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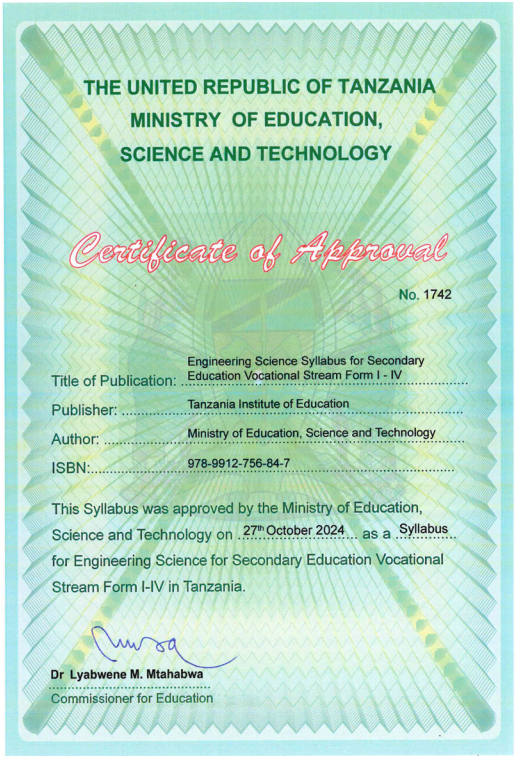

THE UNITED REPUBLIC OF TANZANIA
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Dr Lyabwene M. Mtahabwa
Commissioner for Education

ENGINEERING SCIENCE SYLLABUS FOR SECONDARY EDUCATION VOCATIONAL STREAM FORM I-IV

2024

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Tanzania Institute of Education,
Mikocheni Area,
132 Ali Hassan Mwinyi Road,
P. O. Box 35094,
14112 DAR ES SALAAM

Tel. +255 735 041 168 / 735 041 170
E-mail: director.general@tie.go.tz
Website: www.tie.go.tz

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Abbreviations and Acronyms

AC	Alternating Current
DC	Direct Current
ICT	Information and Communication Technology
LED	Light Emitting Diode
RLC	Resistor Inductor Capacitor
TIE	Tanzania Institute of Education
TSL	Tanzania Sign Language

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Acknowledgements

The writing of the Engineering Science Syllabus for Ordinary Secondary Education Vocational Stream Form I-IV involved various experts from both government and non-government institutions. Therefore, the Tanzania Institute of Education (TIE) would like to thank all the experts who participated in writing this syllabus, namely, lecturers, teachers, and curriculum developers from TIE. The Institute is also grateful to the National Technical Committee that was formed by the Minister for Education, Science and Technology for coordinating the curriculum review process for pre-primary, primary, secondary and teacher education. The Committee discharged its responsibilities professionally by ensuring that the contents of this syllabus are in line with the main objective of the 2023 curricular review, which is to ensure that the graduates acquire skills, knowledge, and attitudes that will enable them to create self-employment, employ others, be employed and able to sustain themselves.

Finally, TIE thanks the Ministry of Education, Science and Technology in a special way for facilitating the preparation and distribution of this syllabus.

Dr Aneth A. Komba
Director General
Tanzania Institute of Education

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1.0 Introduction

Engineering Science is a compulsory subject for Form I–IV students studying Engineering subjects in the Ordinary Secondary Education Vocational Stream. The purpose of learning Engineering Science is to provide students with the concepts, theories and principles underlying engineered systems' design and operation. Furthermore, the subject aims to promote the fundamental knowledge and analytical tools needed to understand, analyse, and optimise the performance of various engineering tasks. It also serves as a bridge to enable students to appreciate the value of resources in Tanzania and develop the ability to create work for self-employment.

This syllabus is designed to guide the teaching and learning of Engineering Science for Ordinary Secondary Education Vocational Stream Form I–IV in the United Republic of Tanzania. The syllabus interprets the competencies indicated in the 2023 Ordinary 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 promote students' engineering and ICT skills and develop 21st century skills, including critical thinking, creativity, communication, collaboration 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) Advance knowledge and 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;

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(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 per the constitution of the United Republic of Tanzania and international conventions.

3.0 Objectives of Ordinary Secondary Education-Vocational Education

The objectives of Ordinary Secondary Education-Vocational Education are to:

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

4.0 General Competencies for Ordinary Secondary Education-Vocational Education

The general competencies for Ordinary Secondary Education Vocational Stream are to:

(a) Use the knowledge and skills developed in Primary Education to strengthen and expand vocational understanding;
(b) Value citizenship and national customs;
(c) Demonstrate confidence in learning various professions, including Science and Technology, theoretical and technical knowledge;

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(d) Use language skills, including Tanzania Sign Language (TSL), Kiswahili language, English and at least one other foreign language to communicate;
(e) Use knowledge of cross-cutting issues to manage the environment; and
(f) Use knowledge and skills acquired for further vocational education and the life of work.

