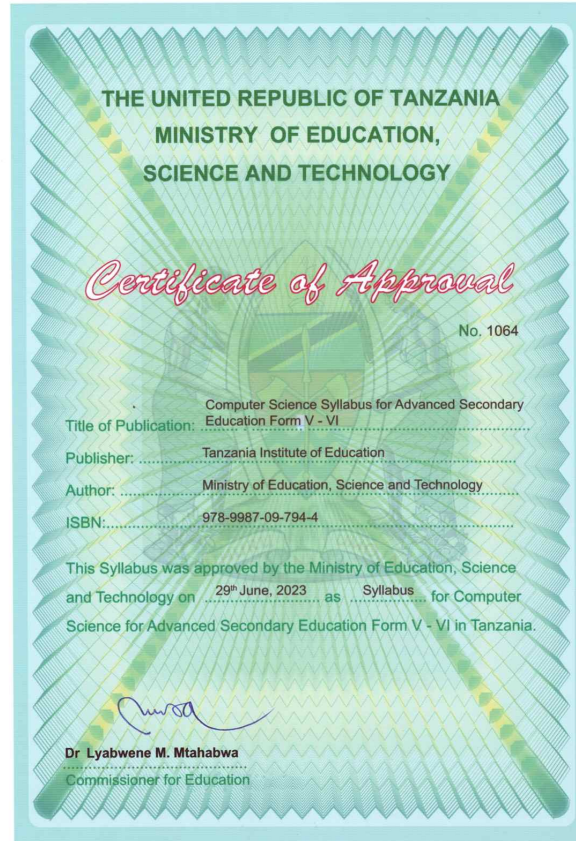


**THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY**



**COMPUTER SCIENCE SYLLABUS FOR ADVANCED SECONDARY EDUCATION
FORM V-VI
2023**

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Abbreviations and Acronyms

VR	Virtual Reality
AR	Augmented Reality
CRUD	Create, Read, Update, Delete
ICT	Information and Communication Technology
NVDA	Non-Visual Desktop Access
PHP	Hypertext Preprocessor
SOC	Security Operations Center
TEHAMA	Teknolojia ya Habari na Mawasiliano
AI	Artificial Intelligence
ChatGPT	Chat Generative Pretrained Transformer

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Dr. Aneth A. Komba

Director General

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1.0 Introduction

Computer Science for Advanced Secondary Education is a compulsory subject for students who choose to join the natural Science stream taking Computer Science among the subjects in their combinations. The subject enables students to learn basic principles and advanced techniques for computer science and data management. It also enables students to consolidate and extend their computer science skills and use them in the web development, creating various program, databases, computer networks and simple automated and AI powered systems using advanced techniques. Upon completion of studies, students develop attitudes and skills that will enable them to engage in individual and industrial work related to the field of computer science.

The Computer Science Syllabus is designed to guide the teaching and learning of Computer Science in Advanced Secondary Education, Form V – VI in the United Republic of Tanzania. The syllabus interprets the competences indicated in the 2023 Advanced Secondary Education Curriculum. It provides information that will enable teachers to plan their teaching process effectively. It also provides teaching and learning opportunities that guide teachers to apply different methods and strategies to develop 21st century skills which include creativity, communication, collaboration, critical thinking and problem solving.

2.0 Main Objectives of Education in Tanzania

The main objectives of education in Tanzania are to enable every Tanzanian to:

- (a) Develop and improve his or her personality so that he or she values himself or herself and develops self-confidence;
- (b) Respect the culture, traditions and customs of Tanzania; cultural differences; dignity; human rights; attitudes and inclusive actions;
- (c) Apply science and technology, creativity, critical thinking, innovation, cooperation, communication and positive attitudes for his or her development and the sustainable development of the nation and the world at large;
- (d) Understand and protect national values, including dignity, patriotism, integrity, unity, transparency, honesty, accountability and the national language;
- (e) Develop life and work-related skills to increase efficiency in everyday life;
- (f) Develop a habit of loving and valuing work to increase productivity and efficiency in production and service provision;

- (g) Identify and consider cross-cutting issues, including the health and well-being of the society, gender equality, as well as the management and sustainable conservation of the environment; and
- (h) Develop national and international cooperation, peace and justice in accordance with the Constitution of the United Republic of Tanzania and international conventions

3.0 Objectives of Advanced Secondary Education in Tanzania

The objectives of Advanced Secondary Education, are to:

- (a) Strengthen, broaden and develop a deeper understanding of the knowledge, skills and attitudes developed at the lower level of Secondary Education;
- (b) Safeguard customs and traditions, national unity, national virtues, democracy, respect for human and civil rights, duties and responsibilities associated with such rights;
- (c) Develop self-confidence and the ability to learn in various fields, including science and technology as well as theoretical and technical knowledge;
- (d) Improve the use of language in academic communication;
- (e) Strengthen accountability for cross-cutting issues, including health, security, gender equality and sustainable environmental conservation;
- (f) Develop competence and various skills which will enable the student to employ himself or herself, to be employed and to manage his or her life by exploiting his or her environment well; and
- (g) Develop readiness to continue to a college education.

