostream>
using namespace std;
class product
{
private:
int idno;
public:
float price;
float vat ;
public:
void getdata(int n, float p)
{
vat = 0.18 * p;
idno = n;
price=p+vat;
} };
intmain() {
product p1,p2;
p1.getdata(1013,1000.00);
p2.getdata(2314,550.00);
cout<<" Net amount payable for spare part1:"<<p1.price<<"frw"<<endl;
cout<<" Net amount payable for spare part2:"<<p2.price<<"frw";
}
```

Question 2:

Which function is called during each function call in the program given:

Functions	Program code
long total(int x) //.....I	total(n); //1
char choose(chara, char b);//.....II	choose('c'); // 2
char choose (char a); //.....III	choose('c','d'); //3
float total (int x, float y); //.....IV	total(n,n1); //4

Answer:

Call 1 invokes function (I)

Call 2 invokes function (III)

Call 3 invokes function (II)

Call 4 invokes function (IV)

Question 3: Define a class student with the following specification:

admno	integer
sname	20 character
eng,math,science	float
total	float
ctotal()	A function to calculate 'total = eng + math + science'

Public member function of a class student:

takedata() To accept values for admno, sname, eng, math, science and invoke ctotal() to calculate total

showdata() To display all the data members on the screen

Solution:

```
class student
{
int admno;
char sname[20];
float eng,math,science;
float total;
void ctotal();
public:
void takedata();
void showdata();
};
void student::takedata()
{
cout<<"\n Enter the admission number of student ";
cin>>admno; cout<<"\n Enter the name of the student";
cin>>sname;
cout<<"\n Enter the marks in English";
cin>>eng;
cout<<"\n Enter the marks in Maths";
cin>>math;
cout<<"\n Enter the marks in Science";
cin>>science;
ctotal(); }
void student::ctotal()
{
total = eng + math + science; }
void student::showdata()
```

```

{
cout<<"\n Name "<<sname;
cout<<"\n Admission no"<<admno;
cout<<"\n Total marks"<<total;
}

```

7.9.3. Extended activities

Question 1: Write a program to calculate Fibonacci series of a number given by the user.

Answer:

```

#include <iostream>
using namespace std;
class Fibonacci{
public:
int a, b, c;
void generate(int);
};
void Fibonacci::generate(int n){
a = 0; b = 1;
cout<< a << " " <<b;
for(inti=1; i<= n-2; i++){
c = a + b;
cout<< " " << c;
a = b;
b = c;
}
}
int main()
{
cout<< "Hello world! Fibonacci series" <<endl;
cout<< "Enter number of items you need in the series: ";
int n;
cin>> n;
Fibonacci fibonacci;
fibonacci.generate(n);
return 0;
}

```

Question 2: Write a C++ program to create student class, read and print N student's details using array of objects.

Answer:

```

#include <iostream>
using namespace std;
#define MAX 10
class student
{
private:
char name[30];
introllNo;
int total;
float perc;
public:
//member function to get student's details
void getDetails(void);
//member function to print student's details

```

```

        void putDetails(void);
};
//member function definition, outside of the class
void student::getDetails(void){
cout<< "Enter name: ";
cin>> name;
cout<< "Enter roll number: ";
cin>>rollNo;
cout<< "Enter total marks outof 500: ";
cin>> total;
perc=(float)total/500*100;
}
//member function definition, outside of the class
void student::putDetails(void){
cout<< "Student details:\n";
cout<< "Name:"<< name <<","Roll Number:" <<rollNo<< ",Total:" << total <<
",Percentage:" <<perc;
}
}
intmain()
{
    student std[MAX]; //array of objects creation
    intrn,loop;
    cout<< "Enter total number of students: ";
    cin>> n;
    for(loop=0;loop< n; loop++){
    cout<< "Enter details of student " << loop+1 <<":\n";
    std[loop].getDetails();
    }
    cout<<endl;
    for(loop=0;loop< n; loop++){
    cout<< "Details of student " << (loop+1) <<":\n";
    std[loop].putDetails();
    }
    return 0;
}

```

Question 3: Determine the output for the following piece of code:

```

#include <iostream>
#include <conio.h>
#include <stdio.h>
#include <string.h>
using namespace std;
class electronics
{
private:
intequipment_no;
public:
char equipment_name[15];
intequipment_price;
electronics()
{
cout<<endl<<" An object of type Electronics has been declared";
}
~electronics()
{
cout<<endl<<" The scope of the created object is now over";
}
void enter(); void display();
};
class computer: public electronics

```

```

{
public:
computer()
{
cout<<endl<<" Computer is a derived class of electronics";
}
char motherboard;
intmodelno; };
void electronics::enter()
{
cout<<" Enter Equipment Name";
gets(equipment_name);
cout<<endl<<" Enter Equipment Price";
cin>>equipment_price;
}
void electronics:: display()
{
cout<<endl<<" Equipment Name ->"<<equipment_name;
cout<<endl<<" Equipment Price ->"<<equipment_price;
}
}
intmain()
{
computer c1;
electronics e1;
strcpy(c1.equipment_name,"Computer");
strcpy(e1.equipment_name,c1.equipment_name);
c1.equipment_price = 2000; c1.display();
e1.equipment_price=c1.equipment_price;
e1.equipment_price--; e1.display();
getch();
}

```

Answer:

An object of type Electronics has been declared

Computer is a derived class of electronics

An object of type Electronics has been declared

Equipment Name ->Computer

Equipment Price ->2000

Equipment Name ->Computer

Equipment Price ->1999

The scope of the created object is now over

The scope of the created object is now over

Question 4: Create class Factorial that calculate factorial of a number typed by the user.

Answer:

```

#include<iostream>
#include<conio.h>
using namespace std;
class factorial{
int f, n;

```

```

    public:
    void fact();
    void display();
};
void factorial::fact()
{
    f=1;
    cout<<"\nEnter a Number:";
    cin>>n;
    for(inti=1;i<=n;i++)
        f=f*i;
}
void factorial::display()
{
    cout<<"\nFactorial of "<<n<<" is "<<f;
}
int main()
{
    factorial ob;
    ob.fact();
    ob.display();
    getch();
}

```

8.1. Key Unit Competency:

To be able to describe a Visual Basic Integrated Development (VB-IDE) and write a program in Visual Basic.

8.2. Prerequisite knowledge and skills:

In order to learn this unit, students should have knowledge and skills related to Introduction to computer algorithms in and develop a simple C++ program S4.

8.3. Cross-cutting issues to be addressed:

- **Financial Education:** To be covered when the students analyze and discuss on the services provided by the ABC hotel in the introductory activity and learning activity 8.4 and many others activities
- **Standardization Culture:** Students must make sure that when they buy the VB software, it contains all the necessary components.
- **Gender education:** When grouping the learners, boys should be mixed with girls. Gender education will be covered in learning activity 8.4.
- **Peace and Values Education:** Students must be able to develop VB programs to help them solve the problems they encounter in their day to day life.

8.4. Guidance on the introductory activity

(with cross referencing to the Student book + answers)

This activity takes place in the computer lab or smart classroom where the learners design the interface in the introductory activity in the students' text and they answer the questions that follow:

- Group the learners into 3 or 5 putting in consideration gender balance disabilities if any.
- Ask the students to do the introductory activity in their groups formed.
- Walk around and see if the students are doing activity in their respective group. Facilitate those with difficulties in understanding the instructions.
- The students present their answer to the rest of class.

- The students react on the answers from other groups.
- Summarize the student group work and correct them where necessary.

Possible Solution for the introductory activity

1. The Graphical user interface of ABC hotel used to record customer information. It is a form containing customers' information in ABC Hotel.
2. It is easier for the user to minimize code writing.
3. The reasons for Word **Add new** ,**Display** and **Exit** are:

Add new is a command used to create a free space of adding one customer's information.

Display is a command used to display on a form the entries of customers' information.

Exit Button is a command used to exit the form.

4. Visual basic 6.0
5. Use different controls and design a form in VB 6.0 as shown in the students' book.

In case some learners fail to design the form, tell the students that they will learn designing the form in the subunit 8.3.

8.5. List of lessons

No	Lesson title	Learning objectives (from the syllabus including knowledge, skills and attitudes):	Number of periods
1	understanding visual basic	Describe the concepts of Visual Basic Describe the different use of graphical user interface, desktop application and Event oriented programming using visual Basic efficiently, and its features.	3
2.	Visual Basic(VB) Integrated Development Environment (IDE) (Standard EXE)	Describe Visual Basic and its Integrated development environment(IDE) features and learner be familiar with VB-IDE	2

3.	Visual basic controls	Uses of properties window.	3
		Design a form using a control.	3
4	Planning and Developing a Visual Basic program.	The process of Planning and Developing a Visual Basic program.	6
		Debugging and handling program.	4
5	Working with Menus in Visual Basic	Creating Menu Command	3

Lesson 1: Understanding visual basic

(Duration: 3 periods: 120 minutes)

a. Prerequisites/Revision/Introduction

Learning activity 8.1 is used to introduce the learners to visual basic application. During this activity, the learners will find out the difference between visual basic and other desktop applications.

b. Teaching resources:

- Computers
- Projector
- Internet connection
- Visual Basic IDE
- digital material

c. Learning activity 8.1:

Guidance on activity

- Organize the students in groups in order to do learning activity 8.1.
- Ask them to read carefully the text in activity 8.1 and answer the questions that follow:
- Move around and see if students are doing activity in their respective group.
- The students present their answer to the rest of class.
- The students react on the finding/ answers from other groups.
- Correct the learners where possible and summarize what the groups have discussed.
- The Students reform the groups and do the application activity 8.1

- Give instructions to the students on how to do application activity8.1
- Students do application activity8.1

Answers to learning activity 8.1

1. Microsoft Visual basic window
2. Project1- Microsoft Visual basic [design] window that contains Form1, properties window and project explorer
3. A desktop application (Visual basic) is a computer program that runs locally on a computer device, such as desktop or laptop computer, where as a web application, which is delivered to a local computer over the Internet through browser from a remote server (Internet Explorer, Mozilla Firefox).

d. Answers to application activity 8.1

1 a)

Command line interface	Graphical user interface
Commands have to be typed in the command line to execute them.	One can click on icons to execute the commands
Commands need to be remembered to be able to type them	Commands don't need to be remembered as they can be executed by clicking on the icons.
Different commands can perform the same job.	Usually a universal icon is used to represent a particular command.
Drag and drop features are usually absent.	Drag and drop features are present
They are less user friendly	They are more user friendly

b. A desktop application is a computer program that runs locally on a computer device, such as desktop or laptop computer, where as web application, which is delivered to a local computer over the Internet through browser from a remote server.

2. Click on: 1.start

2. All program
3. Microsoft visual basic 6.0
4. File
5. New
6. Project
7. EXE
8. Open

Lesson 2: VB Integrated development environment (IDE)

(2 periods: 80 minutes)

a. Prerequisites/Revision/Introduction:

The learners should know how to design the interface using Tool Box elements and change state of objects (controls) using Properties Window.

b. Teaching resources:

- Students' books
- Internet
- Computers with Microsoft Visual Basic software

c. Learning activities:

Guidance

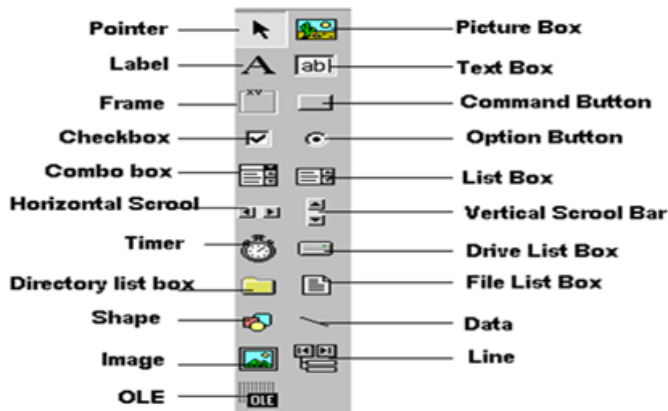
- This lesson should be conducted in the computer lab or smart classroom
- Ask the students to form pairs and answer the questions in Learning Activity 8.2
- Move around to see if the students are doing the activity in their respective groups.
- Students present their answers to the rest of class.
- Students react on answers from other groups.
- Correct false answers and summarize the contents of the group discussion using the students' book.
- Give instructions on how to do Application activities 8.2
- The students do the Application activities 8.2

Answers to learning activity 8.2

- A: Menu bar
- B: Tool Bar
- C: Design Window
- D: Code Window
- E: ToolBox
- F: Form layout
- G: Properties window
- H: Project Explorer.

d. Answers to the application activity 8.2

1. The learners mention any five of these controls.



2. The boxes that make up Visual Basic IDE?:
3. Object Box
4. Procedure Box

Lesson 3: Visual basic controls

Lesson 3.1. Uses of properties window

3 periods: 120 minutes

a. Prerequisites/Revision/Introduction

The learners should know the elements of Tool Box

b. Teaching resources:

- Students' books
- Internet
- Computers with Microsoft Visual Basic software

c. Learning activities:

Guidance on activity 8.3.1

- Introduction of lesson and the learning activity 8.3.1 must be done in computer lab.
- Ask learners in their respective groups to open the project form made in previous lesson and review it and do the Learning Activity 8.3.1
- Move around and see if students are doing Learning Activity in their respective groups.

- Students present their answers to the rest of class.
- Students react on answers from other groups.
- Correct false answers and summarize the contents the results of the group discussions using the students' book.

Answer leaning activity 8.3.1

By using the properties windows instructed in learning activities 8.3.1

The form looks like this.

d. Answer to Application activity 8.3.1

The form window is used to receive and draw the controls so that the programmer can design a form for a particular purpose.

Lesson 3: Visual basic controls

Lesson 3.1. design a form using a control.

(3periods: 120 minutes)

a. Prerequisites/Revision/Introduction

This lesson introduces the learners to VB forms, their meaning and use. The students will also learn the steps of designing a form using controls. Learning activity 8.3 introduces this lesson by making the learners observe a form with controls and afterwards they design it.

b. Teaching resources:

- Students' books
- Internet
- Computers with Microsoft Visual Basic software

c. Learning activities:

Guidance on activity

- Introduction of lesson and the learning activity 8.3 must be done in computer lab.
- Ask the students to form the groups of 5 or 6 to do the Learning Activity 5
- Move around and see if students are doing Learning Activity in their respective groups.
- Students present their answers to the rest of class.
- Students react on answers from other groups.
- Correct false answers and summarize the contents the results of the group discussions using the students' book.

d. Answer of activity 8.3.2

The students design the form above using the controls by using the following steps:

Step 1: Click on the toolbox.

Step 2: Drag and drop a control in the form.

- **Label:** displays a text on the form.
- **Textbox:** a box for entering and displaying text.
- **Frame:** create a group of controls that work together.
- **Optionbox:** select only one option even it displays multiple choices.
- **Combobox:** a list of items where the user can click and select the items from the list.
- **Command Button:** displays an illusion that the button is pressed when the user clicks on it.

Step 3: Set Properties for Specific control.

- **Name:** Enter the name of the label control. It returns the name used to identify object.
- **Alignment:** It returns/sets the alignment of a label
- **Appearance:** It sets whether or not object is painted at run time with 3D effects.
- **Caption:** Enter the caption associated with the label. It sets the text displayed on the form.
- **Font:** It returns the font of object (font face, font style, size and effects)

- **Forecolor:** It returns foreground color of a label
- **Height:** Enter the height of the label.
- **BackColor:** Choose background color. It sets the background color used to display label.
- **BorderStyle:** Choose border style of the label(None-no border or Fixed Single-With border)
- **Backstyle:** Choose background style; Opaque or transparent

Answer application activities 8.3.2

1.

A : Toolbox

B: Form.

C: Project explorer.

D: Properties Window.

2.

A. Command Button: The command button is a very important control as it is used to execute commands. It displays an illusion that the button is pressed when the user clicks on it.

B. Label: The label is a very useful control for Visual Basic, it is used to provide instructions and guides to the users, and it can also be used to display outputs.

C. Check Box: The Check Box control lets the user to select or unselect an option. When the Check Boxes checked, its value is set to 1 and when it is unchecked, the value is set to 0.

D. Combo Box: The function of the Combo Box is to present a list of items where the user can click and select only one item from the list

E. Image Box: The Image Box is another control that handles images and pictures. It functions almost identically to the picture box.

F. Picture Box: The Picture Box is one of the controls that used to handle graphics.

G. Text Box: is the standard control that is used to receive input from the user as well as to display the output. It can handle string (text) and numeric.

H. Option / Radio Button: Radio Button provides the capability to make a mutually exclusive choice among group choices.

I. List Box: A list box displays a list of items from which the user can select one or more items.

The Drive ListBox: The Drive ListBox is used to display a list of drives available in your computer. When you place this control into the form and run the program, you will be able to select different drives from your computer.

Create a form and call it “Rectangle”.

Go in toolbox > drop and drag shape in the form > in properties window choose shape > round rectangle.

The most common Event associated with the command Button is Click Event.

Lesson 4: The process of Planning and Developing a Visual Basic program.

(6periods: 240 minutes)

a. Prerequisites/Revision/Introduction

Students should have knowledge and skills related to designing a form properly and use of all components of VB integrated development environment. Learning activity 8.4.1 introduces this lesson by making the learners how can resolve real life problems by making VB program using control designed in a form(label, command combobox, listbox).

b. Teaching resources:

- Students’ books.
- Internet.
- Computers with Microsoft Visual Basic software.

c. Learning activities:

Guidance on activity

- Teacher organizes students in groups in order to do Activity 8.4.1
- Teacher give an instruction of making activities 8.4.1 to learners

- Teacher walks around and sees if students are doing activity in their respective groups.
- Representatives groups present their answer using projector.
- Students react on the findings / answers from other groups.
- Teacher corrects false answers if any and give the comments.
- Teacher summarizes the contents (Note in students' book) and gives examples that should be done by students.

Answer for learning activity 8.4.1

1.

Label is used to provide information to the user

Text Box is used to receive and display input and output from and to the user

Command button is used to cause an event to happen.

2. Instructions (code) inside command1 code window.
3. The instructions contains errors
4. Debugging instructions.

d. Answer of application activity 8.4.1

The image shows a screenshot of a software application window titled "BORROWING MANAGEMENT SYSTEM". The window contains a form with three input fields. The first field is labeled "NAMES" and contains the text "MUHOZA Ange". The second field is labeled "AGE" and contains the text "15". The third field is labeled "GENDER" and is a dropdown menu currently showing "FEMELE".

A. Design a form like above using all possible control and its proportional properties.

Coding a program.

```
Private Sub cmdadd_Click()
txtnames.Text = ""
```

```

txtage.Text = ""
Cmbgender.Text = ""
Cmbcombination.Text = ""
Cmbclass.Text = ""
txtamount.Text = ""
lblreturn.Caption = ""

```

```
End Sub
```

```

Private Sub cmdcal_Click()
lblreturn.Caption = Val(txtamount.Text) * 3 / 100 + txtamount
End Sub

```

```

Private Sub cmdexit_Click()
Unload Me
End Sub

```

```
Private Sub cmdsave_Click()
```

```

Istborrowers.AddItem txtnames & "" & txtage & "" & Cmbgender & "" & Cmbcombination & ""
& Cmbclass & "" & txtamount & "" & lblreturn
End Sub

```

```

Private Sub Form_Load()
Cmbclass.AddItem "S1"
Cmbclass.AddItem "S2"
Cmbclass.AddItem "S3"
Cmbclass.AddItem "S4"
Cmbclass.AddItem "S5"
Cmbclass.AddItem "S6"

```

```

Cmbgender.AddItem "MALE"
Cmbgender.AddItem "FEMELE"

```

```

Cmbcombination.AddItem "O level"
Cmbcombination.AddItem "EKK"
Cmbcombination.AddItem "MCE"
Cmbcombination.AddItem "PCM"
Cmbcombination.AddItem "MEG"
Cmbcombination.AddItem "MPG"
End Sub

```

Lesson 4.2: Debugging and handling program. (4periods: 160 minutes)

a. Prerequisites/Revision/Introduction

Students should have knowledge and skills about running program in Visual Basic 6.0 and working in the activities 8.4.2 Learning activity 8.4.2 is the best activities help us to handling the code through the activities done.

b. Teaching resources:

- Students' books.
- Internet.

- Computers with Microsoft Visual Basic software.
- Projector.

c. Learning activities:

Guidance on activity

- In their respective groups made in previous lesson to activities.
- Teacher give an instruction of making activities 8.4.2 to learners.
- Teacher walks around and sees if students are doing activity in their respective groups.
- Using projector each group present their program running.
- Students react on the findings / answers from other groups.
- Teacher corrects false answers if any and give the comments.
- Teacher summarizes the contents and gives orient again.
- Students reform group reconfirm it again

Answer of Learning activities 8.4.2

a. Yes.

Print the code, if you find it easier to read code on paper instead of soft-copy.

Run the application to find trouble spots:

b. Debugging

c. The reason can cause program to not run:

- grammatical errors in the formulation of statements and are picked up by the interpreter while you are typing in the code
- attempted division by zero or trying to access a non-existent object
- failure on the part of the programmer to arrive at a correct algorithm for the task

d. Answer application activity 8.4.2

1. There are three kinds of errors:

- Syntax errors
- Run-time errors
- Logic errors

Syntax errors are grammatical errors in the formulation of statements and are picked up by the interpreter while you are typing in the code (providing the syntax checking option - under environment options - is set to yes).

Run-time errors these are errors that cannot be detected until the program is running. The syntax of the statements is correct, but once executed they cause a error situation to arise. Examples of run-time errors are attempted division by zero or trying to access a non-existent object as in the example below (where Label2 has not been created).

Logic errors these are errors that cause the program to behave incorrectly. They generally arise through failure on the part of the programmer to arrive at a correct algorithm for the task. Typical problems might be incorrect ordering of statements, failure to initialise or re-initialise a variable, assignment to an incorrect variable, use of '<' instead of '<=', use of 'and' instead of 'or', or omission of a crucial step in the processing. Logic errors may hide in a program even when it appears to work - they may only surface under certain conditions. This is why careful testing is so important.

2. **Debugging** is a process by which you find and resolve errors in your code.

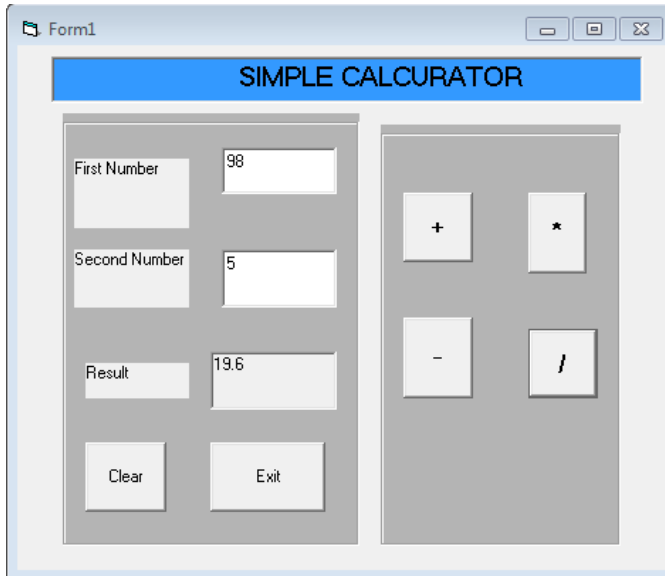
3. Simple calculator code