5.0 Main and Specific Competencies

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

Table 1: *Main and Specific Competencies for Form I-IV*

Main competencies	Specific competencies
0.1 Apply knowledge and skills of Engineering Science in various contexts	0.2 Demonstrate mastery of basic concepts, theories, principles and terminologies in Engineering Science 0.3 Demonstrate mastery of measurements and symbols in Engineering Science 0.4 Use mathematics to explain principles and phenomena in Engineering Science
2.0 Deploy Engineering Science theories and principles to solve problems in different contexts	2.1 Demonstrate knowledge and skills of Engineering Science in developing various engineering artefacts required by society 2.2 Demonstrate the knowledge and skills of Engineering Science in maintaining and repairing engineering artefacts

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6.0 Roles of Teachers, Students, and Parents in Teaching and Learning Process

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

6.1 The teacher

The teacher is expected to:

(a) Help the student to learn and acquire the intended competencies in Engineering 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 the 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.

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6.2 The student

The student is expected to:

(a) Develop the intended competencies by participating actively in various activities inside and outside the classroom; and
(b) Participate in the search for knowledge from various sources, including textbooks, reference books and other publications in online libraries.

6.3 The parent/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 competencies. This syllabus suggests teaching and learning methods for each activity, including 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 students' everyday lives.

8.0 Teaching and Learning Resources/Materials

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 is expected to constantly seek information from various sources to effectively facilitate teaching and learning. The list of approved textbooks and reference books shall be provided by the TIE.

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9.0 Assessment of the Learning Process

Assessment is important in teaching and learning Engineering 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 are 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 mid-term tests, terminal and 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 IV 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*

Assessment Measures	Weight (%)
Standard VI National Assessment	6.0
Form II National Assessment	5.0
Form III Terminal Examination	5.0
Form III Annual Examination	7.0
Form IV Mock Examination	7.0
Form IV National Examination	70
Total	**100**

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10.0 Number of Periods

The Engineering Science Syllabus for Vocational Ordinary Secondary Education provides estimates of the time that will be spent in teaching and learning taking into consideration the complexity of the specific competencies and the learning activities. Therefore, three periods per week for Form I-II and four periods per week for Form III-IV of 40 minutes have been allocated for this subject.

11.0 Teaching and Learning Contents

The contents of this syllabus are presented in matrix form with seven columns that include main competencies, specific competencies, learning activities, suggested teaching and learning methods, assessment criteria, suggested resources, and number of periods as presented in Tables 3-6.