4.0 General Competences of Advanced Secondary Education

The general competences for Advanced Secondary Education are to:

- (a) Apply the knowledge and skills acquired in Ordinary Secondary Education to strengthen and broaden academic understanding;
- (b) Demonstrate an appreciation of citizenship, national virtues, human rights and civil rights;
- (c) Demonstrate confidence in learning various fields, including Science and Technology, as well as theoretical and practical knowledge;

- (d) Use language skills in academic communication;
- (e) Apply knowledge of cross-cutting issues to master the surrounding environment;
- (f) Use knowledge and skills to enable a student to employ oneself, be employed as well as manage life and his/her environment; and
- (g) Demonstrate readiness to proceed to the next level of education.

5.0 Main Competence and Specific Competence

The main and specific competences to be developed are presented in Table 1.

Table 1: *Main and Specific competences for Form V-VI*

Main competences	Specific competences
1.0 Demonstrate mastery of the principles of Computer Science	1.1 Demonstrate understanding of the principles of computer architecture and organisation 1.2 Demonstrate understanding of computer networks 1.3 Demonstrate mastery of web application development (Using PHP/Python; JavaScript; CSS, etc) 1.4 Demonstrate mastery of basic principles of Object Oriented Programming (Using C++; Java; Python; etc) 1.5 Demonstrate mastery of basic principles of Algorithms and Data structures 1.6 Demonstrate understanding of principles of Operating Systems [Types of OS; Memory management; File management; CPU Scheduling; etc]
2.0 Demonstrate mastery of the data management	2.1 Demonstrate mastery of Advanced principles of databases and database management systems 2.2 Mastering principles of computer data analysis (advanced analysis, visualisation and results interpretation, etc) 2.3 Demonstrate understanding of Automated and Emerging technologies [Automated systems, Artificial Intelligence, Machine learning, 3D and holographic imaging, Virtual Reality (VR), Augmented Reality (AR), etc.]

6.0 Roles of Teachers, Students and Parents/Guardians in Teaching and Learning

A good relationship between a teacher, student and parent or guardian is fundamental in ensuring successful learning. This section outlines the roles of each participant in facilitating effective teaching and learning process of Computer Science.

6.1 The teacher

The teacher is expected to:

- (a) Help the student to learn and acquire the intended competences in Computer Science;
- (b) Use teaching and learning approaches that will allow students with different needs and abilities to:
 - (i) develop the competencies needed in the 21st century;
 - (ii) actively participate in the teaching and learning process.
- (c) Use student centred instructional strategies that make the student a centre of learning which allow them to think, reflect and search for information from various sources.
- (d) Create a friendly teaching and learning environment;
- (e) Prepare and improvise teaching and learning resources;
- (f) Conduct formative assessment regularly by using tools and methods which assess theory and practice.
- (g) Treat all the students equally irrespective of their differences;
- (h) Protect the student while at school;
- (i) Keep track of the student's daily progress;
- (j) Identify individual student's needs and provide the right intervention;
- (k) Involve parents/guardians and the society at large in the student's learning process; and
- (l) Integrate cross-cutting issues and ICT in the teaching and learning process.

6.2 The student

The student is expected to:

- (a) Develop the intended competences by participating actively in various activities inside and outside the classroom; and

- (b) Participate in the search for knowledge from various sources, including textbooks, supplementary books and other publications in online libraries.

6.3 The parents/guardian

The parent/guardian is expected to:

- (a) Monitor the child's academic progress in school;
- (b) Where possible, provide the child with the needed academic support;
- (c) Provide the child with a safe and friendly home environment which is conducive for learning;
- (d) Keep track of the child's progress in behaviour;
- (e) Provide the child with any necessary materials required in the learning process; and
- (f) Instil in the child a sense of commitment and positive value towards education and work.

7.0 Teaching and Learning Methods

The teaching and learning methods are instrumental in developing student's competences. This syllabus suggests teaching and learning methods for each activity which includes but not limited to discussions, presentations, field visits, practical work, research, scientific experiments, and project works. However, a teacher is advised to plan and use other appropriate methods based on the environment or context. All the teaching and learning methods should be integrated with the everyday lives of students.

8.0 Teaching and Learning Resources

The process of teaching and learning requires different resources. In that regard, both the teacher and students should work together to collect or improvise alternative resources available in the school and home environment when needed. The teacher and the student are expected to constantly seek for information from various sources in order to effectively facilitate teaching and learning process. The list of approved textbooks and reference books shall be provided by the TIE.

9.0 Assessment

Assessment is important in teaching and learning of Computer Science subject. It is divided into formative and summative assessments. Formative assessment informs both the teacher and students on the progress of teaching and learning, and in making decisions on improving the teaching and learning process. Teachers are, therefore, expected to apply a wide range of formative assessment methods which include but not limited to discussions, presentations, oral questions, experiments, observations, practical and projects.

Summative assessment, on the other hand, will focus on determining student's achievement of learning. Teachers are expected to use a variety of summative assessments including terminal, mock examinations and projects. The scores obtained from these assessments will be used as Continuous Assessment (CA). Therefore, the continuous assessments shall contribute 30% and the National Form VI Examination shall be 70% of the student's final achievement, as indicated in Table 2.

Table 2: *Contribution of Continuous Assessment and National Examination in the final score*

Type of Assessment	Form V	Form VI
First Term Examination	5%	6%
Second Term Examination	5%	-
Project	-	7%
Mock Examination	-	7%
National Examination	-	70%
Total	100%	

10.0 Number of Periods

The Computer Science Syllabus for Advanced Secondary Education provides estimates of the time that will be spent in learning and teaching, in consideration of the complexity of the specific competencies and the learning activities. Ten periods of 40 minutes each have been allocated for this subject per week.

