The New Senior Secondary Curriculum for Sierra Leone

Subject Syllabus for Robotics

Subject Stream: Science and Technologies

This subject syllabus is based on the National Curriculum Framework for Senior Secondary Education. It was prepared by national curriculum specialists and subject experts.

Curriculum Elements for Robotics Engineering – a core subject

Subject Description

Robotics is the science or study associated with the design, fabrication, theory, and application of robots. Robotics is an ideal organizer for engineering education. This curriculum integrates the independent disciplines of Math, Engineering, Literacy, Technology and Science (MELTS) from a learning approach and delivery apropos to our local environment of Sierra Leone. The next generation of creators and technology developers are eager to learn about modern technology and Robotics falls squarely into this category. Learners studying Robotics in Senior Secondary will be imbued with highly sought for 21st Century skills and competencies such as creativity, critical thinking, communication, collaboration, leadership, and technology literacy while learning in a fun but enabling environment.

Rationale for the Inclusion of Robotics Engineering in the Senior Secondary School Curriculum

Sierra Leone has an opportunity to take a quantum leap in its development by transforming its subsistence economy into a high-value-added skill-based and technology-driven one. To realize this goal requires a computational, practical, and thinking-based education for learners.

The rationale of this robotics curriculum is to encourage learners to take ownership of a learning process that allows them to think critically and practically create automation solutions targeted at the 4th industrial revolution using readily available resources, especially those obtained locally. Doing so will offer our learners the affordance to not only learn cutting-edge technologies but use the knowledge gained to contribute to the development of Sierra Leone.

General Learning Outcomes (Broad Goals)

This curriculum is designed for the attainment of the following general broad goals.:

To stimulate, nurture and maintain scientific curiosity in the area of robotics

2. To demystify the difficulty surrounding the study and the practice of robotics by the girl-child
3. To develop competent practically oriented creative skills for tackling everyday problems
4. To systematically analyses technical problems and develop sustainable automated solutions

Subject Content Outline by Broad Themes & Specific Topics

Robots and Society

The History and Future of Robots
Introduction to Robotics
Robotic systems and Subsystems of Robots
Safety and Ethics in Robotics
Application Areas of Robotics

Simple Electronic and Mechanical Machines

Electronic Components

Building Basic electronic circuits
Mechanical Components
Building Basic mechanical machine
Digital systems design principle

- Logic Gates and Truth Tables
- Boolean Algebra
- Combinational Circuits Design principles

Basic Mechanics

- Gears

Reverse-Engineering of simple electronic systems.
Reverse-Engineering of simple mechanical systems.
Fault tracing and correction in electronic systems
Fault tracing and correction in mechanical systems

Accelerating Technologies in the Field Of Robotics
AI and Intelligent machines
Autonomous Vehicles
Drone Technologies
Internet of Things (IoT)

Fundamentals of Programming
Pseudocodes and Flowcharts
Programing Basics

- Variables and Data Types
- Operators
- Input and Output
- Flow Control

Programming responsive Robots for event-driven actions
Programming Robots for Fault Tolerance (Error detection and correction)
Programming Robots for Fault Avoidance (Error Prediction and avoidance)
Autonomous Machines (Unmanned Ground Vehicles and other)

Robots in Action
Writing structured programs to control Robots for defined tasks.
Programming responsive Robots for event-driven actions
Programming Robots for Fault Tolerance (Error detection and correction)
Programming Robots for Fault Avoidance (Error Prediction and avoidance)
Autonomous Machines (Unmanned Ground Vehicles and others)

Drone Technology
Physics of flight
Unmanned Aerial Vehicles Assembling
UAV Flight Controls and Dynamics
Assemble a model airplane using pre-modelled or 3D-printed parts.

Robot Design and Construction
Sensors and Actuators
Light Sensors

- Ultrasonic Sensors
- Motors
- Motor Rotation Sensors

Compound Gear Systems
Rotational Systems
Driving robots with single or multiple motors
Sensors and Actuators II

- Temperature Sensors
- Gyro Sensors
- Touch Sensors

Swinging Mechanisms
Lifting Mechanisms
Walking Machines
Requirement analysis for robot design and construction
High-level and Low-level design specification Definition
3D modelling and Additive Manufacturing
Building Robot Prototypes from local materials and 3D printed parts.