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Form I

Table 3: *Detailed Contents for Form I*

Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
1.0 Apply knowledge and skills of Engineering Science in various contexts	1.1 Demonstrate mastery of basic concepts, principles and terminologies in Engineering Science	(a) Explain the concept of engineering science (*Meaning of engineering science, connection with other fields, application of engineering science*)	**Brainstorming:** Guide students to brainstorm on the concepts of science and engineering science **Group discussion:** Guide students in manageable groups to discuss and come up with the meaning and applications of engineering science **ICT-based learning approach:** Guide students through ICT learning approach to explain the concept of engineering science **Field visit:** Organise field visits and guide students to explore the applications of engineering science in day to day activities	The concepts of science and engineering science are clearly explained	Manila sheets, flip charts, multimedia, posters, engineering science books, and online resources	33
		(b) Describe measurement of physical quantities	**Brainstorming:** Guide students to brainstorm on the concepts and principles of	Measurement of physical quantities in	Metre rules, tape measures, stopwatches,	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		in engineering science (*Measurements, measurement errors, physical quantities, measuring instruments, measuring mass, measuring length, measuring time, measuring volume, measuring density and relative density*)	measurements in engineering science **Think-ink-pair-share:** Guide students through think-ink-pair-share to explain the concepts and principles of measurement in engineering science **Interactive simulation and animation:** Guide students through interactive simulation and animation to visualise the concepts and principles of measurements and measurement errors **Hands-on activities:** Guide students in manageable groups through hands-on activities to demonstrate measurements of mass, length, time, volume, density and relative density	engineering science is clearly described	vernier callipers, micrometre screw-gauges, beam balance, measuring cylinders, engineering science textbooks, and online resources	
		(c) Explore the concept and principles of force (*Force, types of force, effect of forces, friction*)	**Brainstorming:** Guide students to brainstorm on the concepts and principles of force	The concept and principles of force are well explored	Spring balances, spiral springs, magnets, rubber bands,	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			Interactive simulation and animation: Guide students through interactive simulation and animation to visualise the types and effects of force **Think-ink-pair-share:** Guide students through think-ink-pair-share to explore the concepts and principles of force **Hands-on activities:** Guide students in manageable groups through hands-on activities to demonstrate the effects of force and friction		jelly cans, sponges, blocks of wood, rough surfaces, smooth surfaces, tyres, bicycle brake systems, trolleys, weights, rollers, grease, bearings, cotton strings, toy cars, engineering science textbooks, and online resources	
		(d) Describe the concepts and principles of mechanical properties of matter (*Structure of matter, adhesion*	**Brainstorming:** Guide students to brainstorm on mechanical properties of matter **Group discussion:** Guide students through manageable groups, to elaborate different mechanical properties of matter	The concepts and principles related to mechanical properties of matter are well described	Rods of different metals, carbon rods, stainless steel, solid materials of different	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		and cohesion, surface tension and capillarity, osmosis and diffusion, stress and strain, elasticity, plasticity and elongation- Young's modulus, ductility and material tenacity, brittleness, malleability, softness and hardness, toughness and flexibility)	**Microteaching:** Organise students in small groups and give them a concept or a principle in mechanical properties of matter to prepare and perform microteaching **Interactive simulation:** Guide students through interactive simulation to visualise and model different mechanical properties of mater **Hands-on activities:** Guide students through hands-on activities to explore the relationships between different mechanical properties of matter		properties, metre rules, glass, plastic materials, rubber bands, springs, liquids of different properties, tubers (e.g. potatoes), salt/ sugar, narrow tubes, pieces of wood, engineering science text books, and online resources	
		(e) Explain the concepts and principles of linear motion (*Linear motion, distance*	**Brainstorming:** Guide students to brainstorm on the principles and concepts of linear motion.	The concepts and principles of linear motion are well explained	Inclined planes, toy cars, roller, smooth table surfaces,	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		and displacement, speed and velocity, acceleration, equations of linear motion, motion under gravity, Newton's laws of motion)	**Think-ink-pair-share:** Guide students through think-ink-pair-share to explain and relate various concepts and principles of linear motion **Interactive simulation:** Guide students through interactive simulation to develop an understanding of velocity and acceleration, motion under gravity, and Newton's laws of motion **Class activities:** Guide students through class activities to elucidate the concepts and principles of linear motion		single pulleys, spring, slotted masses, string, measuring tapes, metre rules, glass, coins, multimedia resources, and engineering science textbooks	
		(f) Explore the concepts and principles of work, energy and power (Work, energy, forms of energy, conservation of energy, power)	**Brainstorming:** Guide students to brainstorm on the concepts and principles related to work, energy and power **Questions and answers:** Use questions and answers to guide students to explore	The concepts and principles related to work, energy and power are adequately explored	Beam balances, balls, tape measures, stairs, worksheets, spring balances,	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			the principles related to work, energy and power **ICT-based learning:** Guide students through the use of multimedia and simulation to visualise and explore different forms of energy, conservation of energy, and power **Hands-on activities:** Guide students in manageable groups through hands-on activities to familiarise them with the concepts of work, energy and power		sources of different forms of energy (e.g. candle, electric bulb), magnets, simple pendulums, inclined planes, objects of known masses (e.g. stones, bricks), stopwatches, multimedia resources, simulation software, and engineering science textbooks	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(g) Explain the concepts and principles related to pressure (*pressure, pressure due to solids, pressure in fluid, atmospheric pressure*)	**Brainstorming:** Guide students to brainstorm on the concepts and principles of pressure **Hands-on activities:** Guide students in manageable groups through hands-on activities to familiarise them with the concepts of pressure **Circle the Sage:** Guide students through circle the-sage to explore various applications of pressure **ICT-based learning approach:** Guide students through ICT learning approach to visualise different concepts and principles of pressure	The concepts and principles of pressure are clearly explained	Water tanks, basins, different liquids, different solid materials, spring balances, straws, water bottles, metal canes, Magdeburg hemispheres, manometers, syringes, bicycle pumps, balloons, nail/pins, engineering science text books, and online resources	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(h) Explore the concepts and principles related to electricity (*Static and current electricity, Ohm's law, resistors, capacitors, inductors, RLC circuits, electric cells, electrical energy and power*)	**Brainstorming:** Guide students to brainstorm on the concepts and principles of electricity **Think-ink-pair-share:** Guide students through think-ink-pair-share to explain and relate various concepts and principles of electricity **Hands-on activities:** Guide students in manageable groups through hands-on activities to explore the concepts and principles of electricity **Interactive simulation:** Guide students through interactive simulation to visualise and model current electricity, Ohm's law, electrical energy and power **Practical work:** Guide students through	The concepts and principles of electricity are clearly explored	Small pieces of paper, plastic combs, polythene rods, glass rods, capacitors, lighting conductors, connecting wires, batteries, bulbs, ammeters, voltmeters, galvanometers, switches, meter bridges, resistors, inductors, physical models, simulation	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			experimentation to verify Ohm's law		software, and engineering science text books	
	0.2 Demonstrate mastery of measurements and symbols in Engineering Science	(a) Describe various measuring instruments related to physical quantities corresponding to the concepts and principles of *forces, mechanical properties of matter, linear motion, work, energy and power, pressure and electricity*	**Brainstorming:** Guide students through brainstorming to describe different measuring instruments used in engineering science **Group discussion:** Guide students in manageable groups through discussion to explore various instruments used in engineering science **ICT-based learning approach:** Guide students through ICT learning approach to visualise various measuring instruments used in engineering science	Measuring instruments are described correctly	Metre rules, tape measures, stopwatches, vernier callipers, micrometre screw-gauges, beam balances, measuring cylinders, spring balances, ammeters, voltmeters, galvanometers, meter bridges, manometers, virtual labs, multimedia resources, and	32