11.0 Teaching and Learning Contents

The content of this syllabus are presented in matrix form with seven columns which includes main competences, specific competences, learning activities, suggested teaching and learning methods, assessment criteria, suggested resources and number of periods as presented in Table 3-4.

Form V

Table 3: Detailed contents for Form V

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
1. Demonstrate mastery of the principles of Computer Science	1.1 Demonstrate understanding of the principles of computer architecture and organisation	(a) Describe the classification of computer architecture (<i>Von Neumann and Non Von Neumann, Harvard Architecture, Modified Harvard Architecture, Flynn's Taxonomy</i>)	<p>Brainstorming: Guide a student by using video tutorials, Internet or Library search to explore the classification of computer architecture.</p> <p>TIPS: Lead students in manageable groups to describe the classifications of each computer architecture (Overview, importance, and the role in modern computing systems. Give concept of instruction set architecture (ISA) and its relationship to computer architecture.</p>	The classification of computer architecture is properly described	Simulators (Celiot, Celiot++, Jeliot, etc), Computer system, Modals, Video tutorials, Internet resources, Marker pens, flip charts, Non-Visual Desktop Access (NVDA), Virtual Reality (VR)/Augmented Reality (AR) tools, Security Operations Center (SOC) Simulator, Simulator creation tools (TopGen, Grey box, TopoMojo, vTunnel, etc),	91

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>Discuss features, advantages, and disadvantages, and how particular architectures are used in different devices (e.g., smartphones, supercomputers, embedded systems) and industries. Supplement information with diagrams, illustrations, real-life examples or applications that showcase the architecture's strengths.)</p> <p>Collaborative Project: Guide students by assigning them work to analyse, compare, and contrast different computer architectures.</p>		<p>Sensitive Software/Data, interactive online content, practical braille devices, Whiteboard or blackboard, chalk, Handouts with Boolean expressions and truth tables, Presentation slides, Logic gate simulation software.</p>	

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(b) Demonstrate understanding of Boolean algebra and logic gates (<i>Logic expressions, standard logic gate symbols, logic circuits</i>)	<p>Demonstration/ Scenario/Case study/ Game: Guide students by using gamified learning platforms with educational games, scenarios or case studies to explore and demonstrate on Boolean algebra and Logic gates as physical devices in real life</p> <p>Think-Ink-Pair-Share(TIPS): Lead students by using video tutorials, Internet or Library search to understand Boolean algebra and logic gates (importance in computer science, Boolean data types and operators,</p>	Understanding of Boolean algebra and logic gates is correctly demonstrated		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>theorems and laws, truth tables, logic gates, combinational logic circuits, etc.). Highlight how to implement logic gates and Boolean expressions in code</p> <p>Experiment: Guide students to experiment with building and testing circuits using logic gate kits or simulation software</p> <p>Collaborative Project: Guide students by assigning them creative projects that apply Boolean algebra and logic gates to solve real-world problems or challenges in their surrounding environment, such as design a simple security system or a traffic light controller using logic gates, etc</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(c) Explore computer memory (<i>Meaning, design principles, memory hierarchy and interfacing, cache memory, memory mapping, primary & secondary memory</i>)	<p>Simulation/ virtual lab/Tutorial videos/ Case studies: Guide students in manageable groups by using Virtual lab, simulation, tutorial videos, or case study and real world examples to explore how computer memory is utilised in different scenarios (gaming, multitasks, data storage, etc).</p> <p>TIPS: Lead students in manageable groups to explore computer memory and respective functions (build simple memory model using physical objects and simulate memory allocation using simulators)</p>	Computer memory is properly explored		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>Memory Simulation Game: Use or design a memory simulation game for students to play a role of computer processors accessing different memory units to retrieve data. Assign a tasks or challenges where students should make decisions based on memory hierarchy, such as fetching data from registers or retrieving data from secondary storage.</p>			
		<p>(d) Analyse instruction set architecture (<i>Instruction set types, registers, instruction execution cycles, addressing modes, register transfer</i>)</p>	<p>Practical /Scenario/ Simulation/ virtual lab: Lead students to explore the instruction set architecture in computer system using simulation, virtual lab, scenarios, case studies or alternatives</p>	<p>Instruction set architecture is correctly analysed</p>		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		<i>language, ARM and x86 architectures)</i>	<p>TIPS: Guide students in manageable groups to introduce concept of ISA; analyse instruction set architecture (design choices, performance trade-offs, and challenges associated with different ISAs) using Simulator, virtual lab or physical hardware. Relate ISAs to real-world examples on how they have influenced computing devices over time</p> <p>Collaborative Project: Lead students by assigning them to design their own simple ISA and create an emulator for it</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(e) Describe I/O system (<i>Direct Memory Access, Interrupt and exception, privileged / non privileged instruction</i>)	<p>Brainstorm: Guide a student to describe the I/O system</p> <p>Discussion: Lead students in a manageable groups to discuss and describe the I/O system</p>	I/O system is properly described		
		(f) Demonstrate function of memory and input-output system	<p>Simulation/ virtual lab/ video tutorials/ Internet or Library search Guide students to explore the functions of memory and input-output system using simulations, animations, etc</p> <p>Discussion: Lead students in a manageable groups to discuss and demonstrate the function of</p>	Function of memory and input-output system is correctly demonstrated		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>memory and input-output system (memory and I/O system organisation, operation, etc) by relating to real-world applications in everyday technology like smartphones, laptops, gaming consoles, and other devices. Highlight how memory and I/O systems allow interaction with the devices and store data. Provide students with scenarios or challenges related to memory management, device interactions, or data processing</p> <p>Collaborative Project: Lead students by assigning them</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			group projects related to memory and input-output systems such as design a computer system that meets specific memory and input-output requirements, etc			
		(g) Develop understanding of pipelining (<i>Basics, types, stalling & forwarding, throughput and speedup, hazards</i>) and Instruction Level Parallelism (<i>concept, compilation techniques, scalar versus superscalar pipelining, branch prediction, register renaming</i>) and thread and data level parallelism	TIPS and Simulation/ virtual lab/ video tutorials/ Internet or Library search Guide students to explore the pipelining, Instruction Level Parallelism, and thread and data level parallelism using visual aids, diagrams, animations, simulations, and other alternatives for students to visualise the parallelism and pipeline stages and the movement of instructions	Understanding of the pipelining, Instruction Level Parallelism, and thread and data level parallelism is correctly developed		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>Discussion: Lead students in a manageable groups to discuss and understand the pipelining, Instruction Level Parallelism, and thread and data level parallelism by sharing real world examples and case studies where pipelining and parallelism used to improve performance.</p> <p>Project work: Guide students by assigning projects that involve implementing simple pipelines, exploring ILP in code optimisation, or designing parallel algorithms.</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
	1.2 Demonstrate understanding of computer networks	(a) Demonstrate understanding of OSI and TCP/IP Reference models, transmission media, wireless transmission, the public switched telephone networks, mobile telephone system and Network protocols (<i>HTTP, FTP, IP,PPP,etc</i>)	<p>TIPS and Simulation/ virtual lab/ video tutorials/ Internet or Library search: Guide students in their manageable groups to understand OSI and TCP/IP Reference models, transmission media, wireless transmission, the public switched telephone networks, mobile telephone system and Network protocols (<i>HTTP, FTP, IP,PPP,etc</i>)</p> <p>Discussion and Question and Answer: Ask individual students to elaborate the OSI and TCP/IP Reference</p>	Understanding of Reference models and transmission media, wireless transmission, the public switched telephone networks, mobile telephone system and Network protocols is properly demonstrated	Network devices (Router, Switch, Bridge, Repeater, Hub, Gateway, etc.), Packet tracer, Internet resources, Flip charts and braille devices, Simulators (Celiot, Celiot++, Jeliot, etc), Computer system, Modals, Video tutorials, Marker pens, flip charts, Non-Visual Desktop Access (NVDA), Virtual Reality (VR)/Augmented Reality (AR) tools, Security Operations Center (SOC) Simulator, Simulator creation tools.	91