Project Work
Solving everyday problems in a home environment using robots.
Identifying and solving pressing societal or environmental problems using robots.
Creating innovative robot-based solutions for local industries

Structure of the Syllabus Over the 3-Year Senior Secondary Cycle

	SSS 1	SSS 2	SSS 3
First Term	**Robots and Society I** The History and Future of Robots Introduction to Robotics Robotic Systems and Subsystems of Robots **Simple Electronic and Mechanical Machines I** Electronic Components Building Basic Electronic Circuits Mechanical Components • Building Basic Mechanical Machine	**Robots and Society II** Safety and Ethics in Robotics Application Areas of Robotics • Security • Health Care • Space Exploration • Entertainment • Agriculture • Manufacturing • Military, etc. **Simple Electronic and Mechanical Machines II** Digital systems design principle • Logic Gates and Truth Tables • Boolean Algebra • Combinational Circuits Design Principles Basic Mechanics Gears	**Simple Electronic and Mechanical Machines III** Reverse-Engineering of Simple Electronic Systems Reverse-Engineering of Simple Mechanical Systems Fault Tracing and Correction in Electronic Systems Fault Tracing and Correction in Mechanical Systems

Second Term	**Accelerating Technologies in the Field of Robotics** AI and Intelligent Machines Autonomous Vehicles Drone Technologies Internet of Things (IoT) **Fundamentals of Programming I** Pseudocodes and Flowcharts Programing Basics • Variables and Data Types • Operators • Input and Output • Flow Control **Robots in Action I** Writing Structured Programs to Control Robots for Defined Tasks	**Fundamentals of Programming II** Functions Event-driven Programming Higher Order Design Thinking **Robots in Action II** Programming Responsive Robots for Event-driven Actions Programming Robots for Fault Tolerance (Error Detection and Correction) Programming Robots for Fault Avoidance (Error Prediction and Avoidance) • Autonomous Machines (Unmanned Ground Vehicles and Others)	**Drone Technology** Principles of Flight Unmanned Aerial Vehicles (UAV) Assembling UAV Flight Controls and Dynamics Assemble a Model Airplane Using Pre-modelled or 3D-printed Parts. **Robot Design and Construction III** Requirement Analysis for Robot Design and Construction High-level and Low-level Design Specification Definition 3D-modelling and Additive Manufacturing Building Robot Prototypes from Local Materials and 3D-printed Parts
Third Term	**Robot Design and Construction I** Sensors and Actuators • Light Sensors • Ultrasonic Sensors • Motors • Motor Rotation Sensors Compound Gear Systems Rotational Systems	**Robot Design and Construction II** Sensors and Actuators II • Temperature Sensors • Gyro Sensors • Touch Sensors Swinging Mechanisms Lifting Mechanisms	**Project Work III** Creating Innovative Robot-based Solutions for Local Industries

	Driving Robots with Single or Multiple Motors **Project Work I** Solving Everyday Problems in a Home Environment Using Robots	Walking Machines **Project Work II** Identifying and Solving Pressing Societal or Environmental Problems Using Robots	