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
					engineering science text books	
		(b) Relate measuring instruments used in engineering science to physical quantities and their symbols corresponding to *forces, mechanical properties of matter, linear motion, work, energy and power, pressure, electricity*	**Think-ink-pair-share:** Guide students through think-ink-pair-share to relate various measuring instruments to physical quantities and symbols used in engineering science **Problem-based approach**: Guide students to relate measuring instruments to real-life engineering measurement scenarios **Hands-on activities:** Guide students in small groups through hands-on activities to familiarise themselves with various measuring instruments related to forces, mechanical properties of matter, linear	Various measuring instruments used in engineering science are well related to their corresponding physical quantities and their symbols	Metre rules, tape measures, stopwatches, vernier callipers, micrometre screw-gauges, beam balances, measuring cylinders, spring balances, ammeters, voltmeters, galvanometers, meter bridges, manometers, virtual labs, multimedia resources, and	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			motion, work energy and power, pressure, and electricity		engineering science text books	
		(c) Perform measurements of different physical quantities associated with *forces, mechanical properties of matter, linear motion, work, energy and power, pressure and electricity*	**Demonstration:** Guide students to demonstrate the use of specific measuring tools for each concept to enhance understanding through visual examples **Hands-on activities:** Guide students through practical experiments using measuring instruments to observe and record physical quantities related to forces, mechanical properties of matter, linear motion, work energy and power, pressure, and electricity **Virtual lab experiment:** Guide students through virtual lab experiments to perform measurements of different physical quantities	Measurements of different physical quantities are correctly performed	Metre rules, tape measures, stopwatches, vernier callipers, micrometre screw-gauges, beam balances, measuring cylinders, spring balances, ammeters, voltmeters, galvanometers, meter bridges, manometers, virtual labs, multimedia resources, and	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			Experimentation: Guide students in small groups through experiments to perform measurements of different physical quantities associated with forces, mechanical properties of matter, linear motion, work, energy and power, pressure and electricity		engineering science textbooks	
	1.3 Use mathematics to explain principles and phenomena in Engineering Science	(a) Apply mathematical knowledge to describe the relationship between various physical quantities corresponding to different principles and phenomena (*measurements, forces, mechanical properties of matter, linear motion, work, energy and power, pressure, electricity*)	**Group discussion:** Organise students in small groups to describe relationships between various physical quantities through the use of mathematical knowledge **Problem-based approach**: Guide students to solve real-world problems using mathematical knowledge of the relationship between various physical quantities corresponding to different principles and phenomena in engineering science	Mathematical knowledge to describe relationships between various physical quantities corresponding to different engineering science principles and phenomena is correctly applied	Online resources and engineering science books	12

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			Scenario: Organise students in manageable groups and provide scenarios for them to investigate the relationships between various physical quantities corresponding to mechanical properties of matter, work, energy and power, pressure, and electricity			
2.0 Deploy Engineering Science theories and principles to solve problems in different contexts	2.1 Demonstrate knowledge and skills of Engineering Science in developing various engineering artefacts required by the society	(a) Apply the knowledge and skills of engineering science in developing various engineering artefacts required by society	**Scenario:** Provide students in small groups with engineering science scenarios and let them develop artefacts that adequately resolve the scenario **Interactive Simulation:** Guide students to use interactive simulation to design and build different engineering artefacts **Experimentation:** Guide students through experimentation to use knowledge and skills of	Knowledge and skills of engineering science required in developing various engineering artefacts correctly applied	Online resources, virtual labs, multimedia resources, simulation software, various instruments and components, and engineering science books	16

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			properties of matter, linear motion, work, energy and power, pressure, and electricity in performing various engineering tasks **Project-based approach:** Facilitate students through project works to apply knowledge and skills in engineering science to design and build different engineering artefacts			
	2.2 Demonstrate knowledge and skills of Engineering Science in maintaining and repairing engineering artefacts	(a) Use the knowledge and skills of engineering science in maintaining and repairing various engineering artefacts	**Experimentation:** Guide students through experimentation to use the knowledge and skills of properties of matter, linear motion, work, energy and power, pressure, and electricity to maintain and repair different engineering artefacts	Various engineering artefacts required by society are maintained and repaired using knowledge	Online resources, multimedia resources, simulation software, various instruments and	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			Hands-on activities: Guide students in small groups to use knowledge and skills of engineering science through hands-on activities to maintain and repair different engineering artefacts	and skills of engineering science	components, and engineering science books	12

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Form II

Table 4: *Detailed Contents for Form II*

Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
1.0 Apply knowledge and skills of Engineering Science in various contexts	0.1 Demonstrate mastery of basic concepts, principles and terminologies in Engineering Science	(a) Explain the concepts and principles of turning forces (*moment of force, parallel forces, stability of equilibrium, centre of mass and centre of gravity*)	**Brainstorming:** Guide students to brainstorm on the principles and concepts of turning forces **Interactive simulation:** Guide students through interactive simulation to develop an understanding of the principles and concepts of turning forces **Practical work:** Guide students through hands-on activities to elucidate the concepts and principles of turning forces	The concepts and principles of turning forces are clearly explained	Cones, balls, objects with different base sizes, metre rules, wooden or metal rods, knife edges, objects of known masses, beam balances, spring balances, see-saws, plumb-lines, lamina of different shapes, flip charts, steelyard balances, graph papers, gram masses, spanners, car steering wheels, oars, hammers, bicycle pedals, and simulation software	36