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			models (purpose, role of each layers in routing data packet, IP address in identify device, etc.)			
		(b) Develop understanding of Data link layer (<i>Switched LANs: Link-Layer Addressing and ARP, Ethernet, Link-Layer, Switches, VLANs</i>)	TIPS and Simulation/ virtual lab/ video tutorials/ Internet or Library search: Guide students in a manageable groups to demonstrate understanding of data link layer	Understanding of Data link layer is correctly developed		
		(c) Create a network that make use of wireless or Ethernet technology	Practical or Collaborative Project work /Simulation/ virtual lab: Guide students in manageable groups by	The network that make use of wireless or Ethernet technology is correctly created		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			assigning them work to set up a simple network using wired or wireless media, configure network devices, or analysing network traffic using network monitoring tools/Simulator, virtual lab or physical lab practice.			
		(d) Develop understanding of Network layer (<i>design issues, routing algorithms, Congestion control algorithms, Internetworking, the network layer in the internet (IPv4 and IPv6), Quality of Service</i>)	Simulation/ virtual lab/ video tutorials/ Internet or Library search Guide students to explore the network layer using specified or alternate technique/ method by relating with shared real world examples such as ICMP and ARP Discussion: Lead students in a	Understanding of Network layer is correctly developed		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>manageable groups to understand the network layer (Purpose in OSI model, role in routing data packets between networks, importance, subnetting in dividing IP address to smaller networks, routing tables, recent advancement in network layer technologies).</p> <p>Demonstration: Guide students to use a network simulation tool or an online platform to demonstrate routing concepts and configure routing tables</p> <p>TIPS: Lead students to analyse case studies of network layer issues such as DDoS attacks or network congestion and their possible solutions</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			Collaborative Project: Guide students by assigning them project work such as to design a secure network architecture for a small business, analysing the performance of different routing protocols, etc			
		(e) Elaborate the transport layer (<i>Transport service, elements of transport protocol, Simple Transport Protocol, Internet transport layer protocols: UDP and TCP</i>)	TIPS and Simulation/ virtual lab/ video tutorials/ Internet or Library search: Lead students in a manageable groups to understand the transport layer by relating with shared real world examples such as UDP and TCP in online gaming, video streaming, video calling and web browsing	The transport layer is properly elaborated		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>Discussion: Lead students in a manageable group to understand the transport layer (Purpose in OSI model, role in communication between devices, importance, ports, protocols-TCP and UDP, reliable against unreliable transmission).</p> <p>Demonstration: Guide students to use a network simulation tool or an online platform to demonstrate the impact of packet loss and retransmission in TCP. Using reliable software to show network packet captures.</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>TIPS: Lead students to create their simple network protocol using basic principles of the transport layer using interactive software/ tools. Let them capture and analyse network traffic at the transport layer using network monitoring tool</p> <p>Collaborative Project: Guide students by assigning them project works on a specific transport layer protocol such as TCP, UDP, and SCTP with focus to research on the features, advantages, and real-world applications.</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(f) Describe the application layer (<i>Domain name system, electronic mail, World Wide Web: architecture; dynamic web document and http</i>)	<p>Simulation/ virtual lab/ video tutorials/ Internet or Library search: Lead students in a manageable groups to understand the application layer by relating with shared real world examples such as social media platforms, video streaming, online gaming, etc through HTTP, FTP, or SMTP</p> <p>Discussion: Lead students in a manageable groups to understand the application layer (Purpose in OSI model, importance in computer networks, how instant messaging services, web browsers, email clients, etc depends on application layer).</p>	Application layer is clearly described		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>TIPS: Lead students to explore simple applications that utilise the application layer (basic web page created using HTML and CSS or simple chat application created using socket programming in a programming language like Python).</p> <p>Collaborative Project: Guide students by assigning them project works on different application layer protocols such as HTTP, FTP, DNS, SNMP or SMTP, research each protocol and explain how it works.</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(g) Apply network security principles, tools and protocols in computer networks	<p>TIPS: Lead students to explore importance of network security, common network security threats and vulnerabilities, network security tools and protocols, and best network security practices, etc</p> <p>Practical / Simulation/ Virtual lab: Guide students into manageable groups to apply network security principles, tools and protocols in computer networks (configure firewalls, perform security audits in simulated networks, and analyse network traffic using packet tracer or alternative network analysis tool)</p>	Network security principles, tools and protocols in computer network are applied correctly		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>Guest speakers and Field trip: Invite guest speaker from network security industry or organise field trips to help students to explore and experience real world security practices</p> <p>Discussion: Guide students to analyse and discuss case studies on network security breaches and their consequences to society</p> <p>Collaborative Project: Guide students by assigning them project works such as to create secure network configurations, developing security policies, or conducting vulnerability assessments using packet tracer or alternative network analysis tool.</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
	1.4 Demonstrate mastery of Basic principles of Object Oriented Programming Using C++, Java, Python, etc	(a) Describe the concept of Object Oriented Programming (<i>Output, Directives, input, type bool, set width manipulator, type conversion, Object oriented paradigm differences between Object Oriented Programming and Procedure oriented programming, Encapsulation, Inheritance, composition and Polymorphism, Benefits of OOP, Structure of C++/Java/python, namespace, Data types, C++/Java/python tokens,</i>	Scenario/Library or Internet search: Guide students in manageable groups to explore concept of Object Oriented Programming languages from given scenarios or Internet and Library search relating it with real world applications such as building network protocols, designing network applications, or analysing network traffic, etc	Basic principles of Object Oriented Programming Using C++; Java; Python; etc are correctly described	Simulators (Celiot, Celiot++, Jeliot, etc), virtual labs, Computer system, Internet resources, NVDA and braille devices, Flip charts, Text editor, Software (C++ and Python IDEs), marker pen, computer, speaker, OOP video tutorials, projector, whiteboard, compilers (Debugging tools)	52