Teaching Syllabus

Topic	Sub-topic	Expected learning outcomes	Recommended teaching method (s)	Suggested resources
Robots and Society I	The History and Future of Robots	a. Appraise the relevance and impact of robots in society. b. Demonstrate knowledge of the evolution of robot-based solutions from the first to the fourth industrial revolution. a. Critically analyze the peculiar characteristics of the various industrial revolutions.	**Experiential Learning**: Watch videos on the various industrial revolutions and document personal observations. **Collaborative Learning**: Sit in groups and discuss learner observations on the peculiarities of each revolution and the transitions. Groups should classify various machines under the identified industrial revolutions.	Video Documentaries, History Charts, pictures/videos of simple physical machines from the various industrial revolutions, Articles and narratives, Textbooks etc.
	Introduction to Robotics	b. Evaluate the concepts of design, construction, and programming of robots for sensory feedback and automated actuation. c. Explain the flow and sequencing process that takes place in robotic systems starting from sensing to actuation.	**Initiating Talk for Learning:** The facilitator leads a discussion by introducing what robotic systems are, emphasizing their ability to provide intelligent services and interact with their environment. Learners discuss and critique different encounters with systems that they will consider robotic systems. **Problem-Based Learning:** Learners in different groups research and present on either non-feedback loop or feedback loop systems. **Managing Talk for Learning:** The facilitator moderates a discussion where learners draw out contrasting differences from their research findings.	Videos, textbooks, online resources, etc.
	Robotic Systems and Sub-systems of Robots	a. Distinguish between robot and non-robot-based automated systems.	**Experiential Learning**: Learners watch a documentary showcasing the differences between robotic and non-robotic systems and evaluate the concepts of design, construction,	Videos, pictures, online resources, textbooks, simple robotic systems, etc.

		b. Identify and describe the subsystems of robots and their functions.	and programming of robots for sensory feedback and automated actuation. **Think-Pair-Share:** Learners based on the observed characteristics of robotic systems are given a few examples of systems they will classify as robotic or non-robotic systems. Using a think-pair-share approach, learners are given a few minutes to individually classify these examples noting them in their books, then pair with any of their colleagues and share their justification for their classification. The pair then share their collective submissions and resolve their differences, if any, calling on the facilitator where need be. The facilitator finally asks various teams to share their joint classifications and justifications.	
Simple Electronic and Mechanical Machines I	Electronic Components	a. Identify components such as Resistors, Capacitors, LEDs, Inductors, Circuit Breakers, Relays, Diodes, Transistors, etc., their ratings and purposes in electronic circuits. b. Use appropriate measuring instruments to take relevant readings and deduce component ratings from measured values. c. Use appropriate testing equipment to diagnose or test the functionality of electronic components.	**Project-Based Learning:** Facilitators provide learners with pictures of various basic electronic components (e.g. resistors, capacitors, LEDs, inductors, circuit breakers, relays, diodes, transistors, etc.). Learners are then given electronic circuits from which they are made to identify the components on board and their ratings. Learners then research the functions of these components using textbooks and online resources. Finally, they document the identified components, their specifications and their function in the circuit. **Project-Based Learning:** Facilitators will introduce learners to schematic and block notations. They then will take a circuit and develop its block and schematic representations. Learners will then pick other schematic and block diagrams and write descriptive summaries of	Basic electrical components, schematic diagrams, datasheets, measuring instruments, textbooks, pictures, videos, online resources, etc.

			what they observe.	
	Building Basic Electronic Circuits	a. Analyze the relationship among voltage, current and resistance (Ohm's Law) and apply this understanding in the technical design of basic electrical circuits. b. Assemble electronic circuits on solderless breadboards from pre- designed schematic diagrams.	Facilitator gives a brief introduction to electricity to cover the following: • What is electricity? • Voltage Current Resistance and Power • The algebraic relationship to each other Ohms Law **Project-Based Learning:** Facilitators will introduce learners to schematic and block notations. They then will take a circuit and develop its block and schematic representations. Learners will then pick other schematic and block diagrams and write descriptive summaries of what they observe. **Project-Based Learning:** Facilitators will explain the configuration of breadboards to learners and guide learners to use monitoring tools like the digital multimeters. Learners using pre-designed schematic diagrams will assemble and test electronic circuits on a solderless breadboard.	Multimeters, resistors, wires, solderless breadboards, schematic diagrams, textbooks, videos, online resources, etc.
	Mechanical Components	Identify and explain the functions of the foundational components (gears, springs, wheels, pulleys & belts, bolts & nuts, washers, pumps, screws, rivets, etc.) of machines and work- producing devices.	• Discuss principles of operation for simple machines, such as the lever, inclined plane, wheel and axle, pulley, and screw. • Discuss the basic elements of industrial machines, as well as common measurement tools used to monitor and adjust equipment. • Discuss hand tools, power tools and fasteners, and discuss ways to reduce friction and wear.	Videos, pictures, online resources, textbooks