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(b) Describe the concepts and principles of simple machines (*Simple machines*, *law of machine*s, *levers, pulleys, inclined planes, screw jack, wheel and axle, hydraulic press*)	**Brainstorming:** Guide students to brainstorm on different types and classes of simple machines used in day-to-day activities **Group discussion:** Guide students through manageable groups to discuss the principles of simple machines used in day-to-day activities **ICT-based learning approach:** Guide students through ICT learning approach to describe different simple machines **Practical Work:** Guide students through hands-on activities to explore the concepts and principles of simple machines **Think-ink-pair-share:** Guide students through the	The concepts and principles of simple machines are well described	Different types of pulley systems, levers, pair of scissors, wheelbarrows, spades, bottle openers, screws, jacks, inclined planes, wheel and differential axles, hydraulic presses, claw hammers, coal tongs, nutcrackers, crowbars, wire cutters, fishing rods, oars, wedges, biceps and forearm, and simulation software	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			think-ink-pair-share strategy to classify different types of simple machines			
		(c) Describe the concepts and principles of mechanical drives (G*ear drives, chain drives, belt drives*)	**Group discussion:** Guide students to discuss and explore the concepts and principles of mechanical drive **Interactive simulation:** Guide students through interactive simulation to visualise and model the concepts and principles of mechanical drives **Field visit:** Arrange field visits and guide students to recognise and categorise mechanical drives **Experimentation:** Guide students in small groups to build and experiment with simple mechanical drives	The concepts and principles of mechanical drives are clearly described	Animated simulation software, multimedia resources, gear drives (motor vehicle, motorcycle, bicycle), gear wheels, final drives, racks and pinions, conveyor belts, car engines, machines with belt drives, belts, pulleys, windmills, chain drives, chains, and machines with chain drives (e.g. bicycles)	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(d) Explain the concepts and principles of fluid mechanics (*Buoyancy, equation of continuity, Bernoulli's principle*)	**Brainstorming:** Guide students to brainstorm on the concepts and principles of fluid mechanics **Interactive simulation:** Guide students through interactive simulation to visualise the concepts and principles of fluid mechanics **Practical Work:** Provide students with hands-on activities to explore the concepts and principles of fluid mechanics **Hands-on activities:** Guide students through hands-on activities to demonstrate buoyancy, equation of continuity and Bernoulli's equation	The concepts and principles of fluid mechanics are clearly explained	Garden hosepipes with different sizes, objects with different densities and shapes, venture tubes, fluid tanks, simulation software, and spring balance	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		(e) Explore the concepts and principles of thermal energy (*Temperature, thermometers, heat, transfer of thermal energy, measurement of thermal energy, calorific values, change of state, hot water system*)	**Brainstorming:** Guide students to brainstorm on the concepts and principles of thermal energy **Interactive simulation and animations:** Guide students through interactive simulation and animation to visualise the concepts and principles of thermal energy **Practical Work:** Provide students with experiments to explore the concepts and principles of thermal energy **Hands-on activities:** Guide students in manageable groups through hands-on activities to demonstrate the concepts of temperature, heat, transfer of thermal energy, measurement of thermal energy, change of state	The concepts and principles of thermal energy are explored appropriately	Thermometers, calorimeters, heat sources, metal rods, ice, water, alcohol, simulation software, multimedia resources, and water pipes	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			Field visit: Arrange field visits and guide students to explore the components and working principles of hot water systems			
		(f) Describe the concepts and principles of thermal expansion (*Introduction to thermal expansion, solid expansion, liquid expansion, gas expansion, measurement of thermal expansion, linear expansion, areal expansion, volume*	**Brainstorming:** Guide students to brainstorm on the concepts and principles of thermal expansion **Practical work:** Guide students in small groups to conduct experiments to investigate the relationship between various parameters related to thermal expansion **ICT-based learning:** Guide students to visualise various parameters related to thermal expansion using virtual lab **Demonstration:** Guide students to demonstrate thermal expansion of solids, liquids and gases	The concepts and principles of thermal expansion are described correctly	A chart of metals of various expansivities, sources of heat, solid materials, balls and rings, bimetallic strips, bar breakers, ice, cold water, hot water, measuring cylinders, thermometers, tall glasses, virtual labs resources, and measuring tapes	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		expansion, applications of thermal expansion)				
		(g) Explore the concepts and principles of basic analogue electronics (*Conductors, semiconductors and insulators, electronic components, resistors' colour code, capacitors' colour and number codes, diodes, basic power supply, transistors, analogue signals, single stage amplifier*)	**Group discussion:** Guide students to discuss and explore the concepts and principles of basic analogue electronics **Think-ink-pair-share:** Guide students through think-ink-pair-share to explore the concepts of conductors, semiconductors and insulators, analogue signals **Hands-on activities:** Guide students in small groups through hands-on activities to explore the concepts and principles of basic analogue electronics **Interactive simulation:** Guide students to use	The concepts and principles of basic analogue electronics are explored clearly	Breadboards, multimedia projectors, flip charts, semi-conductors, conductors, insulators, batteries, galvanometers, transistors, diodes, resistors, capacitors, inductors, LEDs, integrated circuits (IC), multimetres, DC sources, radios, television sets, amplifiers, switches, sources of analogue	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			different simulation software to visualise the functioning of various electronic components **Practical work:** Guide students in small groups to conduct experiments to investigate the behaviour of diodes, basic power supply, transistors, and, single stage amplifier		signals, and engineering science textbooks	
	0.2 Demonstrate mastery of measurements and symbols in Engineering Science	(a) Describe various measuring instruments related to physical quantities corresponding to the concepts and principles of *turning forces, simple machines,*	**Think-ink-pair-share:** Guide students through think-ink-pair-share to describe various measuring instruments used in engineering science **Hands-on activities:** Guide students in small groups through hands-on activities to familiarise themselves with various measuring instruments related to turning forces, simple machines,	Various measuring instruments used in engineering science are described clearly	Various measuring instruments, online resources, virtual labs, and multimedia resources	29