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		<i>Identifiers, Variables, Constants, Operators, Control structures and Loops)</i>				
		(b) Describe the general structure of Object Oriented Program (Using C++, Java, Python, etc)	Scenario/Library or Internet search: Guide students in manageable groups to explore the general structure of Object Oriented Program (Using C++, Java, Python, etc) from given scenarios or Internet and Library search.	The general structure of Object Oriented Program (Using C++, Java, Python, etc) is correctly described		
		(c) Apply appropriate syntax and constructs to create Object Oriented programs	Problem based Learning/ Practical: Guide students to apply appropriate syntax and constructs to create Object	Appropriate syntax and constructs to create Object Oriented programs are applied correctly		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			Oriented programs (Functions, object and classes; array and string; operator overloading; Composition, Constructors, destructors and inheritance; pointers, virtual functions and polymorphism; streams and files; templates and exceptions; standard template library). Use computer programming language such as C++, Java, Python, etc) for a given problem/ challenge.			
		(d) Debug Object Oriented programs using appropriate skills (<i>Use C++, Java, Python, etc</i>)	Practical/ Simulation/ Virtual lab: Guide students into manageable groups to practice on how to Debug Object Oriented programs using	Object Oriented programs using appropriate skills are correctly debugged		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			appropriate skills (debugging tools, configurations, etc).			
	1.6 Demonstrate understanding of principles of Operating Systems	(a) Describe the concept of operating systems (<i>evolution, types, architecture, structure and design</i>)	Case studies/Guest speaker: Guide students basing on invited guest speaker to understand various given case studies regarding the concept, structure and design of operating systems relating with real world examples such as smartphones, tablets, game consoles, etc Discussion: Lead students in a manageable groups to understand the concept of OS (types, roles and features, major milestones and advancements, etc).	The concepts, structure and design of operating systems is properly described	Internet resources, NVDA and braille devices, Flip charts, marker pen, video tutorials, projector, Computer system, benchmarking tools	39