	Building Basic Mechanical Machine	Design and build simple machines such as levers, inclined planes, wheels and axles, wedges and pulleys. Evaluate and recommend simple machines for basic tasks based on efficiency and mechanical advantage computations.	Identify and discuss four different types of motion.	Videos, pictures, online resources, textbooks, motors, gears, springs, pulleys and belts, bolts and nuts, washers, pumps and other basic mechanic components and tools.
		SSS 2 Term 2		
Accelerating Technologies in the Field of Robotics	AI and Intelligent Machines	Identify and establish the essence for the application of artificial intelligence in robotics.		Videos, pictures, online resources, textbooks, etc.
	Autonomous Vehicles	Examine the use case and relevance of autonomous robotic vehicles.		
	Drone Technologies	Examine the use case and relevance of unmanned aerial vehicles.		
	Internet of Things (IoT)	Examine the use case and relevance of the Internet of Robotic Things (IoRT)		
Fundamentals of Programming I	Pseudocodes and Flowcharts	Use flowchart and pseudocodes to depict defined solutions to problems. Analyze, evaluate and critique flowcharts meant to implement known solutions in robotics. Use digital tools to design flowcharts and pseudocodes.	Through discussions, the facilitator should build learners interest and understanding of programming and create functional decision-making programs that control a built robot in a chosen programming language or environment. **Project-Based Learning:** Learners will work in groups to develop their own functional decision-making programs that implement every single decision condition identified in their flowchart	Videos, CAD tools, flowcharts, pictures, online resources, textbooks, etc.

	Programming Basics • Variables and Data Types • Operators • Input and Output • Flow Control	a. Demonstrate an understanding and application of the fundamentals of structured programming with one entry point and one exit point. b. Define programming problems methodically and formulate corresponding solution algorithms that are specific and correct. c. Explain the differences between syntax errors, runtime errors, and logic errors.		Computers, integrated development environment, suitable programming language, textbooks, tutorial videos, online resources, etc.
Robots in Action I	Writing structured programs to control Robots for defined tasks.	Apply knowledge in procedural programming to control robots for the execution of defined tasks.	**Project-Based Learning:** With the facilitator's guidance, learners will work in groups to develop decision-making programs that implement nested decision condition.	Computers, integrated development environment, suitable programming language, textbooks, tutorial videos, online resources, etc.
		SSS 1 Term 3		
Robot Design and Construction	Sensors and Actuators Light sensors Ultrasonic sensors Motors Motor rotation sensors	a. Critically analyze the similarities between robots and living organisms and outline significant scientific principles that underpin how sensing is achieved in robots. b. Experiment with varying linear sensors and explain their outputs. c. Apply mathematical equations for the calibration of linear sensors.	**Experiential Learning:** Learners should watch videos of various bio-inspired robots and for each robot draw parallel feature maps to living organisms. **Talk for Learning:** Facilitators will lead a discussion on various scientific principles underpinning sensors' operation. **Experiential Learning**: Learners test and discuss the behavior of the various Sensors in groups. They should record the limits/boundary values for all the sensors and discuss real- life situations where and how these sensors can be employed.	Videos, pictures, online resources, textbooks, sensors (e.g. light sensor, ultrasonic, temperature, etc.), actuators (pumps, relays, switches, etc.), multimeter, measuring instruments, graphs, etc.