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		mechanical drives, fluid mechanics, thermal energy, thermal expansion and basic analogue electronics	mechanical drives, fluid mechanics, thermal energy, thermal expansion and basic analogue electronics **Interactive simulation:** Guide students through interactive simulation to visualise and describe various instruments used in engineering science			
		(b) Relate measuring instruments used in engineering science to physical quantities and their symbols corresponding to *turning forces, simple machines, mechanical*	**Think-ink-pair-share:** Guide students through think-ink-pair-share to relate various measuring instruments to physical quantities and symbols used in engineering science **Experimentation:** Guide students in small groups through experiments to relate measuring instruments with their corresponding physical quantities and their symbols	Measuring instruments are correctly related to physical quantities and their symbols	Various measuring instruments, online resources, virtual labs, and multimedia resources	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		drives, fluid mechanics, thermal energy and thermal expansion, basic analogue electronics	**Field visit:** Organise field visits and guide students to explore advanced measuring instruments used in various engineering fields			
		(c) Perform measurements of different physical quantities corresponding to *turning forces, simple machines, mechanical drives, fluid mechanics, thermal energy and thermal expansion, and basic analogue electronics*	**Demonstration:** Guide students to demonstrate the use of specific measuring tools for various concepts in engineering science **Hands-on activities:** Guide students through experiments using measuring instruments to observe and record measurements in various contexts **Problem-based approach**: Guide students through a problem-based approach to apply measurements of respective physical	Measurements of physical quantities in engineering science are adequately performed	Various measuring instruments, online resources, virtual labs, and multimedia resources	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			quantities in solving real-life engineering problems **Experimentation:** Guide students in small groups through experiments to perform measurements of different physical quantities associated with forces, mechanical properties of matter, linear motion, work, energy and power, pressure, and electricity **Virtual lab experiment:** Guide students through virtual lab experiments to perform measurements of different physical quantities			
	1.3 Use mathematics to explain principles and phenomena in Engineering Science	(a) Apply mathematical knowledge to describe the relationship between various	**Group discussion:** Organise students in small groups to describe relationships between various physical quantities through the use of mathematical knowledge	Mathematical knowledge to describe relationships between various physical quantities	Online resources and engineering science books	13

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		physical quantities corresponding to different principles and phenomena (S*imple machines, mechanical drives, fluid mechanics, thermal energy, thermal expansion, basic analogue electronics*)	**Problem-based approach**: Guide students to solve real-world problems using mathematical knowledge of the relationship between various physical quantities corresponding to different principles and phenomena in engineering science **Scenario:** Organise students in manageable groups and provide scenarios for them to investigate the relationships between various physical quantities corresponding to different principles and phenomena in engineering science	corresponding to different engineering science principles and phenomena is correctly applied		
2.0 Deploy Engineering Science theories and principles to solve	2.1 Demonstrate knowledge and skills of Engineering Science in developing	(a) Use the knowledge and skills of *simple machines, mechanical drives, fluid*	**Experimentation:** Guide students through experimentation to use knowledge and skills in simple machines, mechanical drives, fluid mechanics,	Knowledge and skills of engineering science adequately applied in	Online resources, virtual labs, multimedia resources, simulation software, various	17