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>TIPS: Lead students to explore and discuss real world scenarios that OS play critical roles (embedded systems, server management, or virtualisation, etc). Discuss how Internet of Things (IoT) and cloud computing devices rely on OSs for effective operation</p>			
		(b) Describe the impact of operating system design on application system design and performance	<p>Case studies/ Guest speaker: Guide students to understand various given case studies regarding the impact of operating system design on application system design and performance</p>	The impact of operating system design on application system design and performance is correctly described		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>Discussion: Guide students in manageable groups by providing to them OS or application case studies and analyse the impact of specific OS design on the performance and design of various application running on it</p> <p>Collaborative Project: Guide students by assigning them project works on designing and implementing a simple application that will run on different operating systems. Lead them to research and report the challenges they face and behaviour and performance</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		<p>(c) Demonstrate competency in recognising and using operating system design and performance</p> <p>[Process Management (Processes and threads, process creation, synchronisation and Communication),</p> <p>CPU/Processor Scheduling (Deadlock prevention, avoidance and recovery),</p> <p>Memory Management (Main and virtual memory management),</p>	<p>Game/Role-playing/ Simulation/ Virtual lab: Guide students by using simulators to simulate the process, I/O and memory management, processor scheduling, and file system structure of the Operating Systems. Use simulation or game that will assist student to allocate memory or organise files</p> <p>Collaborative Project: Guide students by assigning them project works such as: build a basic CPU simulator or memory management system using programming</p>	Competency in recognizing and using operating system design and performance is correctly demonstrated		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		<i>File System Structure and implementation, Input/output Systems and device management]</i>	languages like Python; design simple task scheduler algorithm or create simple file system structure			
2. Demonstrate mastery of the data management	2.1 Demonstrate mastery of Advanced principles of databases and database management systems	(a) Describe the basic concepts of Relational Database Design, ER Model, SQL, NoSQL, big data, and data warehouse.	<p>Case studies/Guest speaker: Guide students through invited guest speaker, to understand various given case studies regarding the concept of Relational Database Design, ER Model, SQL, NoSQL, big data, and data warehouse relating with real world examples.</p> <p>Discussion: Lead students in a manageable groups to explore principles of relational database design such as E-R</p>	Basic concepts of Relational Database Design, ER Model, SQL, NoSQL, big data, and data warehouse are correctly described	Relational database software, Internet resources, NVDA and braille devices, Flip charts and marker pen, Computer system	

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>modelling, how to identify entities, attributes, and relationships, and create ER diagrams</p> <p>Practical/simulation: Lead students to design database schemas and ER diagrams based on various scenarios in their surrounding environments</p> <p>Demonstration: Guide students to introduce and demonstrate SQL and NoSQL databases with simple and complex queries, and appropriate NoSQL languages or APIs.</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>Collaborative Project: Guide students by assigning them project works that involve designing and implementing a database system, querying data using SQL, analysing big data, or developing a simple data warehouse</p>			
		<p>(b) Demonstrate understanding of database design (<i>conceptual, logical, physical, normalization etc</i>)</p>	<p>Simulation/ Virtual lab/Scenarios: Guide students to explore the three levels of database design in relation to real world scenarios such as social media platforms, online shopping websites or school management system that utilizes database design at each level</p>	<p>Understanding of database design is correctly demonstrated</p>		77

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>Discussion: Guide students in manageable groups to create high-level conceptual model, ER diagrams, and discuss entities, attributes, relationships, cardinality constraints, functional dependencies and normalization forms. Discuss the data types, indexing strategies, optimisation techniques, and how to create table using SQL and performing basic queries</p> <p>Project-Based Learning: Guide students by assigning them project works that incorporates all</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			the concepts learned throughout the course. Assist students to choose a topic of interest and design a database system from scratch by following several procedures such as requirements gathering, entity-relationship modeling, schema design, data population, and query execution.			
		(c) Demonstrate understanding of database models	Practical / Simulation/ Virtual lab: Guide students to explore database models (relational models, hierarchical models, flat file models, object oriented models, entity relationship models,	Understanding of database model is correctly demonstrated		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>network models, etc) relating with real-world scenarios.</p> <p>TIPS: Lead students to create simple relational database using ER diagram and write SQL queries to interact it</p> <p>Project-Based Learning: Guide students to design database schemas for relational databases by considering real-world scenarios that suits their environments.</p>			
		(d) Describe different database management systems (<i>Parallel, distribution</i>)	<p>Case studies/ Scenarios/Practical/ Simulation/ Virtual lab: Explore Database Management Systems (such as MySQL, PostgreSQL, SQLite, Oracle,</p>	Different database management systems is correctly described		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>Microsoft SQL Server, MongoDB) and their roles (such as data storage, indexing, and query optimization) in managing databases</p> <p>Demonstration: Assist students to using a DBMS to create databases and tables, then execute SQL queries.</p>			
		(e) Describe the emerging Database Models, Technologies and Application	<p>Case studies/ Scenarios/ Simulation/ Virtual lab: Guide students to describe various given case studies, scenarios, or simulations regarding emerging Database Models, Technologies and Application (NoSQL databases, Big Data,</p>	Emerging Database Models, Technologies and Application are correctly described		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>and cloud-based databases)</p> <p>Discussion: Lead students to discuss the importance, advantages, and applications of emerging database models in modern systems</p> <p>Collaborative Project: Guide students by assigning them project works to design a database schema for any e-commerce website and implement a simple database application using any chosen modern database technology. Facilitate them to use their design database and data visualisation tool to analyse and visualize data</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(f) Design database using SQL and PHP	Problem based/ Practical/ Simulation/ Virtual lab: Guide students to design database using SQL and PHP based on scenarios in their surrounding environments	Database using SQL and PHP is correctly designed		