```
Private Sub cmdclear_Click()  
txtfirst.Text = ""  
txtsecond.Text = ""  
End Sub  
Private Sub cmddiv_Click()  
lblresult.Caption = Val(txtfirst.Text) / Val(txtsecond.Text)  
End Sub  
Private Sub cmdexit_Click()  
End  
End Sub  
Private Sub cmdminus_Click()  
lblresult.Caption = Val(txtfirst.Text) - Val(txtsecond.Text)  
End Sub  
Private Sub cmdmult_Click()  
lblresult.Caption = Val(txtfirst.Text) * Val(txtsecond.Text)
```

```

End Sub
Private Sub cmdplus_Click()
lblresult.Caption = Val(txtfirst.Text) + Val(txtsecond.Text)
End Sub

```



4. a) misspelling a word or using a language element improperly involve code that may appear to be correct in that it has no syntax errors application is in use.
- b) the follow strategies are used in order to solve this problem.
 - Print the code, if you find it easier to read code on paper instead of softcopy.
 - Run the application to find trouble spots:
 - From the Run menu, choose 'Start' to begin running the application. Run until an error stops execution, Once bugs are found Try out bug fixes and then make edits by testing individual lines of new or debugged code in the Debug window.

Lesson 5: Working with Menus in Visual Basic. (3periods: 120 minutes)

a. Prerequisites/Revision/Introduction

Students should have knowledge and skills about design a form coding a form, running program and handling and debugging a program in Visual Basic 6.0. Learning activity 8.5 is the best activities help us to study menus and MDI form.

b. Teaching resources:

- Students' books.
- Internet.
- Computers with Microsoft Visual Basic software.
- Projector.

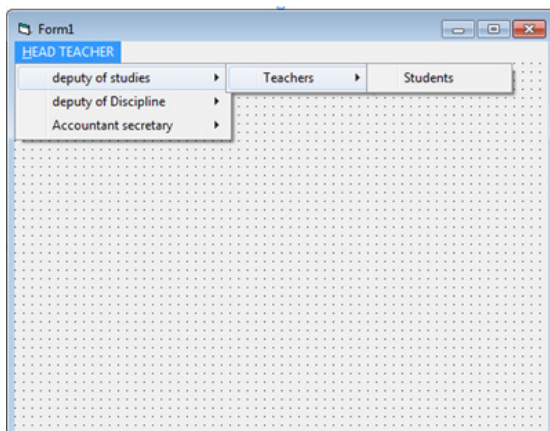
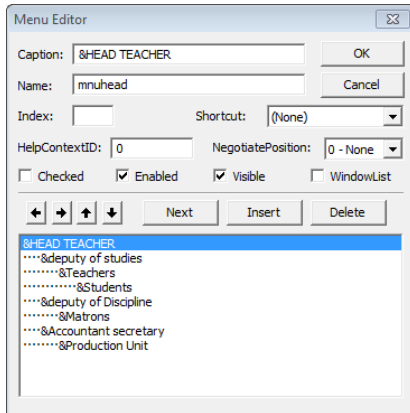
c. Learning activities:

Guidance on activity

- Form new group of learners.
- Instruct how they make activities 8.5 to learners.
- Teacher walks around and checks if students are doing activity in their respective groups.
- Using projector each group present their program running.
- Students react on the findings / answers from other groups.
- Teacher corrects false answers if any and give the comments.
- Teacher summarizes the contents and gives orient again.
- Students reform group recorrect it again

Answer learning activity 8.5

1. 4 levels
2. The possible solution:
Chain of command.
Each one has their responsibilities.
System of leadership.
Time management in services provides.
- 3.



```

Private Sub mnumatrons_Click()
    Frmmetrons.Show "To display form"metrons"
Unload Me
End Sub
Private Sub mnuproduction_Click()
    production.Show "To display form"production"
Unload Me
End Sub
Private Sub mnustudents_Click(Index As Integer)
    Students.Show "To display form"student"
Unload Me
End Sub

```

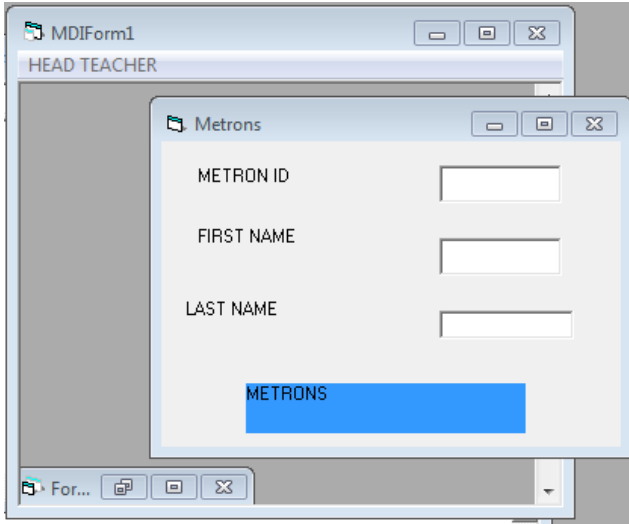
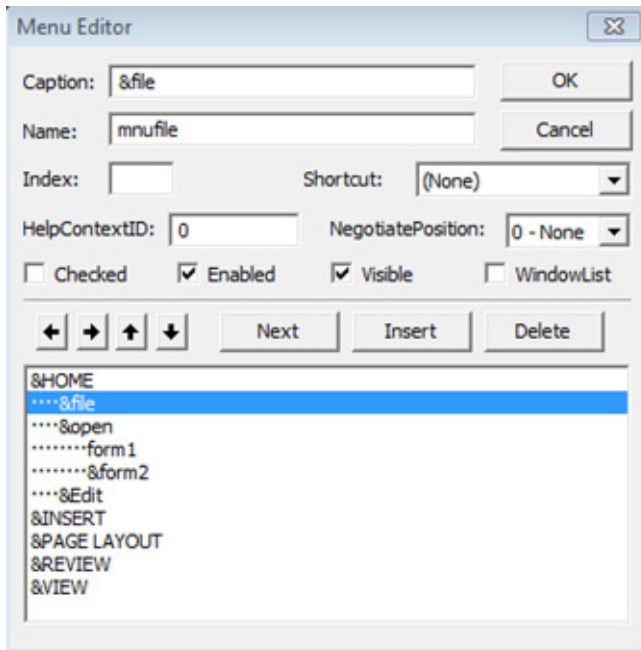
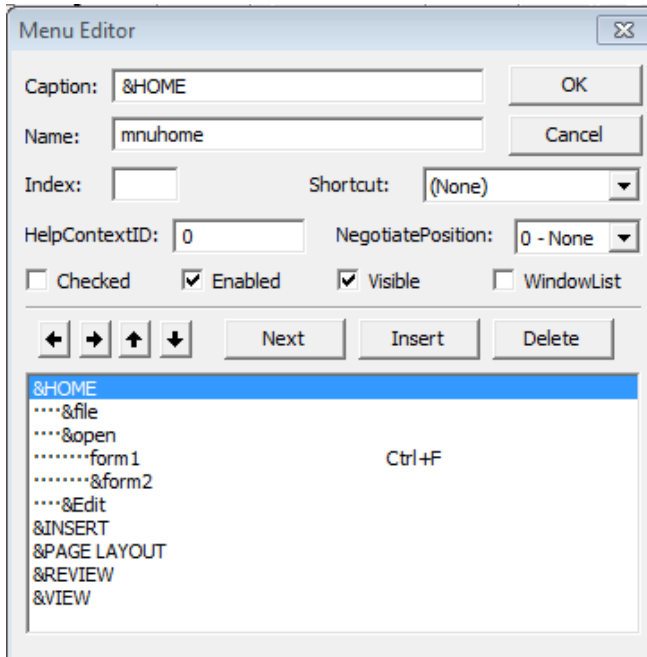


Figure MDI form with MDI child

d. Application activities 8.5





To run form1 in MDIform “our district” use code like

```
Private Sub mnuform1_Click()
    Form1.Show
End Sub
```

8.6. Additional activities

8.6.1. Remedial activities

1. Define a radio button and a check box in what are they different?
2. What the following controls prefix stand for? Chk, fil, cbo, frm, txt
3. What is an event in Visual basics? Give two examples.
4. What is a control? Give three examples.
5. Differentiate an MDI from a SDI.

Solution:

1. - An option button or radio button is a control which helps a user to make a choice; it has a black center circle when selected.
 - Check box is a control which helps a user to make a choice; it has a black check mark when selected.
 - The difference between them is that option buttons are exclusive while

option box are not exclusive.

2. Chk: Check box

Fil: File list box

Cbo: combo box

Frm: form

Txt: text box

3. An event is something that happens, usually but not always due to the user at the keyboard, during a program's operation. Examples: Click, double-click
4. A control is a tool on the toolbox window that you place on a form to interact with the user and control the program flow. Examples: textbox, label, command button
5. MDI is short for Multiple Document Interface; it allows to open multiple data documents within the same application.
SDI is short for Single Document Interface; it allows to open one data document at time.

8.6.2. Consolidation activities

1. Writes codes that display your entered full name on the form when the application is loaded.
2. Write the VB codes which draw a green circle when a program is executed?
3. What is a list control in visual basics 6.0? what is its default setting for name property?
4. What is a combobox control in vb 6.0?
5. What is the use of a drivelistbox
6. Respond that question using True or False:
 - A directory list box is used to display the list of files in a selected drive.
 - A combobox is used to display the list of files in a selected directory or folder.
 - A menu is an on-screen list of available functions or operations that can be performed currently.
 - ADO (Activex Data Object) is a control which helps us to access a data grid offering the possibility of working on different data sources such as text files, relational data base etc.
 - Which modes that VB6 operates in?

Solution:

1. The codes that display your entered full name on the form when the application is loaded.

```
Private sub command1_click ()  
Dim name as string  
Name=Inputbox ("enter your full name ")  
Print "my full name is"; name  
End sub  
Or  
Private sub form1_load ()  
Form1.show  
Print "Bazatsinda James"
```

2. the VB codes which draw a green circle when a program is executed?

```
Private Sub Form_Load()  
Shape1.Top = 0  
Shape1.Left = 0  
Shape1.Height = 1000  
Shape1.Width = 1000  
Shape1.Shape = vbShapeCircle  
Shape1.BorderColor = vbGreen  
End Sub
```

3. What is a list control in visual basics 6.0? what is its default setting for name property?

->A list control in visual basics 6.0 is a control which helps to displays data on vertical list of items. The list default setting for name property is list1

4. What is a combobox control in VB 6.0?

-> a combobox control is a combination of textbox control and a listbox control on only one entity. It allow to add entries or to select from a list predefined values.

5. What is the use of a drivelistbox

->a drivelistbox is used to display a list of drives available in your computer.

6. a) Give the codes for AddNew, Delete methods

```
Privatesub cmdadd_click()  
Adodc1.recordset.AddNew  
End sub
```

```
Privatesub cmddelete_click()  
Adodc1.Recordset.Delete  
Adodc1.Recordset.MoveNext' prevent the error in case a record is not available  
End sub
```

Give the codes for Update, refresh methods

```
Privatesub cmdupdate_click()  
Adodc1.Update  
End sub
```

```
Privatesub cmdrefresh_click()  
Adodc1.recordset.reflesh  
End sub
```

Give the codes for movefirst, movelast methods

```
Privatesub cmdmovefirst_click()  
Adodc1.recordset.movefirst  
End sub
```

```
Privatesub cmdmovelast_click()  
Adodc1.recordset.movelast  
End sub
```

Give the codes for movenext, moveprevious methods

```
Privatesub cmdmovenext_click()  
Adodc1.recordset.movenext  
End sub
```

```
Privatesub cmdmoveprevious_click()  
Adodc1.recordset.moveprevious  
End sub
```

7. Respond that question using True or False

- a directory list box is used to display the list of files in a selected drive. **FALSE**
- a combobox is used to display the list of files in a selected directory or folder. **FALSE**
- a menu is an on-screen list of available functions or operations that can be performed currently. **TRUE**
- ADO (Activex Data Object) is a control which helps us to access a data grid offering the possibility of working on different data sources such as text files, relational data base etc. **FALSE**

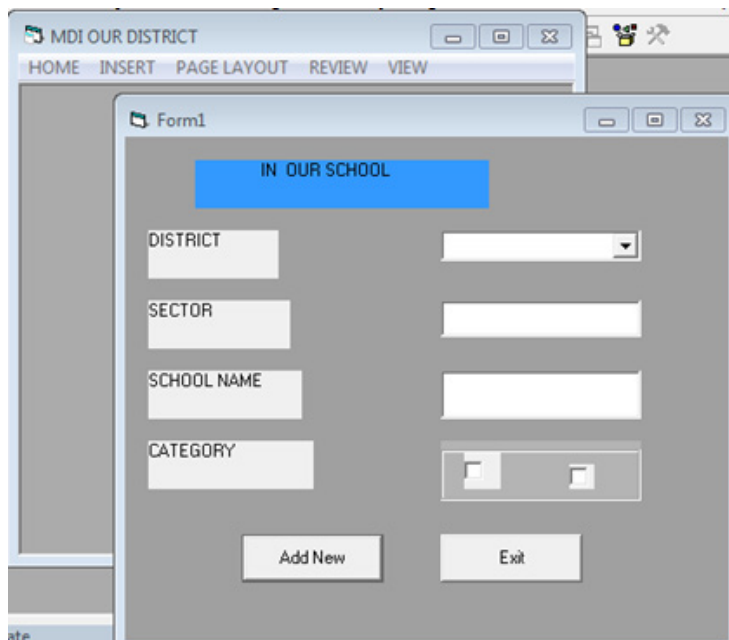
8. The modes that VB6 operates in?

- Design mode - used to build application
- Run mode - used to run the application
- Break mode - application halted and debugger is available

Extended activities.

1. Write a program which contain Fist Name, Last Name, Age and Gen-

der in label and its written in textbox and when make save it display in Listbox.



UNIT 9: VARIABLES, OPERATORS, EXPRESSIONS AND CONTROL STRUCTURES

9

9.1. Key Unit Competency:

To be able to use variables, operators, expressions and control structures in a Visual Basic program.

9.2. Prerequisite knowledge and skills:

Students have learnt Expressions and Operators in C++ and Control Statements in C++. They have some knowledge and skills related to Variables, data types, operators, expressions and control statements learnt in senior 4 in the unit of Introduction to C++ programming, unit of Expressions and Operators in C++ and unit of Control Statements in C++.

9.3. Cross-cutting issues to be addressed:

- **Inclusive Education:** Covered when all students (students with and with no disabilities) take place and are involved in the same class.
- **Gender education:** To be covered when both (girls and boys) are involved in all learning and application activities in a class.

9.4. Guidance on the introductory activity

Instruction to do the introductory activity

This activity takes place in the computer lab (where students can access Computers with installed Microsoft Visual Basic 6.0) and each student must have a computer if possible.

Teacher organizes students in groups

The teacher asks students to do the introductory activity in their respective groups

Teacher lets the students work independently on the activity

The teacher moves around to see how students are working

The teacher invites representatives of groups to present their findings (2 or 3 groups)

The teacher asks the rest of the class to evaluate findings

The teacher may ask some questions to boost the students

The teacher tells the students that they will have complete answers in the forthcoming lessons.

9.5. List of lessons

#	Lesson title	Learning objectives	Number of periods
1	Introductory Activity	<ul style="list-style-type: none"> Analyze the given source code and Answer the corresponding questions 	1
2	Types of Visual Basic Data	<ul style="list-style-type: none"> Identify and describe the types of Visual Basic Data 	2
3	Variables	<ul style="list-style-type: none"> Explain the role and importance of variables in Visual Basic program Declare ,Analyze and manipulate variables in Visual Basic program 	3
4	Scope of a variable	<ul style="list-style-type: none"> Explain and use different scopes of variables in a program 	2
5	Operators and expressions in Visual Basic	<ul style="list-style-type: none"> Describe the use of operators and evaluate expression in Visual Basic program 	3
6	Decision structures in Visual Basic (If... Then, If... Then... Else, Nested If ... Then... Else statements)	<ul style="list-style-type: none"> Write a program in Visual Basic using different types of decision structures 	3
7	Decision structures in Visual Basic (Selected case statements)	<ul style="list-style-type: none"> Write a program in Visual Basic using Selected case statements. 	2
8	Repetition structures (Indeterminate loops)	<ul style="list-style-type: none"> Explain the use of control structures in Visual Basic program Write a program in Visual Basic using different types of indeterminate loop structures 	3
9	Repetition structures (Determinate loops)	<ul style="list-style-type: none"> Write a program in Visual Basic using different types of determinate loop structures 	3
10	End unit Assessment	<ul style="list-style-type: none"> Answer questions 	2

Lesson 1: Introductory activity

Lesson 2: Types of visual basic data

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Teacher invites students in computer lab and school library and asks students to search for answers to the questions in the activity 9.1. From the students' answers, teacher explains to students and introduces the lesson.

b. Teaching resources:

1. Computer lab with internet
2. Textbooks to facilitate research

c. Learning activities:

Guidance

- Teacher organizes students in group in order to do Activity 9.1
- Students elect the group leader and secretary.
- Teacher gives the instructions on how to do Activity 9.1
- Teacher asks the students to work independently in groups on Activity 9.1 during some given time and teacher finds a seat in the corner of the class.
- Students do the activity
- Teacher walks around and sees if students are doing activity in their respective group.
- Representatives of 3 or 4 groups present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents or teacher refers to notes in students' book and gives examples that should be done by students.

Answer of activity 9.1

Let students discuss reasons why the variable declaration is important during the writing of programs, the data types used in programs, the storage size and range of values of data types.

1) In programming we declare a variable for defining it. A variable is characterized by its name, data type and its memory location (address).

2) The data types to be used in visual program are discussed in Students Book. Referring to 9.1 Types of Visual Basic Data

3) The storage size and range of values of data types are discussed in Students Book. Referring to 9.1 types of Visual Basic Data.

d. Answers of Application activity 9.1

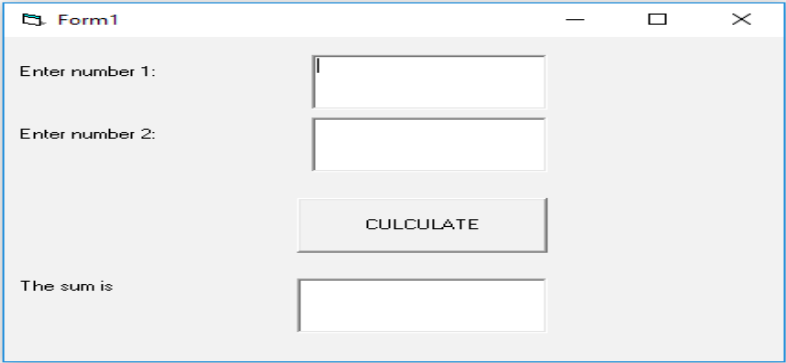
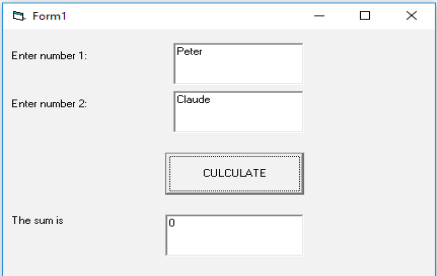
1) When a VB reserved word is used as identifier while programming, it generates compile error (syntax error)

For example, the following statement generates compile error

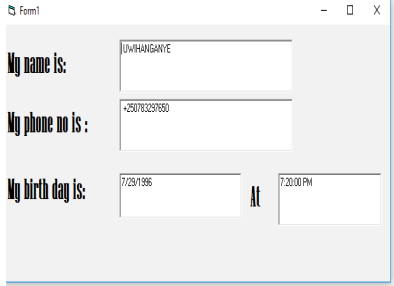
```
Dim Integer As Single
```

2) The produced result is executable error, a variable declared as integer when it receives the string value, it keeps 0.

Example: the program below adds two integers and displays the sum

Interface:	
	
Source code	Output
<pre>Private Sub Command1_Click() Dim num1, num2, sum As Integer num1 = Val(Text1.Text) num2 = Val(Text2.Text) sum = num1 + num2 Text3.Text = sum End Sub</pre>	

3)

Source code	output
<pre>Private Sub Form_Load() Form1.Show Name1 = "UWIHANGANYE" phone = "+250783297650" Jour = #7/29/1996# BithTime = #7:20:00 PM# Text1.Text = Name1 Text2.Text = phone Text3.Text = Jour Text4.Text = BithTime End Sub</pre>	

Lesson 3: Variables

duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Students get prerequisites from **Introduction to C++ programming of Senior four** and the previous lesson **“TYPES OF VISUAL BASIC DATA”**. Activity 9.2 must be done in group and students gather ideas on how to name, declare and initialize a variable. Answers from students varies according to students’ experiences. The target of this activity is to introduce to students **variables**.

b. Teaching resources:

- Computers with installed Microsoft Visual Basic 6.0 in computer lab
- Internet and textbooks to facilitate research

c. Learning activities:

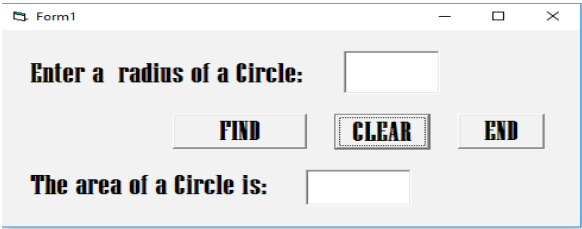
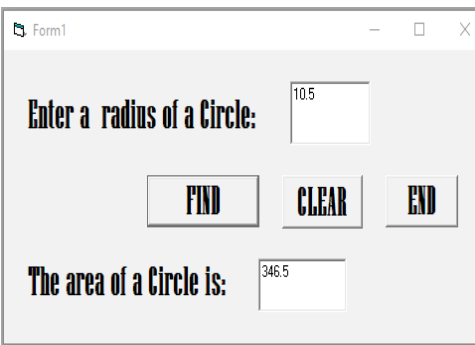
Guidance

- Teacher organizes students in groups in order to do the activity.
- Each group must do all questions of activity 9.2
- Learners do Activity by using computers internet and textbooks
- Students groups work independently
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents or teacher refers to notes in students’ book and gives examples that should be done by students.

Answers of activity 9.2

Teacher provides computer lab with internet, text books and let students finds different rules o naming a variable, discuss general format of variable declaration and variable initialization.

- 1) Rules of naming a variable in Visual Basic are discussed Student’s Book. Referring to 9.2.1 Variable name
- 2) General format of variable declaration. Refer to 9.2.2 declaration (Explicit Declaration)
- 3) General format of variable initialization is discussed in Student’s Book. Referring to 9.2.3 Variable initialization.
- 4) a) The interface:

Interface	
	
Source code	Output
<pre>Private Sub Command1_Click() Dim r , area As Double Const pi = 22 / 7 r = Val(Text1.Text) area = r ^ 2 * pi Text2.Text = area End Sub Private Sub Command3_Click() Unload Me End Sub Private Sub Command2_Click() Text1.Text = "" Text2.Text = "" End Sub</pre>	

d. Answers of Application Activity 9.2

1) We can replace Integer by variant in order to avoid possible memory overflow. Therefore, the given source code becomes:

```
Private Sub Form_Load ()
Form1.Show
Dim fact As variant , n As Byte
n = Text1.Text
fact = 1
```

Do While n > 1

fact = fact * n

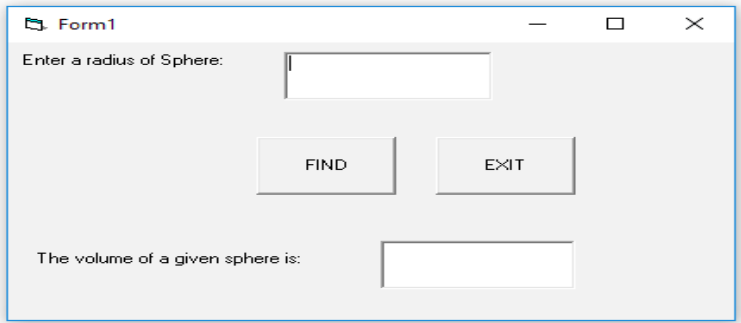
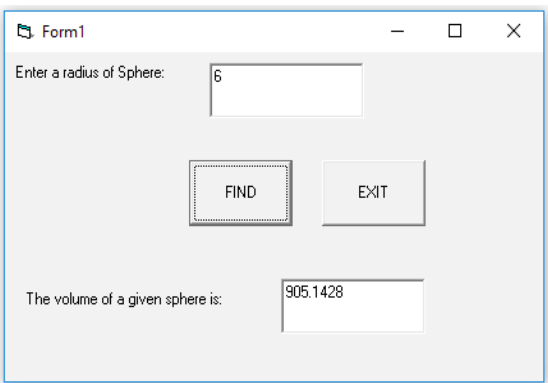
n = n - 1

Loop

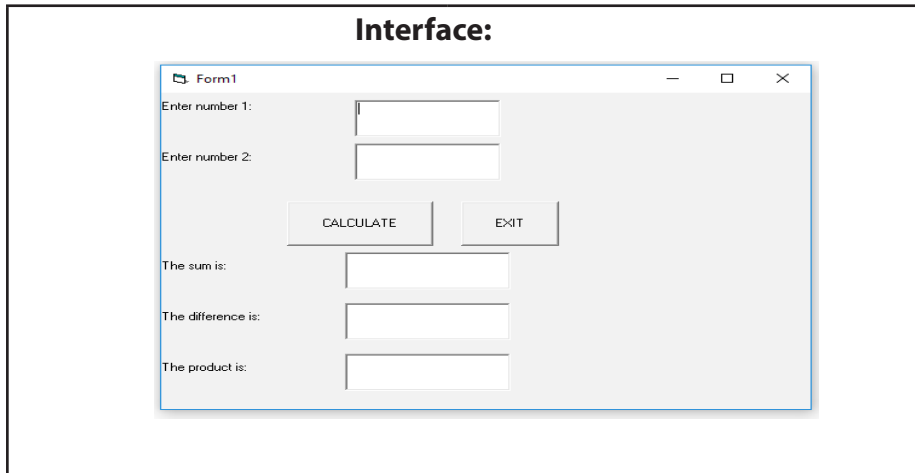
Print fact

End sub

2)

Interface:	
	
Source code	Ouput
<pre>Private Sub Command1_Click() Dim r, volume As Single Const pi As Single = 22 / 7 r = Val(Text1.Text) volume = 4 / 3 * (r * r * r * pi) Text2.Text = volume End Sub Private Sub Command2_Click() Text1.Text = "" Text2.Text = "" End Sub</pre>	

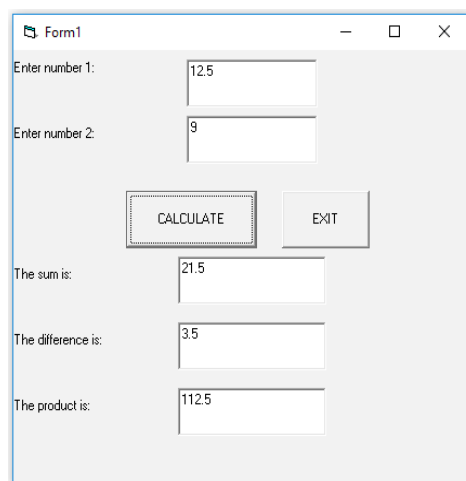
3)



Source code

```
Private Sub Command1_Click()
Dim num1, num2, sum, diff, product
As Single
Const pi As Single = 22 / 7
num1 = Val(Text1.Text)
num2 = Val(Text2.Text)
sum = num1 + num2
diff = num1 - num2
product = num1 * num2
Text3.Text = sum
Text4.Text = diff
Text5.Text = product
End Sub
Private Sub Command2_Click()
Text1.Text = ""
Text2.Text = ""
End Sub
```

Output



Lesson 4: Scope of a variable

duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Students have knowledge and skills about variable declaration and initialization acquired from previous lesson “**VARIABLES**”. Activity 9.3 must be done in computer lab into groups. Students use internet so that they can do Activity 9.3. The target of this activity is to introduce to students **scope of variable**

b. Teaching resources:

- computers in computer lab
- Internet and textbooks to facilitate research

c. Learning activities:

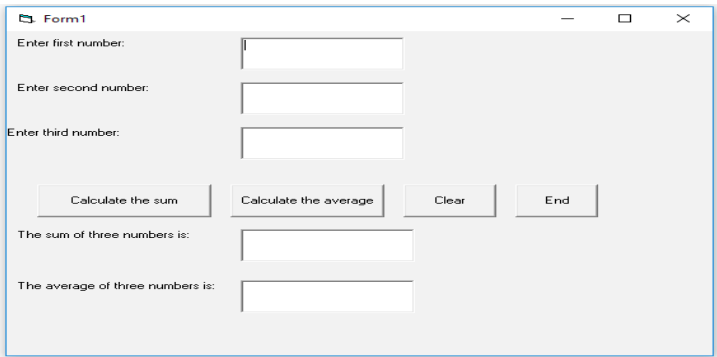
Guidance

- Teacher forms groups of students: 4 students for one group
- Teacher provides internet and laptop and let students finds answers to Activity 9.3
- Students groups work independently
- Teacher asks each group secretary to takes short note about their findings
- Each group representative presents the findings of the whole group
- Students react on the finding/ answers from other groups
- Teacher comments on all presentations by correcting false answers and completing the incomplete answers
- Referring to notes in students’ book, teacher summarizes the contents and gives examples that should be done by students.

Answer of Learning activity 9.3

Scopes of variables are discussed in student’s book. Refer to 9.3 Scope of a variable

d. Answer of Application Activity 9.3

Interface:	
	
Source code	Ouput

<pre> Public sum As Integer Private Sub addition_Click() Dim n1, n2, n3 As Integer n1 = Val(Text1.Text) n2 = Val(Text2.Text) n3 = Val(Text3.Text) sum = n1 + n2 + n3 Text4.Text = sum End Sub Private Sub moyenne_Click() Dim average As Single average = sum / 3 Text5.Text = average End Sub Private Sub clear_Click() Text1.Text = "" Text2.Text = "" Text3.Text = "" Text4.Text = "" Text5.Text = "" End Sub Private Sub exit_Click() Unload Me End Sub </pre>	
--	--

Lesson 5: Operators and expressions in visual basic

duration: 2periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Students have knowledge and skills about operators and expressions acquired from unit” **EXPRESSION AND OPERATOR IN C++ LANGUAGE**”. Activity 9.4 introduces to students **Operators and expressions in Visual Basic**. This activity is done in groups.

b. Teaching resources:

Internet and text books to facilitate research

c. Learning activities:

Guidance

- Teacher forms and organizes students in groups
- Teacher distributes tasks to groups
- Every group must do activity 9.4 independently (10 to 15 minutes)
- Teacher asks each group secretary to takes short note about their findings
- Each group representative presents the findings of the whole group
- Students react on the finding/ answers from other groups
- Teacher comments on all presentations by correcting false answers and completing the incomplete answers

- Referring to notes in students' book, teacher summarizes the contents and gives examples that should be done by students.

Answer of Learning activity 9.4

1) Operators used in C++ programming language are discussed in Computer Science for Rwandan Schools. Senior 4 Student's Book. Here below are operators used in C++ programming language with their precedence:

operators	Description
*	Multiplication
/	Division
%	Modulus
+	Addition
-	Subtraction
<<	Bitwise left shift
>>	Bitwise right shift
>	Relational less than
<=	Relational less than or equal to
>	Relational greater than
>=	Relational greater than or equal
==	Relational is equal to
!=	Relational is not equal to
&	Bitwise AND
^	Bitwise OR
	Bitwise exclusive OR
&&	Logical AND
	Logical OR
?:	Ternary conditional
=	Assignment
+=	Addition assignment
-=	Subtraction assignment
*=	Multiplication assignment
/=	Division assignment
%=	Modulus assignment
&=	Bitwise AND assignment
^=	Bitwise exclusive OR assignment
,	Comma

2) Given the following expression:

- $x+y-5*12/y$ if $x=10$ and $y=5$
- $10 + 5 - 5 * 12/5$ here multiplication operator executes before other operators in expression
- $10+5- 60/5$ division operator has second priority in execution of this expression
- $10 + 5 -12$ addition operation
- $15-12$ the subtraction is the last operation
- The value of expression is 3

3) Evaluation of the following expression if $A=10$, $B=5$, $C=0$ and $D=22$

$(A \text{ AND } B) \text{ OR } (C \text{ OR } D) \text{ AND } A$

10 in binary system is 1010

5 in binary system is 101

0 in binary system is 0

22 in binary system is 10110

- $(10 \text{ AND } 5) \text{ OR } (0 \text{ OR } 22) \text{ AND } 10$
- $(1010 \text{ AND } 101) \text{ OR } (0 \text{ OR } 10110) \text{ AND } 1010$
- $0 \text{ OR } 10110 \text{ AND } 1010$
- $10110 \text{ AND } 1010$
- 10 in binary system

Equals 2 in decimal system

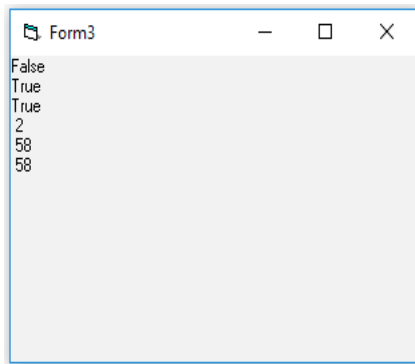
d. Answers of application activity 9.4

1)

Source code

```
Private Sub Form_Load()
    Form1.Show
    Dim x,y,z,q,p,k As Integer
    Dim i,j,a As Boolean
    x = 42
    y=7
    z = 24
    i = (x<=35) And (z = 24)
    j = (x =35) Or (y < 10)
    a = Not (x>30) Xor (y = 7)
    q = x And y
    p = x Or z
    k = x Or z
    Print i
    Print j
    Print a
    Print q
    Print p
    Print k
End sub
```

output



2) a. S=25,T=31

Bitwise And	Bitwise Or	Bitwise Xor
<p>S And T</p> <p>25 is a decimal number which is 11001 in binary system</p> <p>31 is a decimal number which is 11111 in binary system</p> <p>110011 And 11111 = 11001</p> <p>Therefore S And T = 25(decimal value)</p>	<p>S Or T</p> <p>11001 Or 11111 =11111</p> <p>Therefore S Or T =31(decimal value)</p>	<p>S Xor T</p> <p>11001 Xor 11111=110</p> <p>Therefore S Xor T =6(decimal value)</p>

X =50 , Y =18

Bitwise And	Bitwise Or	Bitwise Xor
<p>X And Y</p> <p>50 is a decimal number which is 110010 in binary system</p> <p>18 is a decimal number which is 1001 in binary system</p> <p>110010 And 1001 =0</p> <p>Therefore X And Y =0(decimal value)</p>	<p>X Or Y</p> <p>110010 Or 1001 = 111011</p> <p>Therefore X Or Y = 59 (decimal value)</p>	<p>X Xor Y</p> <p>110010 Or 1001 = 111011</p> <p>Therefore X Xor Y=59 (decimal value)</p>

Lesson 6: Decision structures in visual basic

(If... Then, If... Then... Else, Nested If ... Then.... Else ... Statements)

Duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Students have knowledge and skills about Selection control structure (If ... Then selection, If ... else Selection, Nested IF) acquired from unit” **CONTROL STRUCTURES AND ONE DIMENSION ARRAY**” Senior 4. Activity (9.5 introduces to students **Decision structures in Visual Basic (If... Then, If ... Then... Else, Nested If ... Then.... Else ... Statements)**. This activity is done in groups. Students discuss the use of decision control structures in Visual Basic programming.

b. Teaching resources:

- Computers with installed Microsoft Visual Basic 6.0
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- Teacher forms and organizes students in groups of four students.
- Teacher distributes tasks in groups
- Teacher asks each group secretary to takes short note about their findings
- Let student work independently (10 to 15 minutes)
- Teacher invites group representatives of 2 groups to present the answers of their respective groups

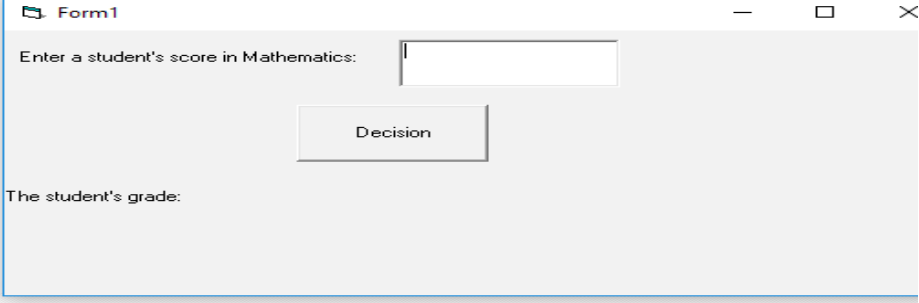
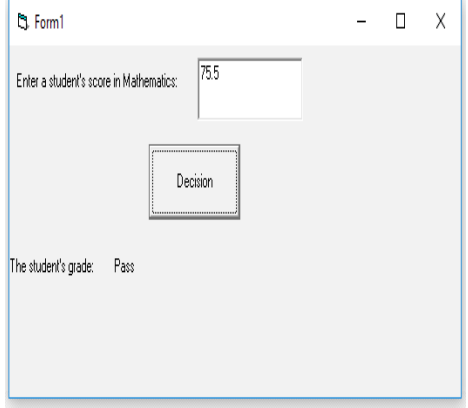
- Students react on the finding/ answers from other groups
- Teacher comments on all presentations by correcting false answers and completing the incomplete answers
- Teacher summarizes the contents referring to notes in student's book
- Teacher walks around each group and see the work of the group
- Teacher gives guides and gives comments every group.

Answer of Learning Activity 9.5

1 Decision control structures (If... Then, If... Then... Else, Nested If ... Then.... Else ... Statements) in Visual Basic programming.

Cfr student book 9.5.1

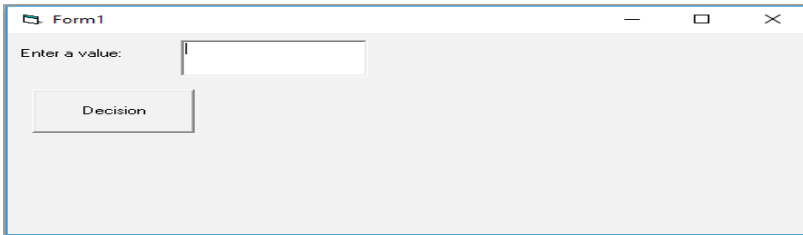
2)

Interface:	
	
Source code	Ouput
<pre>Private Sub Command1_Click() Dim mark As Single mark = Val(Text1.Text) If (mark > 45 And mark <= 100) Then Label3.Caption = "Pass" ElseIf (mark <= 45 And mark >= 0) Then Label3.Caption = "Fail" Else Label3.Caption = "Invalid" End If End Sub</pre>	

d. Answers application activity 9.5

1

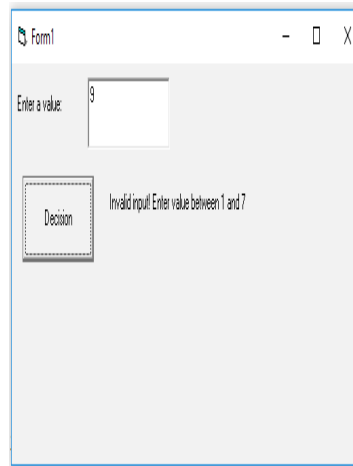
Interface:



Source code

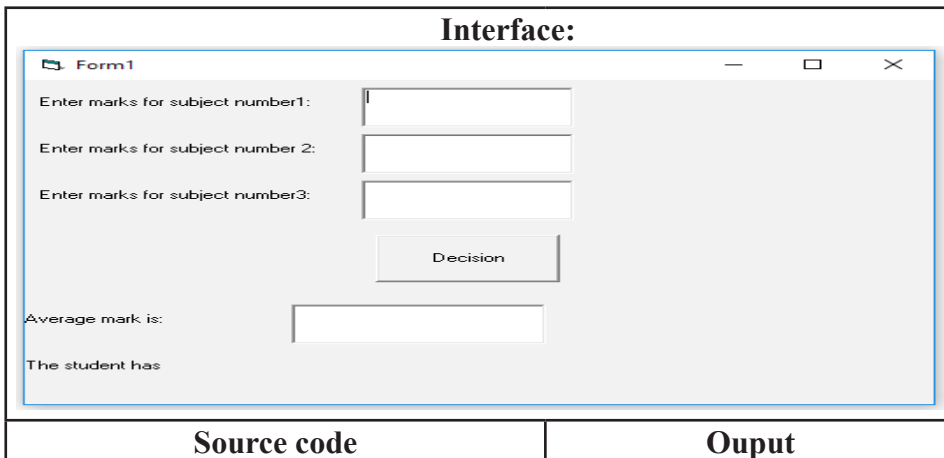
```
Private Sub Command1_Click()
    Dim value As Integer
    value = Val(Text1.Text)
    If (value = 1) Then
        Label2.Caption = "The day is Monday"
    ElseIf (value = 2) Then
        Label2.Caption = "The day is Tuesday"
    ElseIf (value = 3) Then
        Label2.Caption = "The day is Wednesday"
    ElseIf (value = 4) Then
        Label2.Caption = "The day is Thursday"
    ElseIf (value = 5) Then
        Label2.Caption = "The day is Friday"
    ElseIf (value = 6) Then
        Label2.Caption = "The day is Saturday"
    ElseIf (value = 7) Then
        Label2.Caption = "The day is Sunday"
    Else
        Label2.Caption = "Invalid input! Enter value
        between 1 and 7"
    End If
End Sub
```

Ouput



2)

Interface:



```

Private Sub Command1_Click()
Dim mark1, mark2, mark3, average As Single
mark1 = Val(Text1.Text)
mark2 = Val(Text2.Text)
mark3 = Val(Text3.Text)
average = (mark1 + mark2 + mark3) / 3
Text4.Text = average
If (average >= 50 And average <= 100) Then
Labels5.Caption = "Pass class"
ElseIf (average < 50 And average >= 0) Then
Labels5.Caption = "Fail class"
Else
Labels5.Caption = "Invalid class"
End If
End Sub

```

Lesson 7: Decision Structures in Visual Basic (Select case statement)

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Students have knowledge and skills about Selection control structure acquired from unit 8” **CONTROL STRUCTURES AND ONE DIMENSION ARRAY**” Senior 4. Activity (9.6 introduces to students **Decision structures in Visual Basic (Selection case statement)**. **This** activity is done in groups.

b. Teaching resources:

- Computers with installed Microsoft Visual Basic 6.0
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance

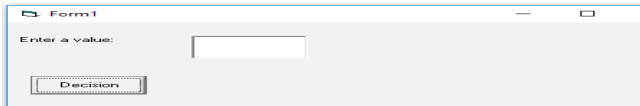
- Teacher forms and organizes students in groups of four students.
- Teacher distributes tasks in groups
- Teacher asks each group secretary to takes short note about their findings
- Let student work independently (10 to 15 minutes)
- Teacher invites group representatives of 2 groups to present the answers of their respective groups
- Students react on the finding/ answers from other groups.
- Teacher comments on all presentations by correcting false answers and completing the incomplete answers.
- Teacher summarizes the contents referring to notes in student’s book

Answer of learning Activity 9.6

1)The use of select case statement is discussed in student’s book. Refer to 9.6 Decision structures in Visual Basic (Select case statement)

2)

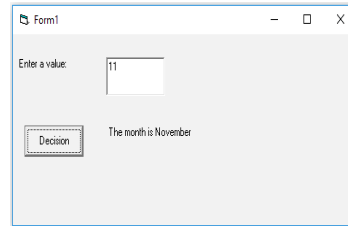
Interface:



Source code