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
problems in different contexts	various engineering artefacts required by society	*mechanics, thermal energy, thermal expansion, and basic analogue electronics* in developing various engineering artefacts required by society	thermal energy, thermal expansion, and basic analogue electronics to build different engineering artefacts **Scenario:** Provide students in small groups with engineering science scenarios and let them develop artefacts that adequately resolve the scenario **Interactive Simulation:** Guide students to use interactive simulation to design and build different engineering artefacts **Project-based approach:** Guide students using knowledge and skills of engineering science to conduct a project for solving real-world engineering problems	developing various engineering artefacts required by society	instruments and components, and engineering science books	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
	2.2 Demonstrate the use of knowledge and skills of Engineering Science in maintaining and repairing engineering artefacts	(a) Use the knowledge and skills of *simple machines, mechanical drives, fluid mechanics, thermal energy, thermal expansion, and basic analogue electronics* in maintaining and repairing various engineering artefacts	**Experimentation:** Guide students through experimentation to use the knowledge and skills of simple machines, mechanical drives, fluid mechanics, thermal energy, thermal expansion, and basic analogue electronics to maintain and repair different engineering artefacts **Hands-on activities:** Guide students in small groups to use knowledge and skills of engineering science through hands-on activities to maintain and repair different engineering artefacts	Knowledge and skills of engineering science adequately used in maintaining and repairing engineering artefacts	Online resources, multimedia resources, simulation software, various instruments and components, and engineering science books	10

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Form III

Table 5: *Detailed Contents for Form III*

Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
1.0 Apply knowledge and skills of Engineering Science in various contexts	1.1 Demonstrate mastery of basic concepts, principles and terminologies of Engineering Science	(a) Explore basic concepts and principles of vectors (*Vectors, resolving vectors by graphical and analytical methods, relative motion*)	**Jigsaw:** Guide students in manageable groups using the jigsaw method to explore the concepts and principles of vectors **Interactive simulation:** Guide students to use interactive simulation to visualise vector addition, subtraction, and resolving vectors and relative motion **Hands-on activities:** Engage students in hands-on experiments to elucidate vector addition, subtraction, resolving vectors by graphical and analytical methods and relative motion	Basic concepts and principles of vectors are clearly described	Diagrams illustrating vectors, vector arrows, graph papers, metre rules, mathematical sets, simulation software, and engineering science textbooks	49
		(b) Describe the concepts and principles of	**Brainstorming:** Guide students through brainstorming to describe the	The concepts of periodic motion are	Textbooks, online simulations, simple pendulum	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		periodic motion (*Periodicmotion, oscillations, simple pendulum, importance of periodic motion*)	concepts and principles of periodic motion **ICT-based learning:** In small groups, guide students use interactive simulation to visualise and explain different concepts and principles related to periodic motion, oscillations and pendulums **Hands-on activities**: Guide students through hands-on activities to demonstrate the concepts and principles of periodic motion using simple pendulums or any oscillating system	properly described	kits, oscillation apparatus, videos and animations and mathematical software	
		(c) Explore the concepts and principles of angular motion (*Angular*	**Think-ink-pair-share:** Guide students through think-ink-pair-share to explore the concepts and principles of angular motion	The concepts and principles related to angular motion are	Wheels of different sizes, gyroscopes, rotary sensors, flip charts,	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		motion, angular displacement, angular velocity, angular acceleration, equations of angular motion, circular motion, centripetal force and torque)	**Hands-on activities:** Guide students in small groups through hands-on activities using rotating wheels or similar devices to explore the concepts and principles of angular motion **ICT-based Learning:** In small groups, guide students use interactive simulation to visualise and model different concepts and principles of angular motion	adequately explored	protractors, metre rules, strings, multimedia resources, online simulations, mathematical software, and engineering science textbooks	
		(d) Describe the concepts and principles of magnetism (*Magnetism, magnets, magnetic fields, magnetisation and demagnetisation, applications of magnets*)	**Circle the Sage:** Guide students through Circle the Sage to describe the concepts and principles of magnetism **Demonstration**: Guide students to demonstrate magnetic fields, magnetisation, demagnetisation, and some applications of magnets using magnets and magnetic materials	The concepts and principles of magnetism are clearly described	Bar magnets, horseshoe magnets, iron filings, office pins, ferrous materials (e.g. iron nails), compasses, electromagnets, magnetic field visualisers, cardboards,	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			Hands-on activities: Guide students through hands-on activities using magnets and compasses to explore magnetic fields, magnetisation and demagnetisation **ICT-based Learning:** Guide students in manageable groups to visualise and describe different concepts and principles related to magnetism		multimedia resources, and engineering science textbooks	
		(e) Explain the concepts and principles of basic digital electronics (*Analogue vs digital signals, binary numbers, logic gates, applications of digital electronics*)	**Brainstorming:** Guide students through brainstorming to explore the concepts and principles of basic digital electronics **Hands-on activities:** Guide students through hands-on activities using oscilloscopes, logic gates breadboards to explore the concepts and principles of digital signals,	The concepts and principles of basic digital electronics are clearly explained	Power supplies, oscilloscopes, multimeters, digital logic trainer kits, logic gates, wires, breadboards, electronic components (LEDs, resistors, capacitors,	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			binary numbers and logic gates **ICT-Based Learning**: In small groups, guide students to visualise digital circuits and logic gate operations using simulation software and online platforms		etc.), simulation software, multimedia resources, charts, and engineering science textbooks	
		(f) Explain the concepts and principles of sustainable energy sources (*Sustainable energy sources, solar energy, wind energy, geothermal energy, hydropower*)	**Brainstorming**: In manageable groups, guide students through brainstorming to explore the concepts and principles of sustainable energy sources **Think-ink-pair-share:** Guide students through think-ink-pair-share to explain the concepts and principles of sustainable energy sources **ICT-based Learning**: In small groups guide students to utilise multimedia	The concepts and principles of sustainable energy sources are clearly explained	Solar panels, mounting racks, inverters, charge controllers, solar batteries, wires, multimeters, solar kits, wind turbine models, geothermal models, hydropower models, online resources, simulation software,	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			resources and simulation to visualise and describe various concepts and principles related to solar energy, wind energy, geothermal energy, hydropower		multimedia resources, and engineering science textbooks	
	1.2 Demonstrate mastery of measure-ments and symbols in Engineering Science	(a) Relate measuring instruments to physical quantities corresponding to the concepts and principles of *vectors, periodic motion, angular motion, magnetism, basic digital electronics and sustainable energy sources*	**Demonstration**: Guide students through demonstrations to relate various measuring instruments to the corresponding physical quantities in engineering science **Think-ink-pair-share:** Guide students through think-ink-pair-share to relate various measuring instruments to physical quantities and symbols used in engineering science **Hands-on activities:** Guide students through hands-on activities to demonstrate	Measuring instruments corresponding to various physical quantities are correctly related	Vector arrows, protractors, stopwatches, pendulums, rotational motion kits, magnetic field sensors, compasses, oscilloscopes, multimeters, solar panels, wind turbines, energy meters, and engineering science textbooks	48