	Compound Gear Systems	a. Build and modify gear trains to increase seed or torque. b. Use building instructions to build and test varying compound gear systems. c. Explore the application of compound gear systems for actuation in robots.	The facilitator introduces students to gears and gear trains. Learners work in teams to build a simple gear train and experiment with how to increase torque or speed. Work with teams as they observe the rotary motion produced by the gear train. Point out how the gears are rotating in opposite directions. Explore the use of different compound gear systems for different forms of robot actuation.	Videos, pictures, online resources, textbooks, already built gear train for demonstration, etc.
	Rational Systems	Systematically follow a Design & Engineering Process guide to develop rotational systems solutions to a defined challenge	Brainstorm on ideas and solutions to a challenge • Discuss design ideas. • Consider building components. • Sketch out design ideas on paper. • Choose the best design. Build A Prototype of the best design using robotics kits or local material Discuss the following items with your team and be prepared to share with the rest of the class. • How did the team arrive at the final design solution? • Is the design realistic and well-proportioned? • How did each team member contribute towards the overall design? • Do you feel like everyone had an equal opportunity to contribute in the creative process?	Flip Charts, brainstorming sheets, Robotic Kits, Instructional Manuals, Textbooks, videos, online resources, reports etc.

	Driving Robots with Single or Multiple Motors	Systemically follow a Design and Engineering Process guide to build driving robots with wheels for a defined challenge.	Brainstorm on ideas and solutions to a challenge • Discuss design ideas. • Consider building components. • Sketch out design ideas on paper. • Choose the best design. Build a prototype of the best design using robotics kits or local material Discuss the following items with your team and be prepared to share with the rest of the class. • How did the team arrive at the final design solution? • Is the design realistic and well-proportioned? • How did each team member contribute towards the overall design? • Do you feel like everyone had an equal opportunity to contribute in the creative process?	Flip charts, brainstorming sheets, robotic Kits, instructional manuals, textbooks, videos, online resources, reports etc.
Project Work	Solving everyday problems in a home environment using robots	Identify and define a problem in an environment and follow a Design & Engineering Process to build a robot-based solution to the identified problem	Brainstorm on problems in a typical Sierra Leonean home setting and identify solutions that address the problem. • Discuss the problems. • Discuss design ideas. • Consider building components. • Sketch out design ideas on paper. • Choose the best design. Build a prototype of the best design using robotics kits or local material. Discuss the following items with your team and be prepared to share with the rest of the class. • How did the team arrive at the final design solution?	Flip charts, brainstorming sheets, robotic kits, local materials, instructional manuals, textbooks, videos, online resources, reports etc.

			• Is the design realistic and well-proportioned? • How did each team member contribute towards the overall design? • Do you feel like everyone had an equal opportunity to contribute to the creative process?	
Robots and Society II	Safety and Ethics in Robotics	Justify the need for integrating robots in human-centered environments for positive impact and outline ethical/safety considerations for successful coexistence.	Learners should analyze and enumerate both the positive and negative impacts of robots on society. Learners should explain the need for robot coexistence with humans, taking into consideration safety and robotics. Learners should write short articles on topics related to ethics, safety and robot coexistence in society.	Videos, pictures, online resources, textbooks, robotic principles and policy documents, news articles, etc.
	Application Areas of Robotics: Security Health Care Space Exploration Entertainment Agriculture Manufacturing Military, etc.	Evaluate and justify situations where robots can be applied to improve performance or reduce risk to humans in relatable local industries. Analyze the performance impact of robot integration in different application areas	Evaluate and justify situations where robots can be applied to improve performance or reduce risk to humans in relatable local industries. Analyze the performance impact of robot integration in different application areas.	Videos, pictures, online resources, textbooks, news articles, etc.
Simple Electronic and Mechanical Machines II	Digital systems design principle • Logic Gates and Truth Tables • Boolean Algebra	Explain Logic gates and their use in the conditional regulation of the flow of electricity through electronic circuits. a. Use Boolean algebra and truth tables for the definition of automation solutions.	Explain Logic gates and their use in the conditional regulation of the flow of electricity through electronic circuits. Use Boolean algebra and truth tables for the definition of automation solutions. Explain how logic gates are combined to build circuits within processors.	Videos, Pictures, Online Resources, Textbooks, Truth Tables, solution narrative, etc.