```
Private Sub Command1_Click()  
Dim value As String  
value = Val(Text1.Text)  
Select Case value  
Case 1  
Label2.Caption = " The month is January"  
Case 2  
Label2.Caption = " The month is February"  
Case 3  
Label2.Caption = " The month is March"  
Case 4  
Label2.Caption = " The month is April"  
Case 5  
Label2.Caption = " The month is May"  
Case 6  
Label2.Caption = " The month is June"  
Case 7  
Label2.Caption = " The month is July"  
Case 8  
Label2.Caption = " The month is August"  
Case 9  
Label2.Caption = " The month is September"  
Case 10  
Label2.Caption = " The month is October"  
Case 11  
Label2.Caption = " The month is November"  
Case 12  
Label2.Caption = " The month is December"  
Case Else  
Label2.Caption = "Invalid input! Enter value be-  
tween 1 and 12"  
End Select  
End Sub
```

Ouput



d. Application activity 9.6

1)

Interface:



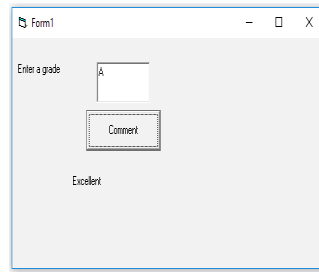
Source code

Ouput

```

Private Sub Command1_Click()
Dim grade As String
grade = Text1.Text
Select Case grade
Case "A"
Label2.Caption = " Excellent"
Case "B"
Label2.Caption = " Good"
Case "C"
Label2.Caption = " Fair"
Case "D"
Label2.Caption = " Poor"
Case "E"
Label2.Caption = " Fail"
Case Else
Label2.Caption = "Invalid input!"
End Select
End Sub

```



2)

Interface:

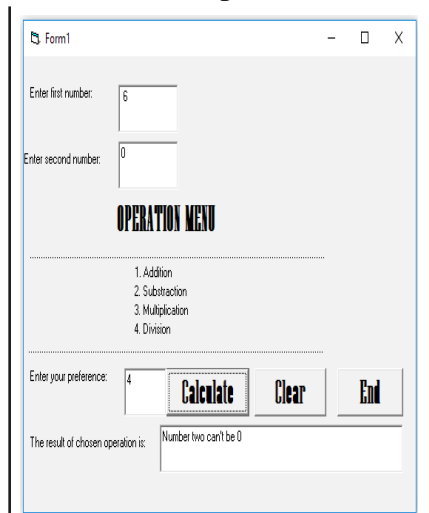
Source code

```

Private Sub Command1_Click()
Dim num1, num2 As Single
Dim choice As Integer
num1 = Val(Text1.Text)
num2 = Val(Text2.Text)
choice = Val(Text3.Text)
Select Case choice
Case 1
Text4.Text = num1 + num2
Case 2
Text4.Text = num1 - num2
Case 3
Text4.Text = num1 * num2
Case 4
If num2 <> 0 Then
Text4.Text = num1 / num2
Else
Text4.Text = "Number two can't be 0"
End If
Case Else
Text4.Text = "Your choice should be 1 to 4 .Please!"
End Select
End Sub
Private Sub Command3_Click()
Text1.Text = ""
Text2.Text = ""
Text3.Text = ""
Text4.Text = ""
End Sub
Private Sub Command2_Click()
Unload Me
End Sub

```

Output



Lesson 8: Repetition structures (indeterminate loops)

duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Students have knowledge and skills about Selection control structure acquired from unit 8” **CONTROL STRUCTURES AND ONE DIMENSION ARRAY**” Senior 4. Activity 9.7 and activity 9.7.1 introduce to students **Repetition structures (Indeterminate loops) in Visual Basic**. This activity is done in groups.

b. Teaching resources:

- Computers with installed Microsoft Visual Basic 6.0
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- Teacher forms and organizes students in groups of 3 students
- Teacher asks each group to do all activities(9.7 and 9.7.1)
- Teacher asks each group secretary to takes short note about their findings
- Let student work independently (10 to 15 minutes)
- Teacher invites group representatives of 3 groups to present the answers of their respective groups
- Students react on the finding/ answers from other groups
- Teacher comments on all presentations by correcting false answers and completing the incomplete answers
- Teacher summarizes the contents referring to notes in student’s book.

Answer of learning activity 9.7

Do While ... Loop, Do Until ... Loop and While ... Wend are discussed in student’s book. Refer to 9.6.1 Indeterminate loops.

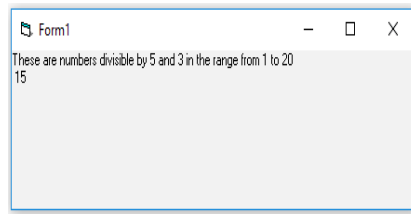
Source code

output

```

Private Sub Form_Load()
Form1.Show
Dim i As Integer
Print "These are numbers divisible by 5 and
3 in the range from 1 to 20"
i = 1
Do While (i <= 20)
If i Mod (5) = 0 And i Mod (3) = 0 Then
Print i
End If
i = i + 1
Loop
End Sub

```



2)

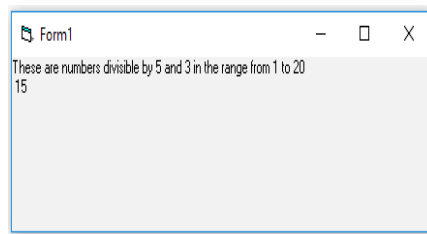
Source code

```

Private Sub Form_Load()
Form1.Show
Dim i As Integer
Print "These are numbers divisible by 5 and
3 in the range from 1 to 20"
i = 1
Do While (i <= 20)
If i Mod (5) = 0 And i Mod (3) = 0 Then
Print i
End If
i = i + 1
Loop
End Sub

```

Output



3)

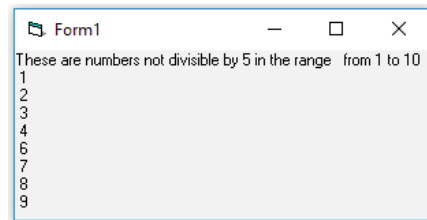
Source code

```

Private Sub Form_Load()
Form1.Show
Dim i As Integer
Print "These are numbers not divisible by 5
in the range from 1 to 10"
i = 1
Do
If Not i Mod (5) = 0 Then
Print i
End If
i = i + 1
Loop While (i <= 10)
End Sub

```

Output



d. Answers of application activity 9.8

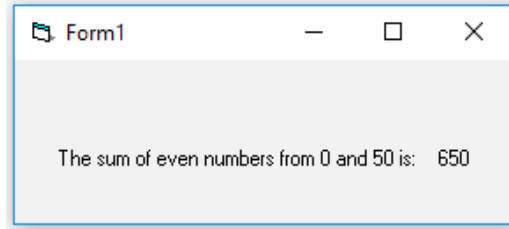
1) A VB program that computes the sum of even numbers from 0 to 50 using

a) Do While Loop

Source code

```
Private Sub Form_Load()  
Form1.Show  
Dim sum, i As Integer  
sum = 0  
i = 0  
Do While (i <= 50)  
If i Mod 2 = 0 Then  
sum = sum + i  
i = i + 2  
End If  
Loop  
Label2.Caption = sum  
End Sub
```

Output



b) While ... Wend loop

Source code

```
Private Sub Form_Load()  
Form1.Show  
Dim sum, i As Integer  
sum = 0  
i = 0  
While (i <= 50)  
If i Mod 2 = 0 Then  
sum = sum + i  
i = i + 2  
End If  
Wend  
Label2.Caption = sum  
End Sub
```

c) Do ... Loop

Output

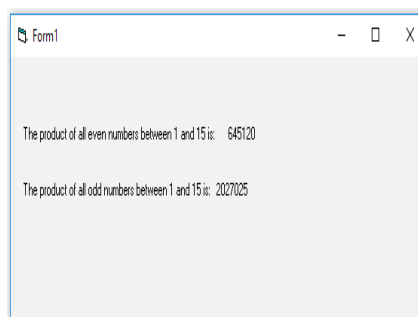
```
Private Sub Form_Load()  
Form1.Show  
Dim sum, i As Integer  
sum = 0  
i = 0  
Do  
If i Mod 2 = 0 Then  
sum = sum + i  
i = i + 2  
End If  
Loop While (i <= 50)  
Label2.Caption = sum  
End Sub
```

2) The product of all even numbers and the product of all odd numbers between 1 and 15 are given by the following:

Source code