Form VI

Table 4: Detailed contents for Form Six

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
1. Demonstrate mastery of the principles of Computer Science	1.3 Demonstrate mastery of web application development (<i>Using PHP/ Python, JavaScript, CSS, etc</i>)	(a) Describe the web application (Meaning, history and development, types, differences between website development and web application development, tags, Application Programming Interfacing -APIs)	<p>Scenario/Case study/ Simulation/ virtual lab/ video tutorials/ Internet or Library search</p> <p>Guide students in a manageable group to describe the web application.</p> <p>TIPS: Lead students to discuss all constructs of web application. Discuss frameworks and libraries such as React, Angular, or Django</p>	The web application is properly and correctly described	Simulators (Celiot, Celiot++, Jeliot, etc), Virtual labs, Computer system, Internet resources, NVDA and braille devices	111

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(b) Create an interactive web pages (<i>Use modern versions of PHP/Python, JavaScript, CSS, etc.) with appropriate responsive techniques</i>	<p>Practical/ Simulation/ Virtual lab: Assist students to create interactive web pages using modern versions of PHP/Python, JavaScript, CSS, or other using appropriate skills through hands on practice, simulation or virtual lab</p> <p>Demonstration: Guide students how to manipulate HTML elements using JavaScript (such as changing text, hiding/ showing elements, handling events, etc). Assist them to explore JavaScript libraries or frameworks such as jQuery or React used for web development.</p>	Interactive web pages using modern versions of PHP/Python, JavaScript, CSS are correctly created		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			Implement user inputs with various form elements using HTML and JavaScript			
		(c) Apply web API in rich web based application (<i>Canvas API, Add canvas, Draw canvas environment, drag and drop API, Representation state transfer and CRUD operations</i>)	TIPS and Simulation/Virtual lab: Lead students to discuss what web APIs are and their types, use-cases and significance in modern web development. Guide them to describe how APIs enable different software systems to communicate and exchange data and allow developers to integrate external functionalities into their applications. Lead them to explore RESTful APIs against other APIs, Client server architecture,	Web API in rich web based applications is correctly applied		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>front end and back end concepts, and HTTP protocols and its methods.</p> <p>Demonstration: Guide students to integrate web APIs into a rich web-based application. Assist them how to build UI components and make API requests from client-side code (JavaScript-JSON) and handle responses effectively. Describe how API improve user experience and add functionality to their applications, authentication and authorisation mechanism. Use computer, simulators or virtual lab</p>			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(d) Create data-driven web based applications that speak to client or server storage systems and embed it with audio and video	<p>TIPS: Guide students to explore and discuss the web apps built with Python or other languages and relate them with scenarios in real- world environments (such as facebook, Spotify, uber, etc).</p> <p>Practical/ Simulation/ Virtual lab: Assist students to create data-driven web applications that speak to client or server storage systems using appropriate skills through hands on practice, simulation or virtual lab (defining purpose and scope of application, designing database schema,</p>	Data-driven web applications that speak to client or server storage systems are created correctly		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			setting development environment, develop back end, create APIs and front end)			
		(e) Create rich-based web applications that deliver similar features and functions as in desktop applications using modern libraries or frameworks	Practical/ Simulation/ Virtual lab: Guide students to create rich-based web applications that deliver similar features and functions as in desktop applications using modern libraries or framework using computer, simulation or virtual lab	Rich-based web applications that deliver similar features and functions as in desktop applications using modern libraries or frameworks are created correctly		
		(f) Use CSS and modern HTML controls in rich based web applications	Practical/ Simulation/ Virtual lab: Guide students to use CSS and modern HTML controls in rich-based web application using computer, simulation or virtual lab	CSS and modern HTML controls in rich based web applications are used correctly		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(g) Develop back-end using PHP/Python, JavaScript, CSS, etc (<i>Back end should be handling user input, producing template output, storing information in databases and data stores, and building systems with secure user accounts</i>)	Practical / Simulation/ Virtual lab: Guide students to explore server-side programming [back-end language or framework (Flask or Django for Python), Node.js (with Express.js), or Java (with Spring Boot); routing and request handling- GET and POST requests, query parameter, request body; Database interaction with ORM (Object Relational Mapping) Library; Best practice for REST API design endpoints and data serialization (e.g., JSON or XML)].	Back-end is correctly developed		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
	1.5 Demonstrate mastery of basic principles of Algorithms and Data structures	(a) Describe the concept of data structure and algorithms	TIPS Lead students in a manageable groups to describe the concept of data structure and algorithms	Concept of data structure and algorithms is properly described	Simulators (Celiot, Celiot++, Jeliot, etc), Virtual labs, Computer system, Internet resources, NVDA and braille devices	111
		(b) Explore and utilise basic data structure (<i>linked lists, stacks, queues and trees.</i>)	TIPS and Simulation/ virtual lab/ video tutorials/ Internet or Library search Lead students in a manageable groups to explore and utilise basic data structure	Basic data structure is explored and utilized correctly		
		(c) Describe the design and performance of various classic searching and sorting algorithms	TIPS and Simulation/ virtual lab/ video tutorials/ Internet or Library search Guide students to describe the design and performance of various classic searching and sorting algorithms	Design and performance of various classic searching and sorting algorithms is correctly described		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(d) Write a program that implements various sorting algorithms and create a report for performance	TIPS and Simulation/ virtual lab/ video tutorials/ Internet or Library search Guide students in a manageable groups to write a program that implements various sorting algorithms and create a report for performance	A program that implements various sorting algorithms and create a report for performance is correctly written		
		(e) Create a program that implements array and a linked list data structure using object-oriented programming language	TIPS and Simulation/ virtual lab/ video tutorials/ Internet or Library search Guide students in a manageable groups to create a program that implements array and a linked list data structure using object-oriented programming language	A program that implements a linked list data structure is correctly created		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(f) Implement stack and queue, binary search tree , balanced tree (<i>such as an AVL tree</i>), graph, hash table data structures in object-oriented programming language.	Practical / Simulation/ virtual lab/ video tutorials/ Internet or Library search Guide students to Implement stack and queue, binary search tree, balanced tree, graph, and hash table data structures	Stack and queue, binary search tree, balanced tree (such as an AVL tree), graph, hash table data structures is correctly implemented		
		(g) Describe the techniques of algorithm analysis	TIPS: Lead students to describe the techniques of algorithm analysis	The techniques of algorithm analysis is correctly described		
2. Demonstrate mastery of the data management	2.3 Demonstrate understanding of Automated and Emerging technologies (<i>Automated systems, Artificial</i>	(a) Demonstrate basic understanding of automated system and how sensors, microprocessors and actuators	Brainstorming: Guide students to demonstrate basic understanding of automated system and how sensors, microprocessors and actuators can be used to create automated	Understanding of automated system and how sensors, microprocessors and actuators can be used in collaboration to create	Automated systems, Virtual lab, Simulations, microprocessors, Computer systems, Internet resources, NVDA and braille devices,	96