	• Combinational Circuits Design principles	b. Explain how logic gates are combined to build circuits within processors. c. Design combinational digital circuits from a solution narrative.	Design combinational digital circuits from a solution narrative.	
	Basic Mechanics	Determine the gear ratio and output speed of a gear train.	Discuss how the arrangement of the small and large gears determines if the gear train will increase torque or speed. Work with teams to determine the gear ratio and output speed of the gear train.	Videos, pictures, online resources, textbooks, etc.
		SSS 2 Term 2		
Fundamentals of Programming II	Functions	Explain the difference between a function and a procedure Define structured functions with appropriate input parameters, correct processing logic and route out valid outputs. Decompose complex procedural programming tasks into sub-tasks using functions.		Computers, integrated development environment, suitable programming language, textbooks, tutorial videos, online resources, etc.
	Event-driven Programming	Establish the relevance of event-driven programming functions, describing possible scenarios where they can be used. Define/program functions that listen for the occurrence of specific anticipated events (from sensors or sent messages or the state of a device/process) and trigger an appropriate response.		Computers, Integrated Development Environment, Suitable Programming Language, Textbooks, Tutorial videos, online resources, etc.

	Higher Order Design Thinking	Determine the inputs, processes and outputs required to solve a particular problem. Define solutions to basic automated and robotic problems using algorithms, pseudocodes, and flowcharts diagrams.		Flip charts, brainstorming sheets, textbooks, videos, online resources, reports, etc.
Robots in Action II	Programming Responsive Robots for Event-driven Actions	Apply knowledge in function-based programming to control finite state machines or finite state robots.	Discuss how finite state machines work by transitioning between different states based on specific event occurrences. Learners brainstorm on how sensors can be used to capture events and trigger functions leading to state changes. Learners program and test finite state machines in software and test them on simple robots.	Flip charts, robotic kits, local materials, instructional manuals, textbooks, videos, online resources, reports, etc.
	Programming Robots for Fault Tolerance (Error Detection and Correction)	Formulate and implement an error-guided continuous time driving robot (e.g., line following robot) using the line. Apply the principle of variation in experimenting the effect of scaling the constant of proportionality on the stability of a feedback-controlled systems.	Facilitators steer a discussion on proportional controllers and the role of proportional gain in a classical Proportional controller. Learners use a single or multiple sensors on a robot to implement proportional controls for the robot to perform an assigned task (e.g., line following robot). Learners work in groups to experiment and document the effects of varying the proportional gain on system stability.	Robotic kit, computers, integrated development environment, robot mats, videos, textbooks, online resources, etc.
	Programming Robots for Fault Avoidance (Error	Formulate and implement error avoidance robotic system using the concept of PID controllers.	Discuss PID controllers stressing on the role of derivative and integral gain as error reduction and avoidance mechanisms.	PID controllers (e.g., line following, light following, color following, wall tracking, object tracking, etc.), robotic kits, videos, textbooks,

	Prediction and Avoidance)	Apply the principle of variation in experimenting the effect of scaling the derivative and integral gains on the stability and performance of a PID controlled.	Learners use a single or multiple sensors on a robot to implement PID controls for the robot to perform an assigned task (e.g., line following robot).	online resources, robot mats, etc.
	Autonomous Machines (Unmanned Ground Vehicles and Other)	Combine knowledge in basic mechanical and electronic machines with understanding of PID controllers and programming to design and prototype an autonomous ground vehicle.	Learners share tasks and coordinate to design, build and program controls for an autonomous ground vehicle.	PID controllers (e.g., line following, light following, color following, wall tracking, object tracking, etc.), sensors, actuators, robotic kits, videos, textbooks, online resources, robot mats, etc.
		SSS 2 Term 3		
Robot Design and Construction II	Sensors and Actuators • Temperature Sensors • Gyro Sensors • Touch Sensors	Examine sensor power source, input and output using appropriate measuring instruments and properly classify them as either active-analogue, passive-analogue, active- digital or passive-digital. Leverage mathematical knowledge for sensor data manipulation and application for digital control of actuators. Explain the effect of noise on sensor readings and demonstrate ability to calibrate linear sensors operating in a noisy environment.	Facilitator leads a discussion to walk learners through to understand Analogue & Digital Signals, Analogue and Digital Systems, Basic Digital Devices, and terminologies/principles in analogue and digital sensor technologies. Learners should classify sensors as either active- analogue, passive-analogue, active-digital or passive- digital. Learners should apply mathematical methods to programmatically convert continuous-time sensor output to discrete-time digital output and to calibrate sensor values	Videos, pictures, online resources, textbooks, sensors (e.g., light sensor, ultrasonic, temperature, etc.), multimeter, measuring instruments, graphs, etc.
	Swinging Mechanisms	Systematically follow a Design & Engineering Process guide to develop solutions to a	Brainstorm on ideas and solutions to a challenge • Discuss design ideas. • Consider building components needed.	Videos, pictures, online resources, textbooks, swinging actuators (e.g., servos, springs, elastics,