```
Private Sub Form_Load()  
Form1.Show  
Dim sum, i As Integer  
even_product = 1  
odd_product = 1  
i = 1  
Do  
If i Mod 2 = 0 Then  
even_product = even_product * i  
Else  
odd_product = odd_product * i  
End If  
i = i + 1  
Loop While (i <= 15)  
Label2.Caption = even_product  
Label4.Caption = odd_product  
End Sub
```

Output



Lesson 9: Repetition structures

(Determinate loop)

Duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Students have knowledge and skills about Selection control structure acquired from unit 8” **CONTROL STRUCTURES AND ONE DIMENSION ARRAY**” Senior 4. Activity (9.7.2 introduces to students **Repetition structures (Determinate loops) in Visual Basic.**

b. Teaching resources:

- Computers with installed Microsoft Visual Basic 6.0
- Internet and textbooks to facilitate research

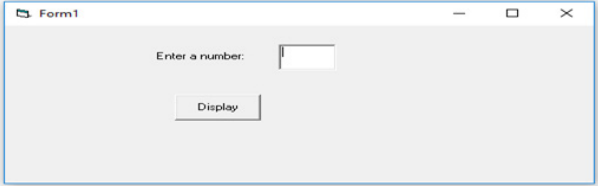
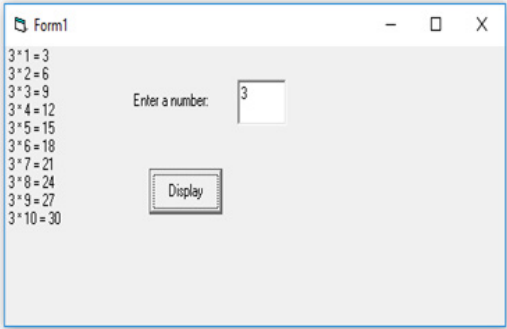
c. Learning activities:

Guidance

- Teacher forms and organizes students in groups of 4 students
- Teacher asks each group secretary to takes short note about their findings
- Let student work independently (10 to 15 minutes)
- Teacher invites group representatives of 2 groups to present the answers of their respective groups.
- Students react on the finding/ answers from other groups.
- Teacher comments on all presentations by correcting false answers and completing the incomplete answers.
- Teacher summarizes the contents referring to notes in student’s book.

Answer of Learning Activity 9.9

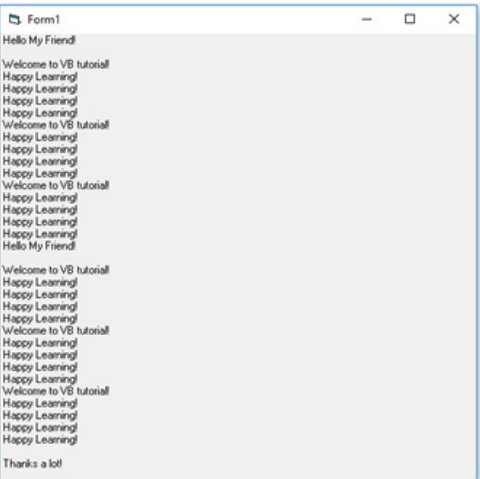
- 1) The syntax of For ... Next loop in Visual Basic is discussed in the student's book
- 2)

Interface	
	
Source code	Output
<pre>Private Sub Command1_Click() Dim a As Integer a = Val(Text1.Text) For i = 1 To 10 Print a; "*" ; i; "=" ; a * i Next i End Sub</pre>	

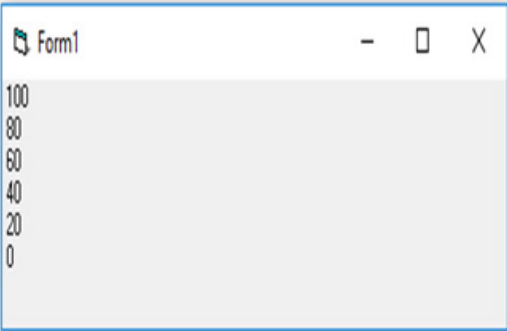
f. Application activity 9.9

- 1)

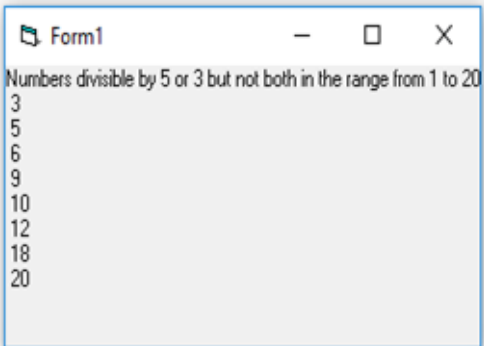
Source code	Output
-------------	--------

<pre>Private Sub Form_Load() Form1.Show Dim firstCounter, secondCounter, thirdCounter As Integer For firstCounter = 1 To 2 Print " Hello My Friend!" Print " " For secondCounter = 1 To 3 Print " Welcome to VB tutorial! " For thirdCounter = 8 To 2 Step -2 Print " Happy Learning! " Next thirdCounter Next secondCounter Next firstCounter Print " " Print " Thanks a lot! " End Sub</pre>	
--	--

2)

Source code	Output
<pre>Private Sub Form_Activate() Dim number As Integer For number = 100 To 0 Step -20 Print number Next number End Sub</pre>	

3)

Source code	Output
<pre>Private Sub Form_Load() Form1.Show Dim i As Integer Print "Numbers divisible by 5 or 3 but not both in the range from 1 to 20" i = 1 For i = 1 To 20 If i Mod (5) = 0 Xor i Mod (3) = 0 Then Print i End If Next i End Sub</pre>	

9.6. Unit summary

Every program acts on data. Types of Visual Basic data are grouped in two major data types:

Numeric data types and Non-numeric data types. Suffixes or appended type character can be used to define the type of a literal.

The table below summarizes Visual Basic Data Types and their suffixes or Appended type character:

Data type	Suffix or Appended type character
Boolean	None
Integer	%
Long (Integer)	&
Single (Floating)	!
Double(Floating)	#
Currency	@
Date	None
Object	None
String	\$
Variant	None

In computer memory, every data must have its memory location known as a variable.

A variable is a name assigned to a data storage location. In a program a variable must be declared, variable declaration can be default, implicit or explicit. A variable has its scope:

- Private(Local) Scope
- Module (Global) Scope
- Public scope

In Visual Basic programming ,we have the following types of variables:

- i. Arithmetic operators
- ii. Relational(Comparison) operators
- iii. Logical operators
- iv. Bitwise operators

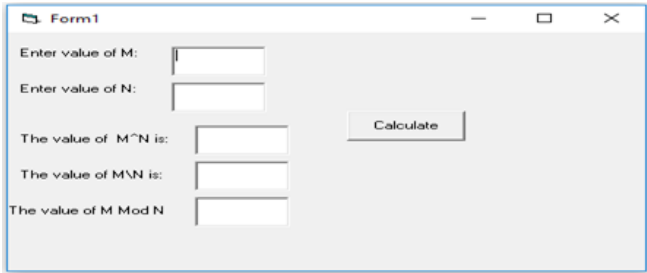
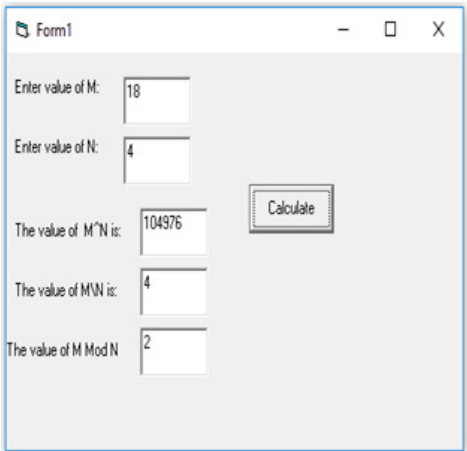
Control structures in Visual basic are into two categories: Decision control structures and repetition control structures.

- Decision control structures are: If... Then, If... Then... Else, Nested If ... Then.... Else ... and Select case Statements
- Repetition control structures are:
 - i. **Indeterminate loops** (Do While... Loop, Do ... Loop while, While Wend, Do Until Loop). These are loops which repeat until a predetermined goal is achieved. Repeating until some initial conditions change.
 - ii. **Determinate loops** (For... loop) This loop repeats a set of operations a fixed number of times.

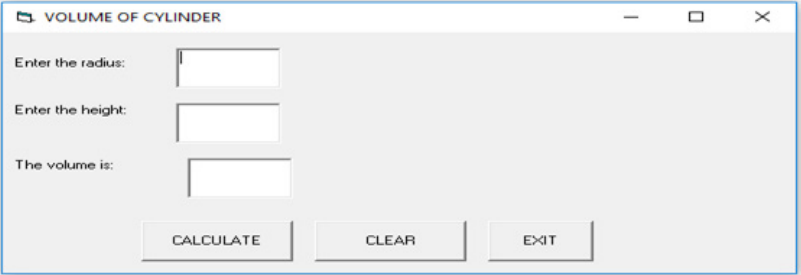
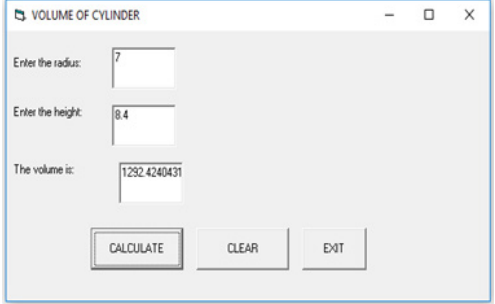
9.7. End unit assessment:

This part provides the answers of end unit assessment activities designed in integrative approach to assess the key unit competence with cross reference to the textbook. The teacher’s guide suggests additional questions and answers to assess the key unit competence.

1)

Interface:	
	
Source code	Output
<pre>Private Sub Command1_Click() Dim M, N, exp, int_div, mode As Integer M = Val(Text1.Text) N = Val(Text2.Text) exp = M ^ N int_div = M \ N mode = M Mod N Text3.Text = exp Text4.Text = int_div Text5.Text = mode End Sub</pre>	

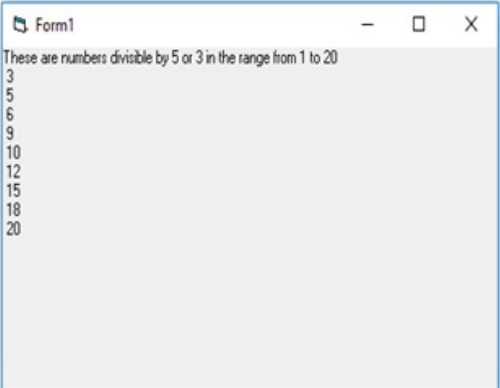
2)

Interface:	
	
Source code	Output
<pre> Private Sub volume_Click() Dim r, h, v, pi As Single pi = 3.14 r = Val(txtradius.Text) h = Val(txtheight.Text) v = pi * (r ^ 2) * h txtvolume.Text = v End Sub Private Sub clear_Click() txtradius = "" txtheight = "" txtvolume = "" End Sub Private Sub end_Click() Unload Me End Sub </pre>	

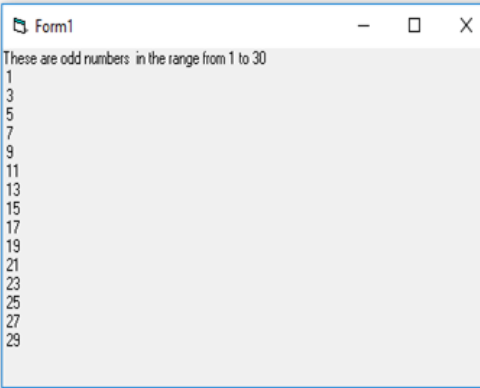
3) The **Select Case** format can be used when there are multiple selection possibilities. Select case instructions are easier to write and decode than complex nested if statements. If the “**case**” matches the condition is selected and all instructions within the matching case are executed.

Syntax of Nested If..Else	Syntax of Select case
<pre> If (Boolean expression/condition) Then VB statement(s) Else if (Boolean expression/condition) VB statement(s) Else VB statement(s) End If </pre>	<pre> Select case expression Case value 1 Block of visual basic statements Case value2 Block of visual basic statements Case value3 Block of visual basic statements Case value4 Case Else Block of visual basic statements End Select </pre>

4)

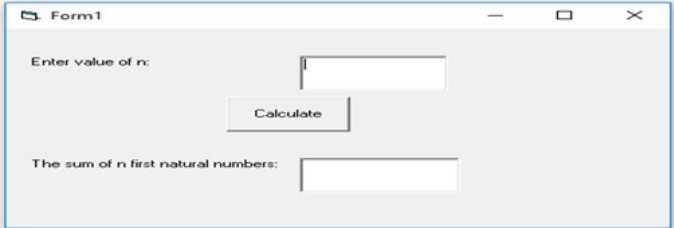
Source code	Output
<pre>Private Sub Form_Load() Form1.Show Print "These are numbers divisible by 5 or 3 in the range from 1 to 20" For i = 1 To 20 If i Mod (5) = 0 Or i Mod (3) = 0 Then Print i End If Next End Sub</pre>	

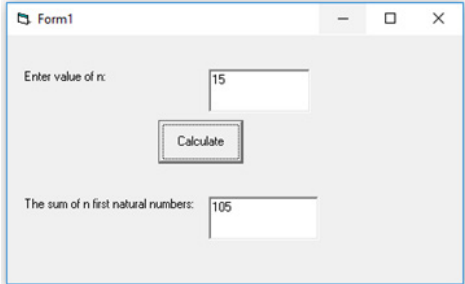
5)

Source code	Output
<pre>Private Sub Form_Load() Form1.Show Print "These are odd numbers in the range from 1 to 30" For i = 1 To 30 If i Mod 2 <> 0 Then Print i End If Next i End Sub</pre>	

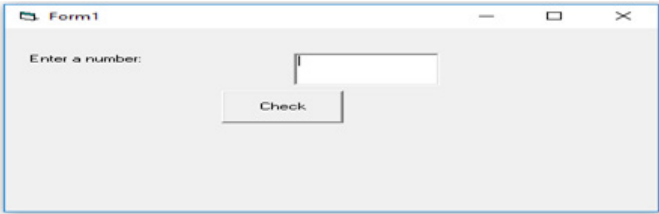
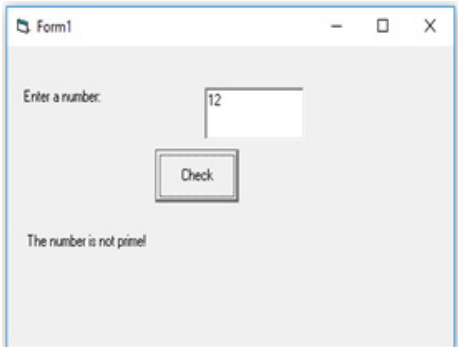
6)

Interface:



Source code	Output
<pre>Private Sub Command1_Click() Dim xi, n As Integer Dim sum As Integer sum = 0 n = Val(txtvalue.Text) For xi = 0 To n - 1 sum = sum + xi txtsum.Text = sum Next xi End Sub</pre>	

7)

Interface:	
	
Source code	Output
<pre>Private Sub Command1_Click() Dim n, i As Integer n = Val(txtvalue.Text) For i = 2 To n / 2 If (n Mod i = 0) Then Label2.Caption = " The number is not prime!" Exit For End If Next i Label2.Caption = " The number is prime!" End Sub</pre>	

9.8. Additional activities

9.8.1. Remedial Activities

Suggestion of Questions and Answers for remedial activities for slow learners.

1. What is an operator?

Answer:

An operator is a symbol or a keyword that instructs a compiler to evaluate mathematical or logical expressions.

- 2.
1. List logical operators
3. Answer:

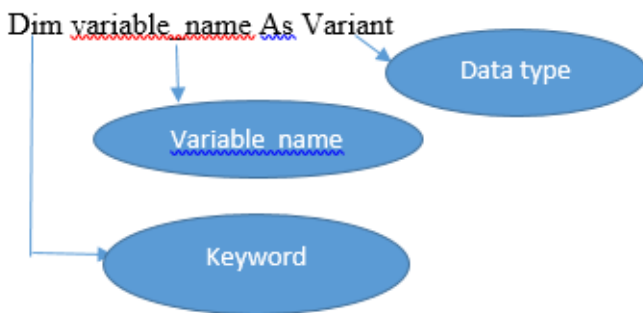
Operator	Operation
Not	Logical not
And / AndAlso	Logical and
Or/ OrElse	Logical or
Xor	Logical exclusion

9.8.2. Consolidation activities

Suggestion of questions and answers for deep development of competences.

1. Give and explain the syntax of default declaration of a variable.

Answer:

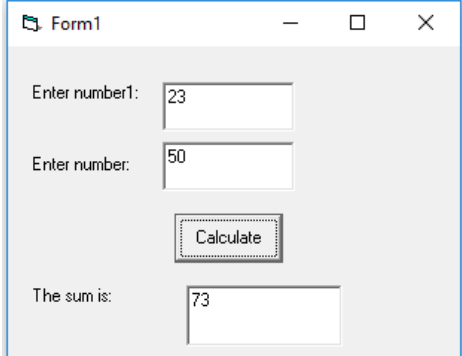


- 2) Design an application which requests two integers and displays the sum

Interface:

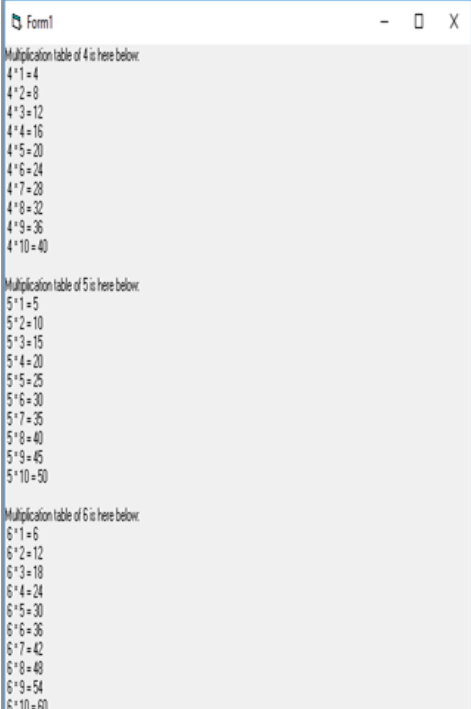
The screenshot shows a Windows application window titled 'Form1'. It contains the following elements:

- Two text boxes for input, each preceded by the label 'Enter number:'.
- A button labeled 'Calculate' positioned between the two input boxes.
- A text box for output, preceded by the label 'The sum is:'.

Source code	Output
<pre>Private Sub Command1_Click() Dim num1, num2, sum As Integer num1 = Val(Text1.Text) num2 = Val(Text2.Text) sum = num1 + num2 Text3.Text = sum End Sub</pre>	

9.8.2. Extended activities

- 1) Write a VB program that displays the multiplication table of 4 to 6

Source code	Output
<pre>Private Sub Form_Load() Form1.Show Dim i, a As Integer Print "Multiplication table of"; 4; "is here below:" For a = 4 To 6 For i = 1 To 10 Print a; "*"; i; "="; a * i Next i Print " " If (a < 6) Then Print "Multiplication table of"; a + 1; "is here below:" End If Next a End Sub</pre>	

10.1. Key Unit Competency:

to be able to create, build and run a java console program

10.2. Prerequisite knowledge and skills:

Students have learnt some concepts of java Introduction in s5. They ideally have some knowledge and skills related to computer programming.

10.3. Cross-cutting issues to be addressed

- **Financial Education:** To be covered when explaining students cost related to java programming in problem solving.
- **Inclusive Education:** To be covered when students organize the inclusive group in activities.
- **Peace and Values Education:** During group activities, debates and presentations, learners should help each other and respect opinions of other colleagues. Students must be aware of crimes that use computer program.
- **Gender education:** Involve both girls and boys in all programming activities: No activity is reserved only to girls or boys.

10.4. Guidance on the introductory activity

(With cross referencing to the Student book + answers)

Instruction to do the introductory activity

1. This activity take place in the class room (where students can share ideas) and each student must have activity and resources correspond with activity.
2. Help students to create small inclusive group
3. Each student must have particular responsibility in their group
4. Guide students to collaborate and share ideas that oriented to the activity

10.5. List of lessons

#	Lesson title	Learning objectives	Number of periods
1	Introductory activity	Analyze the given Search and Answer the corresponding questions	1
2	Concepts of Java Programming	Explain invention and advantages of Java	3
3	Platforms	Identify and describes the platforms of java	3
4	Compile and run of java	Identify steps followed to write a java program	3
5	Variables and Data type	Differentiate data types used in java	3
6	Types of variable	Differentiate variable and constant in java	3
7	Class, object and Method	Identify and describes the elements of java source file	3
8	Flow control	Identify and explain the conditional structure and loop	3
9	End unit Assessment	Answer questions	2

Lesson 1: Concepts of java programming

Duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Introduce this lesson by letting students in their groups discuss about the questions given in activity10.1.

Student should present their findings in class during which they will give the answers and detailed explanations of the questions assigned to them.

Teacher introduces the lesson by reviewing the presentation and reach findings of the students.

b. Teaching resources

Computer lab any room internet and textbooks to facilitate research

c. Learning activities 10.1.

Guidance

- Teacher organize students in groups (according to class size) in order to do learning activity 10.1
- Students elect the group leader and secretary.
- learners analyze and do Learning Activity 10.1
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in students' book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activity 10.1
- Students do Application 10.1

Answer to learning activity 10.1

Teacher supervises the students to conduct these questions with activity 10.1

Reviewing the presentations and research findings of students and completes the half corrected answer then add another information from your research to student's book (Concepts of Java)

d. Answer to application Activity

Answer of application activity 10.1

Features	C	C++	Java
Language	is a procedural language	is a object oriented language	is a pure object oriented language
Header Files	In C we use studio.h header file	In C++ we use iostream.h, conio.h header file	Java does not support any header files.
Platform	C & C++ both are platform dependent that means you can't run the execute code in any other operating system		is a platform independent language
Operator overloading		In C++ we use operator overloading.	Operator overloading concept is not used in Java
Multiple Inheritance		We use multiple inheritance in C++ not in Java	In Java we use Interface instead of multiple inheritance
Translator	but in C & C++ uses compiler only		Java uses compiler and interpreter

Web Application	Internet programming like Frame, Applet is used in Java not in C,C++.
Package	We can create our own package in Java (set of classes) but not in c and C++.

Lesson 2: Platforms of Java Program

Duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Students get prerequisites from previous lesson “Concepts of Java Programming”

Activity must be done in group and students gather ideas on “Platforms of JAVA Program.”The target of this activity is to introduce to students the uses environment of java.

b. Teaching resources:

- Computers, Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- This lesson can be conducted inside of computer lab.
- Teacher asks and help students to form small group to do the Learning Activity 10.2
- Students elect the group leader and secretary.
- learners analyze and do Learning Activity 10.2
- Teacher walks around and sees if students are doing Learning Activity 10.2
- Students present their answer to the rest of class.
- Students react on the finding/ answers from others.
- Teacher corrects false answers and completes the half corrected answers
- Teacher summarizes the contents (Note in student’s book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 10.2
- Students do Application activities 10.2

Answers to learning activity 10.2

Reviewing the presentations and research findings of students and completes the half corrected answer then add another information.

-Refer to **student’s textbook** (Platforms of JAVA Program) or other resources book

(Platforms of JAVA Program).

d. Answer to application Activity

Answers to Application Activity 10.2

- The target of this activity to the students is two understand practically a **Java platform** components (JRE, JDK, and JVM) and difference between C++ and Java programming.
- In this activity evaluate if students understand the concepts of **platform of java** (platform independent). Teacher allows the students to find the comparison of JRE and JDK
- -Refer to **Student’s book** (Platforms of JAVA Program). or other resources and add more information to the student’s presentations(**Cfr Student Book 10.2**)

Lesson 3: Compile and run a java program

duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Students get prerequisites from the previous lesson “Platforms of JAVA Program”.

Guidance on learning activity 10.3

Teacher asks students what they have learnt in previous lessons 1 and 2. From answers given by students, Teacher introduces the activity 10.3.

The objective of this activity is to give students the steps to write, compile and run a program.

b. Teaching resources:

- Computer lab, Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- This lesson can be conducted in the computer lab.
- Teacher asks students to form groups to do the Learning Activity 10.3
- Students elect the group leader and secretary in order to perform Learning Activity 10.3
- learners think and do Learning Activity 10.3
- Teacher walks around and sees if students are doing Learning Activity 10.3 in their respective group.
- Teacher support student to accomplish activity 10.3
- Teacher guide student to write all steps used in activity 10.3
- Teacher gives the instructions on how to do Application activities 10.3

- Students do Application activity. 10.3

Answers to Learning activity 10.3.

1. Install Steps by step the environment of java

Step 0: Un-Install Older Version(s) of JDK/JRE

It is recommended that you install only the *latest* JDK. Although you can install multiple versions of JDK/JRE concurrently, it is messy.

Step 1: Download JDK

Goto Java SE download site @ <http://www.oracle.com/technetwork/java/javase/downloads/index.html>.

1. Under “Java Platform, Standard Edition” ⇒ “Java SE 10.0. {x}”, where {x} denotes a fast running update number ⇒ Click the JDK’s “Download” button.
2. Under “Java SE Development Kit 10.0. {x}” ⇒ Check “Accept License Agreement”.
3. Choose the JDK for your operating system, i.e., “Windows” (for 64-bit Windows OS), and download the installer (e.g., “jdk-10.0. {x}_windows-x64_bin.exe” - 390MB).

Step 2: Install JDK and JRE

Run the downloaded installer (e.g., “jdk-10.0.{x}_windows-x64_bin.exe”), which installs both the JDK and JRE.

By default:

-JDK is installed in directory “C:\Program Files\Java\jdk-10.0.{x}”, where {x} denotes the upgrade number; and

-JRE is installed in “C:\Program Files\Java\jre-10.0.{x}”.

Notes: In 64-bit Windows, “Program Files” is meant for 64-bit programs; while “Program Files (x86)” for 32-bit programs.

Accept the defaults and follow the screen instructions to install JDK and JRE.

Use the “File Explorer”, goto “C:\Program Files\Java” to inspect these folders. Take note of your **JDK installed directory**, in particular, the varying upgrade number, which you will need in the next step.

In the following diagram, the JDK installed directory is “C:\Program Files\Java\jdk-10.0.1”, where {x}=1. I shall refer to the **JDK installed directory** as <JAVA_HOME>, hereafter, in this article.

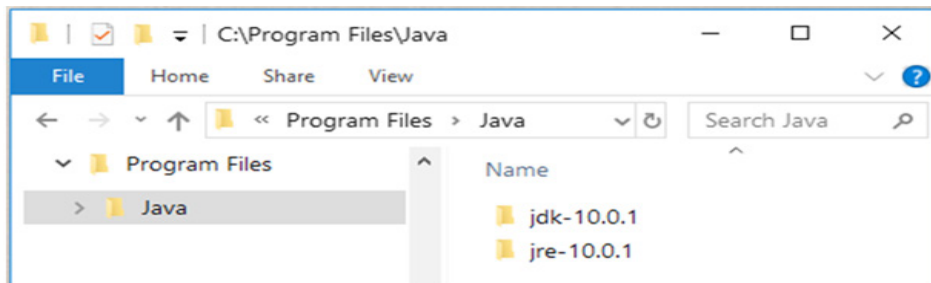
2.

Step1: Create a source document using any editor and save file as .java (e.g. abc.java)

Step2: Compile the abc.java file using “javac” command or eclipse will compile it automatically.

Step3: Byte Code (abc.class) will be generated on disk.

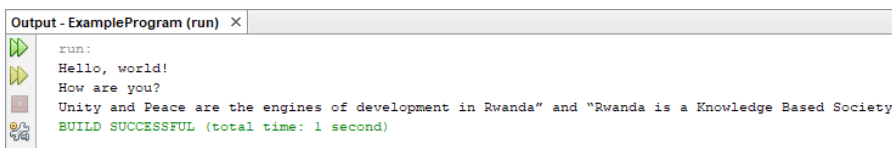
Step4: This byte code can run on any platform or device having JVM (java.exe convert byte code in machine language).



d. Answers to Application activity 10.3

-Teacher evaluates and facilitates students how to **write programs** based on example from **student’s textbook** and run that program and others program from difference recourses.

```
/*
 * First Java program, which says “Hello, world!”
 */
public class ExampleProgram { // Save as “Hello.java”
    public static void main(String[] args) { // program entry point
        System.out.println(“Hello, world!”); // print message
        System.out.println(“How are you?”); // print message
        System.out.println(“Unity and Peace are the engines of development in Rwanda” and “Rwanda is
        a Knowledge Based Society”); // print message
    }
}
```



Lesson 4: Variables and Data Types

Duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction

Students get prerequisites from the previous lesson “Write compile and run Java Program”.

Introduce the lesson using what students have learnt in lesson 3.

Students form group of 5 students, in doing learning activity 10.4. Students have to identify and describe themselves forms of data type the available in the Programming (java).

b. Teaching resources:

- Computer, internet and textbooks to facilitate research

c. Learning activities

Guidance

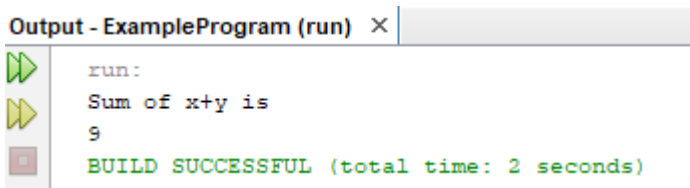
- This lesson can be conducted in the computer lab, class room or outside.
- Teacher asks students to form groups to do the Learning Activity 10.4
- Students elect the group leader and secretary in order to perform Learning Activity 10.4
- Teacher walks around and sees if students are doing Learning Activity 10.4 in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in student's book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 10.4
- Students do Application activity. 10.4

Answer of Learning activity 10.4

1.-1 and 2 Refer to **student's textbook** (Variables and Data type in Java) or other resources and add more information to the student's presentations

Program

```
package exampleprogram;
public class ExampleProgram {
public static void main(String[] args) { // program entry point
int x=5;// variable 1
int y=4;// variable 2
int sum= x+y;// variable
System.out.println("Sum of x+y is"); // print message
System.out.println(sum);
} }
```

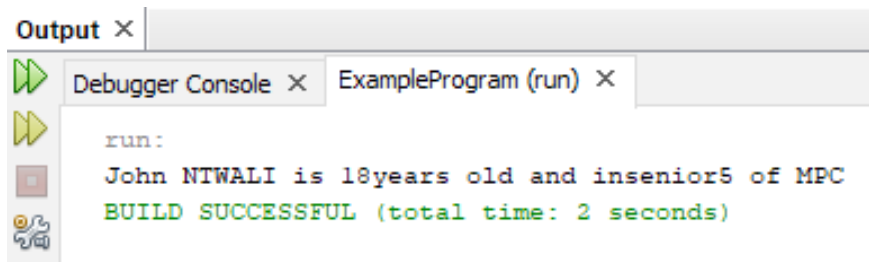


```
Output - ExampleProgram (run) ×
run:
Sum of x+y is
9
BUILD SUCCESSFUL (total time: 2 seconds)
```

d. Answer to Application activity 10.4

1. In this activity evaluate if students understand the concepts of **data type** and **Variable**.

```
package exampleprogram;
public class ExampleProgram {
public static void main(String[] args) { // program entry point
String firstname = "John", lastname= "NTWALI";
String level="senior5";
String combination="MPC";
int age =18;// variable 1
System.out.println(firstname+ " "+lastname+ " "+"is"+" "+age+"years old and in"+level+
"+"of"+" "+combination);
}}
```



```
Output X
Debugger Console X ExampleProgram (run) X
run:
John NTWALI is 18years old and insenior5 of MPC
BUILD SUCCESSFUL (total time: 2 seconds)
```

Lesson 5: Types of variables

duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Students get prerequisites from previous lesson “Variable and data type”.

Activity must be done in group and students gather ideas on “Class, object and Method” Remember that students have at least once Definitions and advantage to use variables. The target of this activity is to introduce to students the uses environment of java.

b. Teaching resources:

Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- This lesson can be conducted inside of computer lab.
- Teacher asks and help students to form small group to do the Learning Activity 10.6
- Students elect the group leader and secretary.
- learners analyze and do Learning Activity 10.6
- Teacher walks around and sees if students are doing Learning Activity 10.6
- Students present their answer to the rest of class.

- Students react on the finding/ answers from others.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in student’s book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 10.5 Students do Application activities 10.5.

Answers to Learning activity 10.5:

1. Not all variables are accessible from all parts of our program, and not all variables exist for the same amount of time. Where a variable is accessible and how long it exists depend on how it is defined.

-We call the part of a program where a variable is accessible its *scope*, and the duration for which the variable exists its *lifetime*.

-A variable which is defined in the main body of a file is called a **global** variable. It will be visible throughout the file, and also inside any file which imports that file.

-Global variables can have unintended consequences because of their wide-ranging effects – **that is why we should almost never use them.**

-A variable which is defined inside a function is *local* to that function. It is accessible from the point at which it is defined until the end of the function, and exists for as long as the function is executing. The parameter names in the function definition behave like local variables, but they contain the values that we pass into the function when we call it.

-When we use the assignment operator (=) inside a function, its default behavior is to create a new local variable – unless a variable with the same name is already defined in the local scope.

2.Refer to student’s book (**Type of variable**)

d. Answers to application activity 10.5

<pre>int x = 10, y; y = x+1; System.out.print(y); Show the answer.</pre> <p style="text-align: center;">11</p>	<pre>int x = 10, y; y = x+1; System.out.print(x); Show the answer.</pre> <p style="text-align: center;">10</p>	<pre>int result = 4 + 5 * 6 + 2; System.out.print(result); Show the answer.</pre> <p style="text-align: center;">36</p>
		<pre>int a = 5 + 7 % 2; System.out.print(a); Show the answer</pre> <p style="text-align: center;">6</p>

Lesson 6: Class, object and method

duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Students get prerequisites from previous lesson “types of variable”

Activity must be done in group and students gather ideas on “Class, object and Method”

Remember that students have at least once Definitions and advantage to use variables.

The target of this activity is to introduce to students the uses environment of java.

b. Teaching resources:

Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- This lesson can be conducted inside of computer lab.
- Teacher asks and help students to form small group to do the Learning Activity 10.4.3
- Students elect the group leader and secretary.
- learners analyze and do Learning Activity 10.4.3
- Teacher walks around and sees if students are doing Learning Activity 10.4.3
- Students present their answer to the rest of class.
- Students react on the finding/ answers from others.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in student’s book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 10.6
- Students do Application activities 10.6

Answers to Learning activity10.6

1. The target of this activity to the students is to understand **structure of java program** in practically.

1.“package sct”:

It is package declaration statement. The package statement defines a namespace in which classes are stored. The package is used to organize the classes based on functionality. If you omit the package statement, the class names are put into the default package, which has no name. Package statement cannot appear anywhere in the program. It must be the first line of your program or you can omit it.

2.“public class HelloWorld”:

This line has various aspects of java programming.

a. public: This is access modifier keyword which tells compiler access to class. Various values of access modifiers can be public, protected,private or default (no value).

b. class: This keyword used to declare a class. Name of class (HelloWorld) followed by this keyword.

3. Comments section:

We can write comments in java in two ways.

a. Line comments: It starts with two forward slashes (//) and continues to the end of the current line. Line comments do not require an ending symbol.

b. Block comments start with a forward slash and an asterisk (/*) and end with an asterisk and a forward slash (*).Block comments can also extend across as many lines as needed.

4. “public static void main (String [] args)”:

Its method (Function) named main with string array as an argument.

a. public: Access Modifier

b. static: static is a reserved keyword which means that a method is accessible and usable even though no objects of the class exist.

c. void: This keyword declares nothing would be returned from the method. The method can return any primitive or object.

d. Method content inside curly braces. { } asdfla;sd

5. System.out.println(“Hello World from Java”) :

a. System: It is the name of Java utility class.

b. out:It is an object which belongs to System class.

c. println: It is utility method name which is used to send any String to the console.

d. “Hello World from Java”: It is String literal set as argument to println method.

2) The method `average ()` has 3 versions, with different parameter lists. The caller can invoke the chosen version by supplying the matching arguments.