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
	<i>Intelligence, Machine learning, 3D and holographic imaging, Virtual Reality (VR), Augmented Reality (AR)</i>	can be used in collaboration to create automated systems	systems. Outline the functionalities and features of the automated system.	automated systems is correctly demonstrated	AI Platforms or tools (ChartGPT, etc), Prolog software, Computer, Simulator (Celiot, Celiot++, Jeliot, etc), Virtual lab	96
(b) Describe the advantages and disadvantages of an automated system used for various scenario (<i>agriculture, Industry, transport, weather, etc</i>)		Case studies/ Scenarios/Practical/ Simulation/ Virtual lab: Guide students to describe various given case studies, scenarios, or simulations regarding advantages and disadvantages of an automated system used for a specified scenario	Advantages and disadvantages of an automated system are correctly described			
(c) Create simple automated system for specific challenge in surrounding environment		Problem based Learning/ Practical: Guide students to create simple automated system for specific challenge in surrounding environment from a given problem/	Simple automated system for specific challenge in surrounding environment is correctly created			

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>challenge available in their surrounding environment.</p> <p>Collaborative Project: Guide students by assigning them a real-world problem or challenges in their surrounding environment such as creating an automated classroom attendance system, a school library book management system, etc</p>			
		(d) Describe the concept of emerging technologies (<i>Meaning, types, importance, advantages and disadvantages, and their impacts in everyday life</i>)	Guest speaker: Guide students by inviting guest speakers, professionals, or researchers experienced on the field of emerging technologies (Artificial Intelligence, Machine learning, 3D and holographic imaging,	Concept of emerging technologies are correctly described		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>Virtual Reality (VR), Augmented Reality (AR), etc) to share their experience</p> <p>Case studies: Guide students to understand various given case studies regarding the concept of emerging technologies</p> <p>Exploration: Guide students to explore and interact with different emerging technologies</p>			
		(e) Demonstrate practical understanding of building blocks and components of artificial intelligence: basics algorithms, machine learning, and neural networks	<p>Scenarios/Practical/ Simulation/ Virtual lab: Guide students to explore machine learning, Neural networks (structure-input layer, hidden layer, output layer; neurons, activation functions, weights, and biases;</p>	Practical understanding of building blocks and components of artificial intelligence is correctly demonstrated		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			<p>training neural networks). Create a simple chatbot using machine learning algorithms with Python</p> <p>Project-Based Learning: Guide students by assigning them project work to develop a basic image classifier using neural networks</p>			
		(f) Demonstrate practical understanding of impacts of emerging technologies in everyday life	TIPS: Guide students to demonstrate understanding of impacts of emerging technologies in everyday life	Understanding of impacts of emerging technologies in everyday life is properly demonstrated		

Main competence	Specific competence	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
2. Demonstrate mastery of the data management	2.2 Mastering principles of computer data analysis (<i>advanced analysis, visualisation and results interpretation, etc</i>)	(a) Perform an advanced data analysis using appropriate tools (<i>Excel, Python, etc</i>)	Practical / Simulation/ virtual lab: Guide students into groups to demonstrate on how to perform an advanced data analysis using appropriate tools	An advanced data analysis using appropriate tools is correctly performed	Internet resources, Computer system, raw data, analysis software (ChartGPT, Excell, SPSS, etc), NVDA, and braille devices	32
		(b) Apply appropriate skills to visualise and interpret data	Practical/ Simulation/ virtual lab: Guide students into groups to appropriate skills to visualise and interpret data	Appropriate skills to visualise and interpret data is correctly applied		

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