		defined problem that requires swinging mechanisms.	• Sketch out design ideas on paper. • Choose the best design. Build a prototype of the best design using robotics kits or local material. Discuss the following items with your team and be prepared to share with the rest of the class. • How did the team arrive at the final design solution? • Is the design realistic and well-proportioned? • How did each team member contribute towards the overall design? • Do you feel like everyone had an equal opportunity to contribute in the creative process?	hinges, gears, etc.), robotic kits, instructional manuals, etc.
	Lifting Mechanisms	Systematically follow a Design & Engineering Process guide to develop solutions to a defined problems that require Lifting mechanisms.	• Brainstorm on ideas and solutions to a challenge Discuss design ideas. • Consider building components needed. • Sketch out design ideas on paper. • Choose the best design. Build a prototype of the best design using robotics kits or local material. Discuss the following items with your team and be prepared to share with the rest of the class. • How did the team arrive at the final design solution? • Is the design realistic and well-proportioned? • How did each team member contribute towards the overall design? • Do you feel like everyone had an equal opportunity to contribute in the creative process?	Videos, pictures, online resources, textbooks, lifting actuators (e.g., servos, gears, pulleys, etc.), robotic kits, instructional manuals, etc.

	Walking Machines	Systematically follow a Design & Engineering Process guide to develop solutions to a defined problems that require Walking Robots.	Brainstorm on ideas and solutions to a challenge • Discuss design ideas. • Consider building components needed. • Sketch out design ideas on paper. • Choose the best design. Build a prototype of the best design using robotics kits or local material. Discuss the following items with your team and be prepared to share with the rest of the class. • How did the team arrive at the final design solution? • Is the design realistic and well-proportioned? • How did each team member contribute towards the overall design? • Do you feel like everyone had an equal opportunity to contribute in the creative process?	Videos, pictures, online resources, walking actuators (e.g. servos, gears, tires, belts, etc.), robotic kits, instructional manuals, etc.
Project Work	Identifying and Solving Pressing Societal or Environmental Problems Using Robots	Identify and define a societal or environmental problem and follow a Design & Engineering Process to build a robot-based solution that addresses the identified problem.	Brainstorm on problems in a typical Sierra Leone setting, society or environment and ideate solutions that address the problem. • Discuss the problems. • Discuss design ideas. • Consider building components. • Sketch out design ideas on paper. • Choose the best design. Build A Prototype of the best design using robotics kits or local material Discuss the following items with your team and be prepared to share with the rest of the class.	Flip charts, brainstorming sheets, robotic kits, local materials, instructional manuals, textbooks, videos, online resources, reports etc.

			• How did the team arrive at the final design solution? • Is the design realistic and well-proportioned? • How did each team member contribute towards the overall design? • Do you feel everyone had an equal opportunity to contribute to the creative process?	
Simple Electronics and Mechanical Machines III	Reverse-engineering of Simple Electronic Systems	Demonstrate skills in reverse-engineering of combinational digital electronic systems.	Learners reverse engineer an existing combinational circuit and implement similar circuit or improved versions.	Combinational circuits, datasheets, schematic diagrams, measuring instruments, online resources, etc.
	Reverse-engineering of Simple Mechanical Systems.	Demonstrate skills in reverse-engineering of mechanical machines.	Learners reverse engineer an existing mechanical machine and implement prototypes of similar machines or improved versions.	Datasheets, schematic diagrams, block diagrams, mechanical toolkit, online resources, pictures, videos, etc.
	Fault Tracing and Correction in Electronic Systems	Demonstrate skills in the use of appropriate measuring tools to trace and correct defects in electronic systems.		Measuring instruments, schematic diagrams, datasheets, online resources, etc.