```
public static int average(int n1, int n2) { // version A
System.out.println(“Run version A”);
return (n1+n2)/2;
}
public static double average(double n1, double n2) { // version B
System.out.println(“Run version B”);
return (n1+n2)/2;
}
public static int average(int n1, int n2, int n3) { // version C
System.out.println(“Run version C”);
return (n1+n2+n3)/3;
}
```

```

public static void main(String[] args) {
System.out.println(average(1, 2)); // Use A
System.out.println(average(1.0, 2.0)); // Use B
System.out.println(average(1, 2, 3)); // Use C
System.out.println(average(1.0, 2)); // Use B - int 2 implicitly casted to double 2.0
// average(1, 2, 3, 4); // Compilation Error- No matching method
}
}

```

```

Output - ExampleProgram (run) ×
1
Run version B
1.5
Run version C
2
Run version B
1.5
BUILD SUCCESSFUL (total time: 4 seconds)

```

d. Answer to application Activity 10.6

```

package sct;
//This is car test class to instantiate and call Car objects.
PublicclassCarTest{
Publicstaticvoidmain(String[] args){
Car maruti =newCar("Red",160);
Car ferrari =newCar("Yellow",400);
System.out.println(maruti.carInfo());
System.out.println(ferrari.carInfo());
}
}

```

Lesson 7: Flow control

duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Students get prerequisites from previous lesson “Class, object and Method”

Activity must be done in group and students gather ideas on “Flow control”.

The target of this activity is to introduce to students the Flow control

Internet and textbooks to facilitate research

b. Teaching resources:

Internet and textbooks to facilitate research

c. Learning activities:

Guidance

- This lesson can be conducted inside of computer lab.
- Teacher asks and help students to form small group to do the Learning Activity 10.5

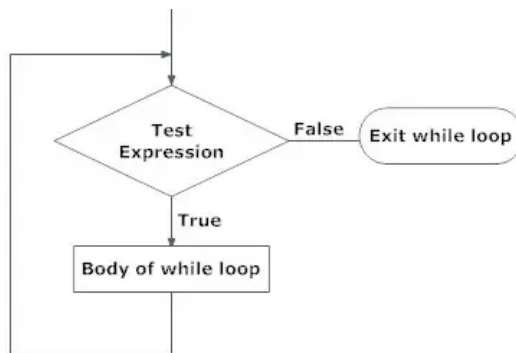
- Students elect the group leader and secretary.
- learners analyze and do Learning Activity 10.5
- Teacher walks around and sees if students are doing Learning Activity 10.5
- Students present their answer to the rest of class.
- Students react on the finding/ answers from others.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in student’s book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activities 10. Students do Application activities 10.6 and Application activities 10.5

Answers to Learning activity 10.7

1. Refer to **student’s textbook (Flow control)** or other resources to add more information on i) and ii).

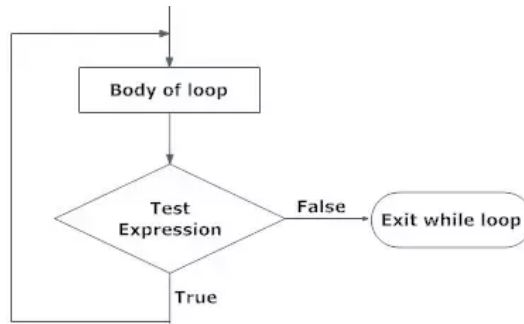
2. **While-** condition is at the beginning of the loop block, and makes possible to *never enter the loop*.

In While loop, the condition is first tested and then the block of code is executed if the test result is true.



Do While- your condition is at the end of the loop block, and makes obligatory to *enter the loop at least one time*.

In Do-While, the code is first executed and then the condition is checked. The next iteration is executed if the test result is true.



d. Answers to application activity 10.7

1. In this activity evaluate if students understand the concepts of **Flow control**. Teacher allows the students to find and use the **Flow control** in different ways.
2. Refer to **student’s textbook (Flow control)** or other resources to add more information to the student about this activity

```

Output - myfirstprogram (run) x
run:
x is not between 1 and 4
x is one
x is two
x is three
x is four
x is not between 1 and 4
BUILD SUCCESSFUL (total time: 4 seconds)
  
```

10.6. Unit summary

Java is an object-oriented language, which means that it has constructs to represent objects from the real world. Each Java program has at least one class that knows how to do certain things or how to represent some type of object. For example, the simplest class, Hello World, knows how to greet the world. Classes in Java may have methods (or functions) and fields (or attributes or properties)

We have discussed about:

- Concepts of Java Programming
- Platforms
- Compile and run of java
- Variables and Data type
- Types of variable
- Class, object and Method
- Flow control
- End unit Assessment

Today Java programming language is one of the most popular programming languages which is used in critical applications like stock market trading system on BSE, banking systems or android mobile application.

10.7. Addition information

h. JDK or JRE

JRE (Java Runtime) is needed for *running* Java programs. JDK (Java Development Kit), which includes JRE plus the development tools (such as compiler and debugger), is need for *writing (developing)* as well as *running* Java programs. In other words, JRE is a subset of JDK. Since you are supposed to write Java Programs, you should install JDK, which includes JRE.

i. The Scanner class

The System class also provides the special value System. In, which is an Input Stream that provides methods for reading input from the keyboard. These methods are not easy to use; fortunately, Java provides other classes that make it easier to handle common input tasks. For example, Scanner is a class that provides methods for inputting words, numbers, and other data. Scanner is provided by java. Util, which is a package that contains classes so useful they are called “utility classes”.

Before you can use Scanner, you have to import it like this:

```
import java.util.Scanner;
```

This import statement tells the compiler that when you say Scanner, you mean the one defined in java.util. It’s necessary because there might be another class named Scanner in another package. Using an import statement makes your code unambiguous. Import statements can’t be inside a class definition. By convention, they are usually at the beginning of the file. Next you have to create a Scanner:

```
Scanner in = new Scanner(System.in);
```

This line declares a Scanner variable named in and creates a new Scanner that takes input from System. In. Scanner provides a method called next Line that reads a line of input from the keyboard and returns a String. The following example reads two lines and repeats them back to the user:

```
import java.util.Scanner;
public class Echo {
public static void main(String[] args) {
String line;
Scanner in = new Scanner(System.in);
System.out.print(“Type something: “);
line = in.nextLine();
System.out.println(“You said: “ + line);
System.out.print(“Type something else: “);
line = in.nextLine();
System.out.println(“You also said: “ + line);
}}
```

Types of errors

Three kinds of errors can occur in a program: compile-time errors, run-time errors, and logic errors. It is useful to distinguish among them in order to track them down more quickly.

1) Compile-time errors occur when you violate the syntax rules of the Java language. For example, parentheses and braces have to come in matching pairs. So (1 + 2) is legal, but 8) is not. In the latter case, the program cannot be compiled, and the compiler displays an error. Error messages from the compiler usually indicate where in the program the error occurred, and sometimes they can tell you exactly what the error is.

Example

```
public class Hello {  
    public static void main(String[] args) {  
        // generate some simple output  
        System.out.println("Hello, World!");  
    }  
}
```

If you forget the semicolon at the end of the print statement, you might get an error message like this:

```
File: Hello.java [line: 5]  
Error: ';' expected
```

2) The second type of error is a **run-time error** so-called because it does not appear until after the program has started running. In Java, these errors occur while the interpreter is executing byte code and something goes wrong.

These errors are also called “exceptions” because they usually indicate that something exceptional (and bad) has happened.

Run-time errors are rare in the simple programs you will see in the first few chapters, so it might be a while before you encounter one. When a run-time error occurs, the interpreter displays an error message that explains what happened and where.

For example, if you accidentally divide by zero you will get a message like this: Exception in thread “main” java.lang.ArithmeticException: / by zero at Hello.main(Hello.java:5)

3) The third type of error is **the logic error**. If your program has logic error, it will compile and run without generating error messages, but it will not do the right thing. Instead, it will do exactly what you told it to do. For example, here is a version of the hello world program with a logic error:

```
public class Hello {  
    public static void main(String[] args) {  
        System.out.println("Hello, "); System.out.println("World!");  
    }  
}
```

This program compiles and runs just fine, but the output is: Hello, World!

Assuming that we wanted the output on one line, this is not correct. The problem is that the first line uses **println**, when we probably meant to use **print**.

10.8. End unit assessment

This part provides the answers to end unit assessment activities designed in integrative approach to assess the key unit competence with cross reference to the textbook. The teacher's guide suggests additional questions and answers to assess the key unit competence.

1. the difference between a statement and a comment

Statement: A part of a program that specifies a computation. **The Comment:** A part of a program that contains information about the program, but that has no effect when the program runs.

2. class, object, methods and Instance variable

- a. **Object:** Objects have states and behaviors. Example: A dog has states - color, name, breed as well as behavior such as wagging their tail, barking, eating. An object is an instance of a class.
- b. **Class :** A class can be defined as a template/blueprint that describes the behavior/state that the object of its type supports.
- c. **Methods:** A method is basically a behavior. A class can contain many methods. It is in methods where the logics are written, data is manipulated and all the actions are executed.
- d. **Instance Variables :** Each object has its unique set of instance variables. An object's state is created by the values assigned to these instance variables

3. The following variable types:

- a. **Local variables:** Variables defined inside methods, constructors or blocks are called local variables. The variable will be declared and initialized within the method and the variable will be destroyed when the method has completed.
- b. **Instance variables:** Instance variables are variables within a class but outside any method. These variables are initialized when the class is instantiated. Instance variables can be accessed from inside any method, constructor or blocks of that particular class.
- c. **Class variables:** Class variables are variables declared within a class, outside any method, with the static keyword.

4. Conditional statements in java

To write useful programs, we almost always need to check conditions and react accordingly. Conditional statements give us this ability. The simplest Conditional statement in Java is the

a. **if statement:**

```
if (x > 0) {  
System.out.println("x is positive");  
}
```

The expression in parentheses is called the condition. If it is true, the statements in braces get executed. If the condition is false, execution skips over that

Block of code. The condition in parentheses can be any Boolean expression

b. A second form of conditional statement has two possibilities, indicated by **if and else**.

The possibilities are called branches, and the condition determines which one gets executed:

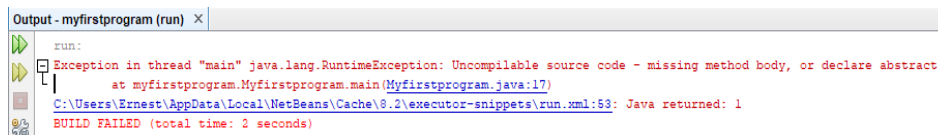
```
if (x % 2 == 0) {  
System.out.println("x is even");  
} else {  
System.out.println("x is odd");  
}
```

c. Sometimes you want to check related conditions and choose one of several actions. One way to do this is by chaining a series of if and else statements

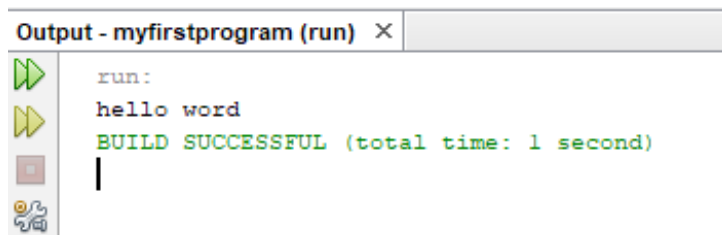
```
if (x > 0) {  
System.out.println("x is positive");  
} else if (x < 0) {  
System.out.println("x is negative");  
} else {  
System.out.println("x is zero");  
}
```

5. After making each change, compile the program, read the error message (if there is one), and then fix the error.

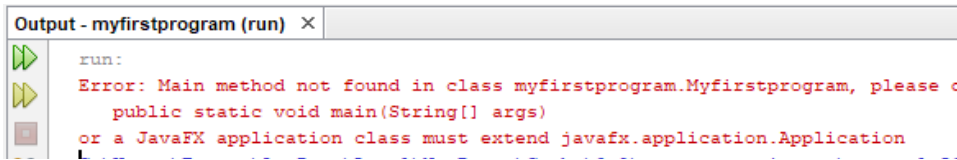
i) Remove one of the open squiggly braces.



ii) Remove one of the close squiggly braces.

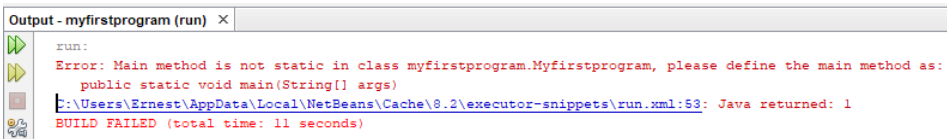


iii) Instead of main, write mian.



```
Output - myfirstprogram (run) X
run:
Error: Main method not found in class myfirstprogram.Myfirstprogram, please define the main method as:
public static void main(String[] args)
or a JavaFX application class must extend javafx.application.Application
```

iv) Remove the word static.



```
Output - myfirstprogram (run) X
run:
Error: Main method is not static in class myfirstprogram.Myfirstprogram, please define the main method as:
public static void main(String[] args)
C:\Users\Ernest\AppData\Local\NetBeans\Cache\8.2\executor-snippets\run.xml:53: Java returned: 1
BUILD FAILED (total time: 11 seconds)
```

10.9. Additional activities

10.9.1. Remedial Activities:

Suggestion of Questions and Answers for remedial activities for slow learners.

a. What is a java program?

Answer

Java is a **programming** language and computing platform first released by Sun Microsystems in 1995. There are lots of **applications** and websites that will not work unless you have **Java** installed, and more are created every day. **Java** is fast, secure, and reliable.

b. Write a Java program to print 'Hello' on screen and then print your name on a separate line.

Answer

```
public class Exercise1 {
    public static void main (String[] args) {
        System.out.println ("Hello\nAlexandra Abramov!");
    }
}
```

10.9.2. Consolidation activities

Suggestion of questions and answers for deep development of competences:

1. Differentiate type of errors of java programming

Answer:

Compile-time errors occur when you violate the syntax rules of the Java language.

Run-time error: so-called because it does not appear until after the program has started running. In Java, these errors occur while the interpreter is executing byte code and something goes wrong. These errors are also called “exceptions” because they usually indicate that something exceptional (and bad) has happened.

The logic error: If your program has logic error, it will compile and run without generating error messages, but it will not do the right thing.

Extended activities: Suggestion of Questions and Answers for gifted and talented students.

Write a Java program to print ‘Hello’ on screen and then print your name on a separate line **.using input from the user.**

Answer:

```
import java.util.Scanner;
public class Main {
    public static void main(String[] args) {
        Scanner input = new Scanner(System.in);
        System.out.print("Input your first name: ");
        String fname = input.next();
        System.out.print("Input your last name: ");
        String lname = input.next();
        System.out.println();
        System.out.println("Hello \n"+fname+" "+lname);}}}
```

2. Write a Java program that takes two numbers as input and display the product of two numbers.

Answer:

```
import java.util.Scanner;
public class Exercise5 {
    public static void main(String[] args) {
        Scanner in = new Scanner(System.in);
        System.out.print("Input first number: ");
        int num1 = in.nextInt();
        System.out.print("Input second number: ");
        int num2 = in.nextInt();
        System.out.println(num1 + " x " + num2 + " = " + num1 * num2);
    }
}
```


11.1. Key Unit Competence

To be able to use objects to manipulate data in Java program

11.2. Prerequisite knowledge and skills

Learners have learnt programming knowledge and skills in C++ and Java programming languages in Senior 4 and Senior 5. Learners are able to write and run a program in Java Virtual Machine.

11.3. Cross-cutting issues to be addressed:

- **Standardization culture:** learners follow Java programming coding standards.
- **Gender Education:** make sure learning groups are gender balanced where it is applicable and participants are working on activities.
- **Inclusive Education:** in all lessons make sure that learners with disability are mixed and participate with their fellows without disability in the same groups for their assigned work.
- **Financial education:** through discussion, explain learners to understand the contribution of Object Oriented Programming paradigms in software development in terms of reusability, reduced cost of software development through Java programming language.

11.4. Guidance on the introductory activity

Instruction to do the introductory activity:

- The introduction activity take place in the computer lab and each learner must have a computer which has the NetBeans IDE installed.
- Learners examine the picture in the introductory activity; the picture shows various classes and their respective methods and class members. The objective of the activity is to help learners to recall what they have learnt in Unit 7: Object oriented programming in C++ and unit 10 introduction to the Java.
- Then, learners start to do the introductory activity in group of 4 or 5 learners. They may not be able to answer all the questions but let them try and get answers as they learn this unit.

Below are suggested answers for questions in the Introductory Activity.

Object-oriented programming (OOP) is a programming paradigm based upon objects (having both data and methods) that aims to incorporate the advantages of modularity and reusability. Objects, which are usually instances of classes, are used to interact with one another to design applications and computer programs.

defined classes are Student, Circle, SoccerPlayer and Car

5. data members

- data members for class Student are name and grade
- data members for class Circle are radius and area
- data members for class SoccerPlayer are name,number,xLocation,yLocation
- data members for class Car are plateNumber, xLocation,yLocation and speed

6. Member functions for each class?

- class Student has getName() and PrintGrade() member functions
- class Circle has getRadius() and getArea() member functions
- class Student has run(),jump(),kickball() member functions
- class Student has move(),park(),accelerate member functions

7. Instance of a class is An object of the class

8. Instances of student class can be as following:

```
student s1=new student();
```

```
student s1=new student();
```

9. Declaration of the Student class in Java

```
class Student {  
    string name;  
    int;  
    getName(){  
    }  
    PrintGrade(){  
    }  
}}
```

11.5. List of lessons

#	Lesson title	Learning objectives	Number of periods
1	Introductory Activity		1
2	Classes vs Objects in Java	Create and instantiate a class using main method. Describe instance, class, and local (method) variables in an object-oriented program.	3
3	Constructor in Java	Describe instance, class, and local (method) variables in an object-oriented program. Use constructor to initialize instance variable of a given object	2
4	The use of “new” and “This” keywords	Describe the use of “new” and “this” keywords in an object-oriented program.	2
5	Arrays in Java	Store elements and retrieve them in array.	3
6	Inheritance in Java	Create a parent class that is being inherited by child classes and instantiate both parent and child classes.	3
7	Access modifiers in Java	Describe the use of Public, Protected, Private, Private keywords in an object-oriented program.	2
8	Overriding methods	Understand the use of overriding methods in Java	2
9	Encapsulation in Java	Understand the use of encapsulation in Java	3
10	Abstract classes and method	Understand the use of abstract classes and methods in Java	2
11	END UNIT ASSESSMENT	Evaluate the key unit competence	1

Guidance on different lessons outlined above

Lesson 1: Classes vs objects in java

duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Learners have prerequisites seen in Unit 7: Object Oriented Programming in C++ and Unit 10: Introduction to Java.

b. Teaching resources:

- Computer with NetBeans IDE installed.
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance on Activities

- Teacher organizes students in group in order to do learning activity.
- Students elect the group leader and secretary.
- Learners do the Activity 11.1.
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on the findings / answers from other groups.
- Teacher corrects false answers and completes the half corrected answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students

Answers to learning Activity 11.1

1. The output of the program is :

Student name is: Kiberinka

Student age is: 18

Variable Value: 18

2. The new keywords are :

a. `student mystudent = new student("Kiberinka ");`

b. `mystudent.setAge(18);`

3. All items that makes up a class are under bracelet `{}`. The main parts under `{}` are :

Data member: `int Age;`

Methods: `public student (String name), public voidsetAge (int age), public intgetAge()`

4. Data member in class student is : `int Age;`

5. Functions /methods are `student(String name), public voidsetAge(int age), public intgetAge()`

6. In Java Programming, the Keywords” new “creates a Java object and it allocates memory

d. Answersto Application activity 11.1

1. In object oriented programming, the instantiation is the process of the creating the real object of a class (instance).

2. The difference between a class and an object are described in bellow table:

No.	Object	Class
1	Object is an instance of a class.	Class is a blueprint or template from which objects are created.
2	Object is a real world entity such as pen, laptop, mobile, bed, keyboard, mouse, chair etc.	Class is a group of similar objects.
3	Object is a physical entity.	Class is a logical entity.
4	Object is created through new keyword mainly e.g. <code>Student s1=new Student();</code>	Class is declared using class keyword e.g. <code>class Student{}</code>
5	1. Object is created many times as per requirement.	Class is declared once.
6	Object allocates memory when it is created.	Class doesn't allocated memory when it is created.
7	There are many ways to create object in java such as new keyword, <code>newInstance()</code> method, <code>clone()</code> method, factory method and deserialization.	There is only one way to define class in java using class keyword.

3. In programming, a method is like a function. Method is a block of code that performs a specific task. In object-oriented programming, method is a jargon used for function. Methods are bound to a class and they define the behavior of a class.
4. The declaration `public static void main`. It means that you create a main method within the Java application.
 - **Public:** public is an access specifier which allows the main method to be accessible everywhere.
 - **Static:** static helps main method to get loaded without getting called by any instance/object.
 - **Void:** void clarifies that the main method will not return any value.
 - **Main:** it is the name of the method
 - **String[] args:** it defines a String array to pass arguments at command line. And args is the variable name of the String array. It can be changed to anything such as String []
5. The meaning of the terms instance variable and instance method are follows:
 - a. Instance variable is the variable declared inside a class, but outside of a method
 - b. Instance method are methods which require an object of its class to be created before it can be called.

Lesson 2: Constructor in java

duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Learners have prerequisites seen in Unit 7: Object Oriented Programming in C++ and Unit 10: Introduction to Java.

b. Teaching resources:

- Computer with NetBeans IDE installed.
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance on Activities

- Teacher organizes students in group in order to do learning activity.
- Students elect the group leader and secretary.
- Learners do the Learning Activity 11.2.
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.

- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the half corrected answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activity 11.2
- Students do Application activity 11.2

Answers to learning Activity 11.2

1. The output of the program is:
 - i) Rwanda has 30 districts
 - ii) Null
 - iii) 0
2. The difference between class district and district () is that:
 - i) Class district is a class
 - ii) District () is a constructor of class district
3. The reason the function district () does not have a return type is because it is a constructor.

d. Answers to application activity 11.2

1. The purpose of constructor is to initialize the object of a class
2. There are basically two rules defined for the constructor:
 - Constructor name must be same as its class name
 - Constructor must have no explicit return type
- 3 .A default constructor refers to a constructor that is automatically generated by the compiler if no constructors have been defined for the class.
- 4 .The important difference between constructors and methods is that constructors initialize objects that are being created with the new operator, while methods perform operations on objects that already exist.

Constructors can't be called directly; they are called implicitly when the new keyword creates an object. Methods can be called directly on an object that has already been created with new.

Constructors must be named with the same name as the class name. They can't return anything, even void (the object itself is the implicit return).Methods must be declared to return something, although it can be void.

5.

```
class Hello{
String greet;
Hello(){
System.out.println(“ Amakuru Yawe ?”);
}
Hello(String greetings){
String greets;
}
}
public class Helloprogram {
public static void main(String[] args) {
Hello greetings = new Hello();
Hello greetings1 = new Hello (“Amakuru Yawe”);
}
}
```

6. The output is

121 Kwizera

121 Kwizera

Lesson 3: The use of “new” and “this” keyword in java

duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Learners have prerequisites seen in Unit 7: Object Oriented Programming in C++ and Unit 10: Introduction to Java.

b. Teaching resources:

- Computer with **NetBeans IDE** installed.
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance on Activities

- Teacher organizes students in group in order to do learning activity.

- Students elect the group leader and secretary.
- Learners do the Learning Activity 11.3
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the half corrected answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activity 11.3
- Students do Application activity 11.3

Answers to learning activity 11.3

1. The output of the program is: The Area of rectangle is : 25
2. `this.length = length;` during the execution it references current object length, `this.length` refers to the variable length of the current object that has invoked the constructor. `length` only refers to the parameter received in the constructor
3. It allows Java Virtual machine to display the correct value
4. An object `rect` is created using parameterized constructor.

d. Answers to application activity 11.3

1. The computer allocate the memory to the object `gorilla` created
2. Verify if the rule of using `this` keyword has been followed.
3. The output of the program is : `Murwanashyaka Balance: 5000`

Lesson 4: Array in java

Duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Learners have prerequisites seen in Unit 7: Object Oriented Programming in C++ and Unit 10: Introduction to Java.

b. Teaching resources:

- Computer with NetBeans IDE installed.
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance on Activities

- Teacher organizes students in group in order to do learning activity.
- Students elect the group leader and secretary.
- Learners do the Learning Activity 11.4
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the incomplete answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activity 11.4
- Students do Application activity 11.4

Answers to learning activity 11.4

1. The output of the program is :

```
19.0
29.0
34.0
35.0
Total is 117.0
Max is 35.0
```

2.

i) `double[] myList = {19, 29, 34, 35};` is the initialization of the array myList

ii) The statement for `(int i = 0; i < myList.length; i++)`

`System.out.print(myList[i] + " ");` is used to print arrays by using the for loop.

d. Answers to application activity 11.4.

1) the output is 2) 0 2 4 6 8

3)

```
package arrayexercise;
import java.util.Arrays;
public class Exercise1 {
public static void main(String[] args){
int[] my_array1 = {
17, 20, 18, 14, 13,
14, 24, 54, 72, 23,
56, 21, 57, 56};
String[] my_array2 = {
```

```

        "Java",
        "Python",
        "PHP",
        "C#",
        "C Programming",
        "C++"
    };
    System.out.println("Original numeric array : "+Arrays.toString(my_array1));
    Arrays.sort(my_array1);
    System.out.println("Sorted numeric array : "+Arrays.toString(my_array1));
    System.out.println("Original string array : "+Arrays.toString(my_array2));
    Arrays.sort(my_array2);
    System.out.println("Sorted string array : "+Arrays.toString(my_array2));
}
}
4)public class Exercise {
public static int findIndex (int[] my_array, int t) {
if(my_array == null) return -1;
int len = my_array.length;
int i= 0;
while (i < len) {
if (my_array[i] == t) return i;
else i=i+1;
}
return -1;
}
public static void main(String[] args) {
int[] my_array = {25, 14, 56, 15, 36, 56, 77, 18, 29, 49};
System.out.println("Index position of 25 is: " + findIndex(my_array, 25));
System.out.println("Index position of 77 is: " + findIndex(my_array, 77));
}}

```

Lesson 5: Inheritance in Java

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Learners have prerequisites seen in Unit 7: Object Oriented Programming in C++ and Unit 10: Introduction to Java.

b. Teaching resources:

- Computer with NetBeans IDE installed.
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance on Activities

- Teacher organizes students in group in order to do learning activity.
- Students elect the group leader and secretary.
- Learners do the Learning Activity 11.5

- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the half corrected answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students

Answers to learning activity 11.5

1. The output of the program is Lycee de Kigali

Teacher

Computer Science

Teaching

2. The statement means theta class computer teacher is derived from the class teacher

d. Answers to application activity 11.5

1. Refer to the students 'book
2. Refer to the students 'book
3. Refer to the students 'book
4. Refer to the students 'book
5. No, a class is not a subclass of itself. An inner class could be a subclass of some other class, but that is a separate class.
6. Lab activity (refers to student book 11.5.3)
7. The output of the program is :

Inside display

Inside area

Inside volume

Lesson 6: Access modifiers in java

duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Learners have prerequisites seen in Unit 7: Object Oriented Programming in C++ and Unit 10: Introduction to Java.

b. Teaching resources:

- Computer with NetBeans IDE installed.
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance on Activities

- Teacher organizes students in group in order to do learning activity.
- Students elect the group leader and secretary.
- Learners do the Learning Activity 11.6
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the half corrected answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students

Answer for the activity 11.6

1. The output of the program is:

Lycee de Kigali
 Teacher
 Computer Science
 Teaching

2. Refer to the student's book

d. Answers to application activity 11.6

1. In Java, there is the access modifiers and non-access modifiers.
 - Access Modifiers: public, private, protected, default
 - Non- Access Modifiers: abstract, final
2. Refer to the students 'book
3. Refer to the students 'book
4. Refer to the students 'book
5. Refer to the students 'book 11.6

Lesson 7: Overriding methods in java

duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Learners have prerequisites seen in Unit 7: Object Oriented Programming in C++ and Unit 10: Introduction to Java.

b. Teaching resources:

- Computer with NetBean Installed.
- Internet and textbooks to facilitate research.

c. Learning activities:

Guidance on Activities

- Teacher organizes students in group in order to do learning activity.
- Students elect the group leader and secretary.
- Learners do the Learning Activity 11.7
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the half corrected answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students

Answers to activity 11.7

- a. The output of the above program is : Boy is eating
- b. The method is implemented through method overriding

d. Answersto application activity 11.7

1. Refer to the concept of a method overloading in Java
2. Refer to the concept of a method overriding in Java
3. Refer to the students 'book
4. The output of the program is :

This is Address of Rwanda Tea Company...

This is Address of Rwanda Tea Company...

This is Rwanda Coffee Company's Address...

Lesson 8: Encapsulation in java

duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Learners have prerequisites seen in Unit 7: Object Oriented Programming in C++ and Unit 10: Introduction to Java.

b. Teaching resources:

- Computer with NetBeans installed.
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance on Activities

- Teacher organizes students in group in order to do learning activity.
- Students elect the group leader and secretary.
- Learners do the Learning Activity 11.8
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the half corrected answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students

Answers to learning activity 11. 8

1. The output of the program is :

Name: Masabo

Age: 19

Registration 51

2. They are used in encapsulation process. Encapsulation in Java is a mechanism of wrapping the data (variables) and code acting on the data (methods) together as a single unit. Declare the variables of a class as private. Provide public setter and getter methods to modify and view the variables values.

d. Answers to application activity 11. 8

1. Refer to the students 'book
2. refer to the students 'book
3. refer to the students 'book
4. refer to the students 'book

5. refer to the students 'book

Lesson 9: Abstract class and method in java

Duration: 2 periods: 80 minutes

a. Prerequisites/Revision/Introduction:

Learners have prerequisites seen in Unit 7: Object Oriented Programming in C++ and Unit 10: Introduction to Java.

b. Teaching resources:

- Computer with NetBeans installed.
- Internet and textbooks to facilitate research

c. Learning activities:

Guidance on Activities

- Teacher organizes students in group in order to do learning activity.
- Students elect the group leader and secretary.
- Learners do the Learning Activity 11.9
- Teacher walks around and sees if students are doing activity in their respective group.
- Students present their answer to the rest of class.
- Students react on the finding/ answers from other groups.
- Teacher corrects false answers and completes the half corrected answers
- Teacher summarizes the contents (Note in students book) and gives examples that should be done by students
- Teacher gives the instructions on how to do Application activity 11.9
- Students do Application activity 11.9

Answers to learning activity 11.9

1. The output of the program is

Shape constructor called

Circle constructor called

Shape constructor called

Rectangle constructor called

Circle color is Red and area is: 15.205308443374602

Rectangle color is Yellow and area is: 8.0

2. The “abstract” Keyword. The keyword abstract can be used on class declaration.

When a class is declared abstract, it cannot be instantiated. When a method is declared abstract, it cannot have definition. Only abstract classes can have abstract methods.

3. When an abstract class is the subclass, the subclass usually provides implementations for all of the abstract methods in its parent class.

d. Answers to application activity 11.9

1. Refer to the students 'book
2. Refer to the students 'book
3. Refer to the students 'book
4. Refer to the students 'book
5. The output of the program is :

 this is callme.

 this is concrete method

11.6. Summary of the unit

Java is an object-oriented language, it represents objects from the real world in programming. Class plays a key role in Java programming and a class has methods and fields. Methods is a function that represents actions which can be performed by a class.

Variables are values representing an object and they can change over the program's lifetime and some remain constants.

Below are key concepts discussed in students 'book:

- **Class:** A template for an object which contains variables and methods representing behavior and attributes. Classes can inherit variables and methods from other classes.
- **Class method:** A method defined within a class and operates on the class itself and can be called via the class or any of its instances.
- **Class variable:** A variable that is "owned" by the class and all its instances as a whole and is stored in the class.
- **Instance:** The same thing as an object and each object is an instance of some class.
- **Instance method:** A method defined in a class and it operates on an instance of that class. Instance methods are usually called just methods.
- **Instance variable:** A variable that is owned by an individual instance and whose value is stored in the instance.
- **Object:** it is a concrete instance of some class. Multiple objects that are instances of the same class have access to the same methods, but often have different values for their instance variables.
- **Package:** A collection of classes and interfaces. Classes from packages other

than **java.lang** must be explicitly imported or referred to by full package name.

- **Subclass:** A class lower in the inheritance hierarchy than its parent, the superclass. When you create a new class, it's often called subclassing.
- **Superclass:** A class further up in the inheritance hierarchy than its child, the subclass.
-
-

11.7. Additional Information

This section provides additional content for the teacher to have a deeper understanding of the topic.

Below are some addition concepts that you can use in this unit.

Abstract Data Type: is a user-defined data type which includes both attributes (its state) and methods (its behaviour).

Aggregation: Objects that are made up of other objects are known as aggregations. The relationship is generally of one of two types:

- **Composition:** the object is composed of other objects. This form of aggregation is a form of code reuse.

Example: a Car is composed of Wheels, a Chassis and an Engine

- **Collection:** the object contains other objects.

Example: a List contains several Items; A Set several Members.

Attribute: it is a characteristic of an object and collectively attributes of an object describe its state.

Example: a Car may have attributes of Speed, Direction, Registration Number and Driver.

Dynamic Binding: The identification at run time of which version of a method is being called and when the class of an object cannot be identified at compile time, it is impossible to use static binding to identify the correct object method, then, dynamic binding is used.

Encapsulation: The combining together of attributes (data) and methods (behaviour/processes) into a single abstract data type with a public interface and a private implementation. This allows the implementation to be altered without affecting the interface.

Interface: The behaviour that a class exposes to the outside world; its public face. Also called its 'contract'. In Java `interface` is also a keyword similar to class. However a Java interface contains no implementation: it simply describes the behaviour expected of a particular type of object, it doesn't so how that behaviour should be implemented.

11.8. Aswers toend unit assessment

```
Publicclass Invoice {
private String partNumber;
private String partDescription;
privateint quantity;
privatedouble price;

public Invoice(String pNum, String pDesc,int qty,double prc){
if(pNum !=null) partNumber=pNum;
else partNumber="0";
if(pDesc !=null) partDescription=pDesc;
else partDescription="0";
if(qty >0) quantity=qty;else quantity=0;
if(prc >0.0) price=prc;else price=0;
}
public String getPartNum(){
return partNumber;
}
public String getPartDesc(){
return partDescription;
}
publicint getQuantity(){
return quantity;
}
publicdouble getPrice(){
return price;
}
publicvoid setPartNum(String pNum){
if(pNum !=null){partNumber=pNum;}
else{partNumber="0";}
}
Publicvoid setPartDesc(String pDesc){
if(pDesc !=null){
partDescription=pDesc;}
else{partDescription="0";}
}

publicvoid setQuantity(int qty){
if(qty >0){quantity=qty;}
else{quantity=0;}
}
publicvoid setPrice(double prc){
if(prc >0.0){price=prc;}
else{price=0.0;}
}
Publicdouble getInvoiceAmount(){
return(double)quantity*price;
}
}

publicclass InvoiceTest {
publicstaticvoid main (String args[]){
Invoice invoice1=new Invoice ("A5544", "Big Black Book",500,250.00);
Invoice invoice2=new Invoice ("A5542", "Big Pink Book",300,50.00);
System.out.printf("Invoice 1: %s\t%s\t%d\t$%.2f\n", invoice1.getPartNum(), invoice1.getPartDesc(),
invoice1.getQuantity(), invoice1.getPrice());
System.out.printf("Invoice 2: %s\t%s\t%d\t$%.2f\n", invoice2.getPartNum(), invoice2.getPartDesc(),
invoice2.getQuantity(), invoice2.getPrice());}
}

1. a.
PUBLICCLASS CAR {
```



```
Price %.2f", myCar.getSalePrice());  
}}
```

11.9. Additional activities

11.9.1. Remedial Activities

Suggestion of questions and answers for deep development of competences

1. Explain about abstract classes in java?

Sometimes we may come across a situation where we cannot provide implementation to all the methods in a class. We want to leave the implementation to a class that extends it. In such case we declare a class as abstract. To make a class abstract we use key word abstract. Any class that contains one or more abstract methods is declared as abstract. If we don't declare class as abstract which contains abstract methods we get compile time error. We get the following error.

“The type <class-name> must be an abstract class to define abstract methods.”

Signature ; abstract class <class-name>

```
{  
}
```

The important features of abstract classes are :

- Abstract classes cannot be instantiated.
- An abstract classes contains abstract methods, concrete methods or both.
- Any class which extends abstract class must override all methods of abstract class.

An abstract class can contain either 0 or more abstract methods. Though we cannot instantiate abstract classes we can create object references. Through superclass references we can point to subclass.

10. Examine if it is possible to create a constructor in abstract class?

Yes, a constructor can be created in abstract class but it doesn't give any compilation error and it cannot instantiate class there is no use in creating a constructor for abstract class.

11.9.2. Consolidation activities:

1. What access modifiers can be used for class?

Answer

We can use only two access modifiers for class public and default.

public: A class with public modifier can be visible :

- In the same class

- In the same package subclass
- In the same package non subclass
- In the different package subclass

In the different package non subclass.

default : A class with default modifier can be accessed

- In the same class
- In the same package subclass
- In the same package non subclass
- In the different package subclass
- In the different package non subclass.

protected: When a method is declared as protected it can be accessed

Within the same class,

Within the same package subclass,

Within the same package non subclass,

Within different package subclass

It cannot be accessed non subclass in different package.

private : When a method is declared as private it can be accessed only in that class. It cannot be accessed in Same package subclass, Same package non subclass, Different package subclass, Different package non subclass.

2. What is final access modifier in java?

The final access modifier can be used for class, method and variables. The main advantage of final access modifier is security no one can modify our classes, variables and methods. The main disadvantage of final access modifier is we cannot implement object oriented programming concepts in java.

The final variables: If a variable is declared as final, it behaves like a constant. We cannot modify the value of final variable. Any attempt to modify the final variable results in compilation error. The error is as follows “final variable cannot be assigned.”

3. What is the difference between this() and super() in java ?

this() is used to access one constructor from another with in the same class while super() is used to access superclass constructor. Either this() or super() exists it must be the first statement in the constructor.

11.9.3. Extended activities

Suggestion of questions and answers for deep development of competences

1. What are difference between method overloading and method overriding in java?

Method Overloading	Method Overriding
Method Overloading occurs within the same class	Method Overriding occurs between two classes superclass and subclass
Since it involves with only one class inheritance is not involved.	Since method overriding occurs between superclass and subclass inheritance is involved.
In overloading return type need not be the same	In overriding return type must be same.
Parameters must be different when we do overloading	Parameters must be same.
Static polymorphism can be achieved using method overloading	Dynamic polymorphism can be achieved using method overriding.
In overloading one method can't hide the another	6) In overriding subclass method hides that of the superclass method.

2. Discuss the use of the super keyword in java?

Variables and methods of super class can be overridden in subclass. In case of overriding, a subclass object call its own variables and methods. Subclass cannot access the variables and methods of super class because the overridden variables or methods hides the methods and variables of super class. But still java provides a way to access super class members even if its members are overridden. Super is used to access superclass variables, methods, constructors. Super can be used in two forms:

- First form is for calling super class constructor.
- Second one is to call super class variables, methods. Super if present must be the first statement.

12.1. Key unit competence:

To be able to use streams, readers and writers in Java

12.2. Prerequisite

(knowledge, skills, attitudes and values)

Students have learnt computer programming. They have some knowledge and skills related to java units learnt previously in the unit of **Introduction to Java and OOP and Java**

12.3. Cross-cutting issues to be addressed:

- **Gender Education:-** When grouping the learners, boys should be mixed with girls in all activities.
- **Inclusive Education:** in all lessons make sure that learners with disability are mixed and participate in the groups and give their opinions

12.4. Guidance on the introductory activity:

Instruction to do the introductory activity

- This activity take place in the class room
- Teacher organizes students into groups
- Students elect the group leader and secretary
- The teacher asks students to do the introductory activity in their respective groups.
- Teacher lets the students work independently on the activity during 15 minutes .
- The teacher moves around to see how students are working.
- The teacher invites representatives of groups to presents their findings (2 or 3 groups).
- The teacher asks the rest of the class to evaluate findings.
- The introductory goal is to give students idea of entering value into variable or files.

- The teacher may ask some questions to boost the students.
- The teacher tells the students that they will have complete answers in the forthcoming lessons.

12.5. List of lessons

#	Lesson title	Learning objectives	Number of periods
1	Introduction to IO streams	Read , manipulate and display user inputs to the console	2
2	InputStream and OutputStream	Catch Input/Output Exceptions while reading data to the console.	3
3	FileStreams	Read and display data of text file	3
4	Readers and writer	Appreciate the manipulation user’s inputs and of files using streams, readers and writer	3
5	End unit Assessment	Answers to end unit assessment	1

Guidance on different lessons outlined above

Lesson 1: Introduction to IO Streams

Duration: 3 periods: 120 minutes

a. Prerequisites/revision/introduction:

Teacher invites a student and asks him/her to write five numbers and calculate the sum of those numbers and asks students to observe each step in order to respond to the questions in the activity 12.1. From the students’ answers, teacher explains to students and introduces the lesson using technical explanations.

b. Teaching resources

Textbooks to facilitate research

c. Learning activities’:

Guidance

- Teacher organizes students in group in order to do Activity 12.1
- Students elect the group leader and secretary.
- Teacher gives the instructions on how to do Activity 12.1
- Teacher asks the students to work in groups on Activity 12.1 during 15 minutes.

- Learners discuss on the steps needed in order to do activity 12.1
- Teacher walks around and sees if students are doing activity in their respective group.
- Representatives of 3 or 4 groups present their answers to the rest of the class.
- Students react to the finding/ answers from other groups.
- Teacher corrects false answers and completes the half correct answers
- Teacher summarizes the contents or teacher refers to notes in students' book and gives examples that should be done by students.
- Teacher gives the instructions on how to do Application activity 12.1
- At the end of the lesson, teacher requests students to do Application activity 12.1 in the groups as they have done Activity 12.1

Answers to learning activity 12.1

Let students discuss the types, similarities and differences of stream from different programming languages C++ and JAVA.

1st step: Declaration of 11 variables

2nd step: Entering 10 numbers into different variables

3rd step: Calculating the sum

4th step: printing the sum

d. Answers to application activity 12.1

1: stream, type of stream and class of stream refer to the section 12.1 introduction to IO Stream

2. For the difference between System.in and System.out, output stream and input stream refer to 12.1.1 Role of I/O Stream. These sections contain explanation for each term which can be used in deducing their difference

Lesson 2: Inputstream and outputstream

Duration: 3 periods: 120 minutes

a. Prerequisites/revision/introduction:

Learning activity 12.2 is used to introduce InputStream and OutputStream. The purpose of this activity is to show learner how to allocate the values to the variables.

Teacher asks students to give a sample program (c++ or algorithm) that allow user to enter data into variables. From the students' answers, teacher explains and introduces the lessons using real terms to the students.

b. Teaching resources:

Students' books

Computer Labs

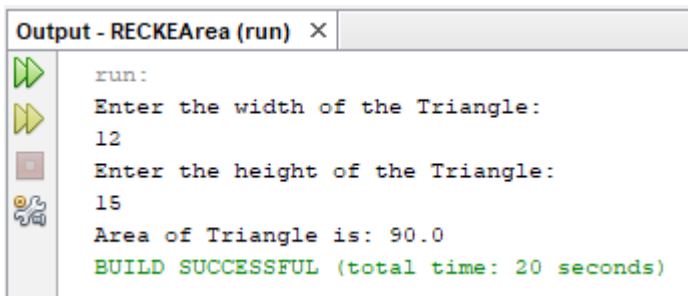
c. Learning activities:

Guidance on learning activity

- This lesson can be conducted in the computer lab.
- Teacher asks students to form pairs to do the Learning Activity 12.2
- Students elect the group leader and secretary in order to perform Learning Activity 12.2
- Teacher walks around and sees if students are doing Learning Activity 12.2 in their respective groups.
- Students present their answers to the rest of the class.
- Students react on answers from other groups.
- Teacher corrects false answers and completes the half correct answers
- Teacher summarizes the contents (Note in student's book) and gives examples that should be done by students

Answers to learning activities 12.2