SSS 3 Term 2				
Drone Technology	Principles of Flight	Analyze a flight vehicle for trim conditions, stability and handling qualities. Design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	Discuss steady and unsteady airflow. Explain the concept of a streamline and explain airflow through a stream tube. Discuss the force resulting from the pressure distribution around an aerofoil and explain center of pressure and aerodynamic center. Learners resolve the resultant force into components of 'lift' and 'drag' and describe the direction of lift and drag Discuss the following parameters of a wing: • span • tip and root chord • taper ratio • wing area • wing planform • aspect ratio • dihedral angle • sweep angle	Online resources, textbooks, videos, pictures, etc.
	Unmanned Aerial Vehicles Assembling	Assemble a model flying object based on understanding of the Physics of flight.	Learners research and review existing flying machines and flying organisms to design an fit for purpose flying machine for a defined mission. • Discuss the purpose of the flying device • Discuss design ideas. • Consider building components. • Sketch out design flying device on paper. • Choose the best design. Build a prototype of the best design using 3D printed or local material	Drone Assembly Kit, Mechanical Tool Kit, Instructional Manual, online resources, videos, pictures, textbooks, CAD tools, 3D printer, local materials, etc.

			Discuss the following items with your team and be prepared to share with the rest of the class. • How did the team arrive at the final design solution? • Is the design realistic and well-proportioned? • How did each team member contribute towards the overall design? • Do you feel like everyone had an equal opportunity to contribute in the creative process?	
	UAV Flight Controls and Dynamics			
Robot Design and Construction III	Requirement Analysis for Robot Design and Construction			
	High Level and Low Level Design Specification Definition			
	3D Modelling and Additive Manufacturing	a. Work with and navigate the unique features of the digital 3D modeling tools and workspaces to create 3D objects. b. Identify characteristics of rendering 3D objects for optimal system processing and printing. c. Operate and service a 3D printer.	Facilitator provides an introduction to creating, editing, and analyzing 3D models. Learners will set up a Tinkercad or Fusion 360 accounts and explore the Tinkercad or Fusion modelling workspace. Learners work with, and navigate the digital 3D modeling workspace to create 3D models of robot parts.	

			Learners use rendering tools like Cura to prepare and convert 3D models into g- codes for 3D printing. Learners operate a 3D printer to actualize their models.	
	Building Robot Prototypes From Local Materials and 3D Printed Parts.	Design a proof of concept that demonstrates functionality to be vetted out by customers, clients, or a design team.	Learners design 3D printed parts to improve aesthetics and support functionality of prototype robots.	3D Printers, CAD tools, videos, online resources, etc.

SSS 3 Term 3				
Project Work	Creating Innovative Robot-based Solutions for Local Industries	Identify and define a problem in any local industry and follow a Design & Engineering Process to build a robot-based solution that addresses the identified problem.	Brainstorm on problems in a typical Sierra Leonean local industry and ideate solutions that address the problem • Discuss the problems • Discuss design ideas. • Consider building components. • Sketch out design ideas on paper. • Choose the best design. Build a prototype of the best design using robotics kits or local material. Discuss the following items with your team and be prepared to share with the rest of the class. • How did the team arrive at the final design solution? • Is the design realistic and well- proportioned? • How did each team member contribute towards the overall design? • Do you feel everyone had an equal opportunity to contribute to the creative process?	3D printers, CAD tools, videos, online resources, mechanical and electrical toolkits, brainstorming sheets, flip charts, robotic kits, local materials, etc.