```
import java.util.Scanner;
class AreaTriangle {
    public static void main(String args[]) {
        Scanner scanner = new Scanner(System.in);
        System.out.println("Enter the width of the Triangle:");
        double base = scanner.nextDouble();
        System.out.println("Enter the height of the Triangle:");
        double height = scanner.nextDouble();
        double area = (base* height)/2;
        System.out.println("Area of Triangle is: " + area);
    }
}
```



```
Output - RECKEArea (run) ×
run:
Enter the width of the Triangle:
12
Enter the height of the Triangle:
15
Area of Triangle is: 90.0
BUILD SUCCESSFUL (total time: 20 seconds)
```

d. Answers to application activities 12.2

1)

```
import java.util.Scanner;
```

```

public class Exercise2 {
public static void main(String[] args)
{
Scanner in = new Scanner(System.in);
System.out.print("Input the first number: ");
double x = in.nextDouble();
System.out.print("Input the second number: ");
double y = in.nextDouble();
System.out.print("Input the third number: ");
double z = in.nextDouble();
System.out.println("the first nuber is " + " " + x );
System.out.println("the second number is " + " " + y );
System.out.println("the third number is " + " " + z );
}
}

```

```

Input the first number: 12
Input the second number: 5
Input the third number: 10
the first nuber is 12.0
the second number is 5.0
the third number is 10.0

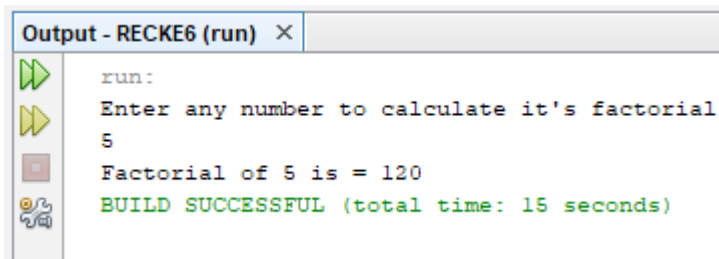
```

2)The below source code allows to calculate Factorial of any given number

```

import java.util.Scanner;
class Factorial
{
public static void main(String args[])
{
int n, number, fact = 1;
System.out.println("Enter any number to calculate it's factorial");
Scanner in = new Scanner(System.in);
n = in.nextInt();
if (n < 0)
System.out.println("Number should be positive number.");
else
{
for (number = 1; number <= n; number++)
fact = fact*number;
System.out.println("Factorial of "+n+" is = "+fact);
}}}

```

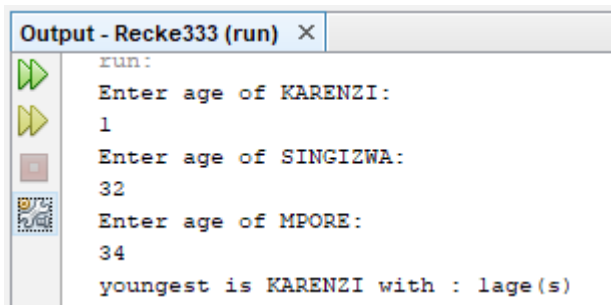


3)

a. Using Scanner

Using scanner, bellow source code ask user to enter the ages of three students and display the youngest.

```
import java.util.Scanner;
class youngest
{
public static void main(String[] args)
{
int karenzi,singizwa,mpore,largest;
Scanner s=new Scanner(System.in);
System.out.println("Enter age of KARENZI: ");
karenzi=s.nextInt();
System.out.println("Enter age of SINGIZWA: ");
singizwa=s.nextInt();
System.out.println("Enter age of MPORE: ");
mpore=s.nextInt();
if (karenzi<singizwa && karenzi<mpore)
{
System.out.println("youngest is KARENZI with : "+karenzi +"age(s)");
}
else if (singizwa<karenzi && singizwa<mpore)
{
System.out.println("youngest is SINGIZWA with: "+singizwa +"age(s)");
}
else if (mpore<karenzi && mpore<singizwa)
{
System.out.println("youngest is MPORE with: "+mpore +"age(s)");
}
else
System.out.println("KARENZI, SINGIZWA and MPORE are in the same age" );
}
}
```



```
Output - Recke333 (run) x
run:
Enter age of KARENZI:
1
Enter age of SINGIZWA:
32
Enter age of MPORE:
34
youngest is KARENZI with : lage(s)
```

b. Using DataInputStream

Using DataInputStream , bellow source code ask user to enter the ages of three students and display the youngest.

```
import java.io.*;
public class KeyboardReading1
{
public static void main(String args[]) throws IOException
{
```

```

try (DataInputStream dis = new DataInputStream(System.in)) {

    System.out.println("Enter the age of KARENZI: ");
    String karenzi = dis.readLine();
    int karenziage = Integer.parseInt(karenzi);
    System.out.println("Enter the age of SINGIZWA: ");
    String singizwa = dis.readLine();
    int singizwaage = Integer.parseInt(singizwa);
    System.out.println("Enter the age of MPORE: ");
    String mpore = dis.readLine();
    int mporeage = Integer.parseInt(mpore)
    if (karenziage<singizwaage && karenziage<mporeage)
    {
    System.out.println("youngest is KARENZI with : "+karenziage +"age(s)");
    }
    else if (singizwaage<karenziage && singizwaage<mporeage)
    {
    System.out.println("youngest is SINGIZWA with: "+singizwaage +"age(s)");
    }
    else if (mporeage<karenziage && mporeage<singizwaage)
    {
    System.out.println("youngest is MPORE with: "+mporeage +"age(s)");
    }
    else
    System.out.println("KARENZI, SINGIZWA and MPORE are in the same age");
}
}
}
}
}

```

```

Output - RECKE4 (run) X
run:
Enter the age of KARENZI:
34
Enter the age of SINGIZWA:
1
Enter the age of MPORE:
32
youngest is SINGIZWA with: lage(s)
BUILD SUCCESSFUL (total time: 1 minute 22 seconds)

```

c. Using bufferedreader

Using BufferedReader, bellow source code ask user to enter the ages of three students and display the youngest.

```

import java.io.BufferedReader;
import java.io.InputStreamReader;
class Test {
    public static void main(String args[]) throws Exception {
        int karenzi, singizwa, mpore;
        InputStreamReader is = new InputStreamReader(System.in);
        BufferedReader br = new BufferedReader(is);
        System.out.println("Enter the age of KARENZI :");
        karenzi = Integer.parseInt(br.readLine());
        System.out.println("Enter the age of SINGIZWA :");
        singizwa = Integer.parseInt(br.readLine());
        System.out.println("Enter the age of MPORE :");
    }
}

```

```

mpore = Integer.parseInt(br.readLine());
if (karenzi<singizwa && karenzi<mpore)
{
System.out.println("youngest is KARENZI with : "+karenzi +"age(s)");
}
else if (singizwa<karenzi && singizwa<mpore)
{
System.out.println("youngest is SINGIZWA with: "+singizwa +"age(s)");
}
else if (mpore<karenzi && mpore<singizwa)
{
System.out.println("youngest is MPORE with: "+mpore +"age(s)");
}
else
{
System.out.println("KARENZI, SINGIZWA and MPORE are in the same age" );
}
}
}

```

```

Output - RECKE5 (run) X
run:
Enter the age of KARENZI :
32
Enter the age of SINGIZWA :
34
Enter the age of MPORE :
1
youngest is MPORE with: lage(s)
BUILD SUCCESSFUL (total time: 41 seconds)

```

Lesson 3: Filestreams

Duration: 3 periods: 120 minutes

a. Prerequisites/Revision/Introduction:

Learning activity 12.3 is used to introduce FileStream . The purpose of this activity is to show to learners how to allocate the values into the file.

Teacher asks students to give a sample program in Java that allows user to enter data into a file. From the students' answers, teacher explains and introduces the lessons.

b. Teaching resources:

- Students' books,
- Computer Lab

c. Learning activities:

Guidance on learning activity

- This lesson can be conducted in the computer laboratory
- Teacher ask students to form pairs to do the Learning Activity 12.3
- Students elect the group leader and secretary in order to perform Learning

Activity 12.3

- Teacher lets groups work independently in 15 minutes
- Students present their answers to the rest of class.
- Students react on answers from their colleagues.
- Teacher corrects false answers and completes the half correct answers
- Teacher summarizes the contents (Note in student's book) and gives examples that should be done by students
- At the end of the lesson 3, teacher gives the instructions on how to do Application activities 12.3

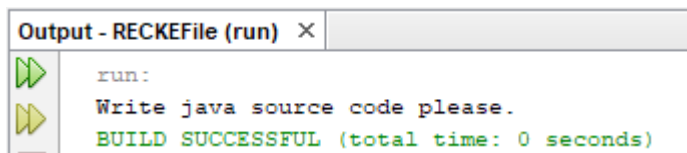
Answers to learning activity 12.3

1. use Netbeans or Notepad

b. The role of `fileinputstream` is to read data from the files. Objects can be created using the keyword `new` and there are several types of constructors available.

While `FileOutputStream` is used to create a file and write data into it. The stream would create a file, if it doesn't already exist, before opening it for output.

.c. output



d. Answers to application activities 12.3

1. to create a file

2. How are you to day.

```
output
h
3.package javaioapps;
import java.io.FileOutputStream;
import java.io.IOException;
import java.io.OutputStream;
public class FileOutputStreamDemo{
public static void main(String args[]){
    OutputStream os = null;
    try {
        String text=" Rwanda is a country of one thousand hills located in East Africa Region ";
        byte[] byteData = text.getBytes();
        os = new FileOutputStream ("C:/test/test2.txt");
        for (int i=0; i<byteData.length; i++){
            os.write(byteData[i]);
        }
        System.out.println(" File written successfully");
    } catch (Exception ex){
        ex.printStackTrace();
    } finally{
```

```

try{
os.close();
} catch (IOException ex){
ex.printStackTrace();
}}}
```

Lesson 4: Readers and writers

Duration: 3 Period: 120 minutes

a. Prerequisites/Revision/Introduction:

Learning activity 12.4 is used to introduce Reader and Writer . The purpose of this activity is to show to learner how to allocate the values to the file using Reader and Writer.

b. Teaching resources:

Students' books, computers, projector

c. Learning activities:

Guidance on learning activity

- This lesson can be conducted in the Computer Laboratory.
- Teacher asks students to form pairs to do the Learning Activity 12.4
- Students elect the group leader and secretary in order to perform Learning Activity 12.4
- Teacher lets students group work independently in 15 minutes
- Teacher walks around and sees if students are doing Learning Activity 12.4 in their respective groups.
- Students present their answers to the rest of the class.
- Students react on answers from other groups.
- Teacher corrects false answers and completes the half correct answers
- Teacher summarize the contents (Note in students book) and gives examples that should be done by students
- At the end of this lesson, teacher gives the instructions on how to do Application activities

Answers to learning activity 12.4

Refer to the student' book section 12.4 reader and writer

d. Answer to application activity 12.4

Answers refer to the student' book 12.4 Reader and writer

12.6. Unit summary

Introduction to I/O Stream means

The java.io package contains many classes that your programs can use to read and write data.

The java.io package contains nearly every class you might ever need to perform input and output (I/O) in Java. All these streams represent an input source and an output destination.

- `InputStream` is used to read data from the source, it may be data, a file, an array. There are different input stream classes can be applied to input data from user.
- `Scanner()` is used to Convenient methods for parsing primitives (`nextInt()`, `nextFloat()`, ...) from input devices and regular expressions to find tokens. So to use the `Scanner` class, we first need to include `java.util` package in the program. We include a package in a program with the help of **import** keyword. We can either import the **java.util.Scanner** class or the entire **java.util** package.
- `BufferedReader()` is used to read the text from a character-based input stream. It can be used to read data line by line by `readLine()` method. It makes the performance fast. It inherits `Reader` class.

Reader: The Java `Reader` is the base class of all `Reader`'s in the Java IO. subclasses including a `BufferedReader`, `PushbackReader`, `InputStreamReader`, `StringReader` and several others.

BufferedReader: The Java `BufferedReader` class (`java.io.BufferedReader`) provides buffering to your `Reader` instances. Buffering can speed up IO quite a bit. Rather than read one character at a time from the network or disk, the `BufferedReader` reads a larger block at a time. This is typically much faster, especially for disk access and larger data amounts.

InputStreamReader: The Java `InputStreamReader` class (`java.io.InputStreamReader`) is intended to wrap an `InputStream`, thereby turning the byte based input stream into a character based `Reader`.

12.7. Additional Information

This section offers additional content for the teacher to understanding well the I/O Stream and java.

12.8. End unit assessment

1. Write a java program that allows user to enter 2 inputs through the keyboard and calculate the sum, average and difference

```
import java.util.Scanner;
class AddNumbers
{
    public static void main(String args[])
    {
        double x, y, sum, average, difference;
        System.out.println("Enter two numbers to calculate their sum");
```

```

Scanner in = new Scanner(System.in);
x = in.nextInt();
y = in.nextInt();
sum = x + y;
average = (x+y)/2;
difference = x-y;
System.out.println("Sum of the integers = " + sum);
System.out.println("average of the integers = " + average);
System.out.println("difference of the integers = " + difference);
}
}

```

2. Write a java program that asks user to enter any number and find out if number is prime number

```

import java.util.Scanner;
class PrimeNumbers
{
    public static void main (String[] args)
    {
        Scanner scanner = new Scanner(System.in);
        int i=0;
        int num =0;
        String primeNumbers = "";
        System.out.println("Enter the value of n:");
        int n = scanner.nextInt();
        scanner.close();
        for (i = 1; i <= n; i++)
        {
            int counter=0;
            for(num =i; num>=1; num--)
            {
                if(i%num==0)
                {
                    counter = counter + 1;
                }
            }
            if (counter ==2)
            {
                primeNumbers = primeNumbers + i + " ";
            }
        }
        System.out.println("Prime numbers from 1 to n are :");
        System.out.println(primeNumbers);
    }
}

```

```

Output - RECKEENDUNIT2 (debug) X
debug:
Enter the value of n:
10
Prime numbers from 1 to n are :
2 3 5 7
BUILD SUCCESSFUL (total time: 18 seconds)

```

3. Analyze the following source code and find out its output

```

import java.util.Scanner;
class AreaOfCircle
{
    public static void main(String args[])
    {
        Scanner s= new Scanner(System.in);
        System.out.println("Enter the radius:");
        double r= s.nextDouble();
        double area=(22*r*r)/7;
        System.out.println("Area of Circle is: " + area);
    }
}

```

```

Output - RECKEENDUNIT3 (run) X
run:
Enter the radius:
4
Area of Circle is: 50.285714285714285

```

12.9. Additional activities

12.9.1. Remedial Activities

Suggestion of Questions and Answers for remedial activities for slow learners.

1. Write a program to find the roots of and quadratic equation of type ax^2+bx+c .

```

import java.util.Scanner;
public class Quadratic_Equation
{
    public static void main(String[] args)
    {
        int a, b, c;
        double root1, root2, d;
        Scanner s = new Scanner(System.in);
        System.out.println("Given quadratic equation:ax^2 + bx + c");
        System.out.print("Enter a:");
        a = s.nextInt();
        System.out.print("Enter b:");
        b = s.nextInt();
        System.out.print("Enter c:");
        c = s.nextInt();
        System.out.println("Given quadratic equation:"+a+"x^2 + "+b+"x + "+c);
        d = b * b - 4 * a * c;
        if(d > 0)
        {
            System.out.println("Roots are real and unequal");
        }
    }
}

```

```

    root1 = (-b + Math.sqrt(d))/(2*a);
    root2 = (-b - Math.sqrt(d))/(2*a);
    System.out.println("First root is:"+root1);
    System.out.println("Second root is:"+root2);
}
else if(d == 0)
{
    System.out.println("Roots are real and equal");
    root1 = (-b+Math.sqrt(d))/(2*a);
    System.out.println("Root:"+root1);
}
else
{
    System.out.println("Roots are imaginary");
}}
}
}

```

12.9.2. Consolidation activities

Consolidation activities: Suggestion of questions and answers for deep development of competences.

1. Write a java program which accept principle, rate and tie from the user and print the simple interest

```

import java.util.Scanner;
public class Simple_Interest
{
    public static void main(String args[])
    {
        float p, r, t;
        Scanner s = new Scanner(System.in);
        System.out.print("Enter the Principal : ");
        p = s.nextFloat();
        System.out.print("Enter the Rate of interest : ");
        r = s.nextFloat();
        System.out.print("Enter the Time period : ");
        t = s.nextFloat();
        float si;
        si = (r * t * p) / 100;
        System.out.print("The Simple Interest is : " + si);
    }
}

```

2. Write a java program to swap the values of two variable

```

import java.util.Scanner;
public class Main {
    public static void main(String[] args) {
        int number1, number2, swapnumbers;
        Scanner in = new Scanner(System.in);
        System.out.println("Input the first number: ");
        number1 = in.nextInt();
        System.out.println("Input the second number: ");
        number2 = in.nextInt();
        swapnumbers = number1;
        number1 = number2;
        number2 = swapnumbers;
        System.out.println(" Swapped values are:" + number1 + " and " + number2);
    }
}

```

3. Write java program to check whether the given number is positive or negative

```
import java.util.Scanner;
public class PositiveNegative
{
    public static void main(String[] args)
    {
        int number;
        Scanner scan = new Scanner(System.in);
        System.out.print("Enter the number you want to check:");
        number = scan.nextInt();
        scan.close();
        if(number > 0)
        {
            System.out.println(number+" is positive number");
        }
        else if(number < 0)
        {
            System.out.println(number+" is negative number");
        }
        else
        {
            System.out.println(number+" is neither positive nor negative");
        }
    }
}
```

4. Write a program to check whether the given number is even or odd

```
import java.util.Scanner;
public class EvenOdd {
    public static void main(String[] args) {
        Scanner reader = new Scanner(System.in);
        System.out.print("Enter a number: ");
        int num = reader.nextInt();
        if(num % 2 == 0)
            System.out.println(num + " is even");
        else
            System.out.println(num + " is odd");
    }
}
```

12.9.3. Extended activities

Suggestion of Questions and Answers for gifted and talented students.

Find out the output of the following source code when a number of rows is 7

```
import java.util.Scanner;
public class MainClass
{
    public static void main(String[] args)
    {
        Scanner sc = new Scanner(System.in);
        System.out.println("How many rows you want in this pattern?");
        int rows = sc.nextInt();
        System.out.println("Here is your pattern.....!!!");
        for (int i = 1; i <= rows; i++)
        {
            for (int j = 1; j <= i; j++)
            {
                System.out.print(i+" ");
            }
            System.out.println();
        }
    }
}
```

```
    }  
    sc.close();  
}}
```

```
How many rows you want in this pattern?
```

```
7
```

```
Here is your pattern....!!!
```

```
1
```

```
2 2
```

```
3 3 3
```

```
4 4 4 4
```

```
5 5 5 5 5
```

```
6 6 6 6 6 6
```

```
7 7 7 7 7 7 7
```

REFERENCES

1. Abraham Silberschartz, H. F. (2011). *Database System Concepts* (Vol. 6th Edition). New York: McGraw-Hill.
2. Eng., A. W. (2012). *Database design* (Vol. 2nd Edition). Western Ontario.
3. Last, P. J. (2012). *Concepts of Database Management* (Vol. 8th Edition). Boston; Cengage Learning.
4. Scheider, R. D. (1997). *Microsoft SQL Server:Planning and Building a High Performance Database*. Prentice Hall PTR.
5. Sylvia Langfield, D. D. (2015). *Cambridge International AS and A level Computer Science*. Cambridge CB2 BBS, United Kingdom: Cambridge University Press .
6. Thalheim, B. (2000). *Fundamentals of entity-relationship model* . New York: Springer.
7. Williams, D. W. (2014). *Cambridge IGCSE Computer Science*. London: London NW1 3BH Hodder Education A Hachetter UK Compan
8. LOFTUS, L. &. (2003). *Foundation of program design 3 edition* . United States of America: Pearson Education.
9. Galiwango Kityo Michael,Luzinda Roland Babumba,Sserwanja Joseph. (2013). *MK Senior Secondary Computer Science Student’s Book Grade 6*. Kigali: MK Publishers Ltd.
10. Herman Oduor. (n.d.).
11. Microsoft.com. (n.d.). Retrieved from Logical-and-bitwise-operators: <https://docs.microsoft.com>
12. Oduor, H. (2013). *Computer Science For Rwanda Student’s Book 6*. Kigali: East African Publishers Rwanda Ltd.
13. Oduor, H. (2013). *Senior Secondary Certificate Computer Science For Rwanda Student’s Book 6*. Kigali: East African Publishers Rwanda Ltd.
14. Owoyesigyre Davis , Stephen Mburu , Geoffrey Chemwa. (2016). *Computer Science For Rwandan Schools Senior 4*. Kigali: Longhorn Publishers Ltd.
15. Abraham Silberschartz, H. F. (2011). *Database System Concepts* (Vol. 6th Edition). New York: McGraw-Hill.
16. Eng., A. W. (2012). *Database design* (Vol. 2nd Edition). Western Ontario.
17. Last, P. J. (2012). *Concepts of Database Management* (Vol. 8th Edition). Boston; Cengage Learning.
18. Scheider, R. D. (1997). *Microsoft SQL Server:Planning and Building a High Performance Database*. Prentice Hall PTR.

19. Sylvia Langfield, D. D. (2015). *Cambridge International AS and A level Computer Science*. Cambridge CB2 BBS, United Kingdom: Cambridge University Press .
20. Thalheim, B. (2000). *Fundamentals of entity-relationship model* . New York: Springer.
21. Williams, D. W. (2014). *Cambridge IGCSE Computer Science*. London: London NW1 3BH Hodder Education A Hachetter UK Compan