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			proficiency in the measurement of physical quantities in vectors, periodic motion, angular motion, magnetism, basic digital electronics and sustainable energy sources using different measuring tools **Field visit:** Organise field visits and guide students to explore advanced measuring instruments used in various engineering fields			
		(b) Perform measurements in *vectors, periodic motion, angular motion, magnetism, basic digital electronics and sustainable energy sources*	**Demonstration:** Guide students to demonstrate the use of specific measuring instruments for various physical quantities in engineering science **Hands-on activities:** Guide students through practical experiments using measuring instruments to observe and record measurements in vectors, periodic motion,	Measurements of various physical quantities related to engineering science are adequately performed	Vector arrows, protractors, stopwatches, pendulums, rotational motion kits, magnetic field sensors, compasses, oscilloscopes, multimeters, solar panels, wind turbines,	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			angular motion, magnetism, basic digital electronics and sustainable energy sources		energy meters, online resources, and engineering science textbooks	
	1.3 Use mathematics to explain principles and phenomena in Engineering Science	(a) Use mathematical knowledge to describe relationships between various physical quantities related to *vectors, periodic motion, angular motion, magnetism, basic digital electronics and sustainable energy sources*	**Group Discussion:** Guide students in groups to collaboratively analyse and explore the mathematical relationships between different physical quantities in engineering science **Demonstration:** Guide students through demonstrations to illustrate mathematical equations relating to vectors, periodic motion, angular motion, magnetism, basic digital electronics and sustainable energy sources **ICT-based learning:** Guide students in small groups to model equations and visualise relationships	Principles and phenomena in engineering science are adequately explained using mathematics	Physical models (e.g. force boards), simulation software, online resources, virtual labs, multimedia resources, and engineering science textbooks	12

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			between various physical quantities in engineering science using computer simulation and software tools			
2.0 Deploy Engineering Science theories and principles to solve problems in different contexts	2.1 Demonstrate knowledge and skills of Engineering Science in developing various engineering artefacts required by society	(a) Use knowledge and skills of *vectors, periodic motion, angular motion, magnetism, basic digital electronics and sustainable energy sources* in developing various engineering artefacts required by society	**Discussion:** Organise students in manageable groups to discuss the development of artefacts using knowledge and skills of Engineering Science **Field visit**: Organise field visits and guide students to exploring the development of artefacts related to magnetism, basic digital electronics and sustainable energy sources **Project-based approach:** Assign students a project to design and build practical engineering artefacts related to vectors, periodic motion, angular motion, magnetism, basic digital electronics and sustainable energy sources	Knowledge and skills of engineering science are correctly used in developing various engineering artefacts	3D printers, microcontrollers, breadboards, electronic components, oscilloscopes, simulation software, online resources, virtual labs, multimedia resources, and engineering science textbooks	13

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
	2.2 Demonstrate the use of knowledge and skills of Engineering Science in maintaining and repairing engineering artefacts	(a) Apply knowledge and skills of *vectors, periodic motion, angular motion, magnetism, basic digital electronics and sustainable energy sources* in maintaining and repairing engineering artefacts	**Group Discussion:** Guide conversations where students share their experiences, identify issues, and brainstorm solutions to common problems faced during maintenance and repair activities **Hands-on activities:** Guide students in small groups to use knowledge and skills of vectors, periodic motion, angular motion, magnetism, basic digital electronics and sustainable energy sources to maintain and repair different engineering artefacts **Experimentation:** Guide students through experimentation to use the knowledge and skills of engineering science to maintain and repair different engineering artefacts	Knowledge and skills of engineering science are effectively applied to maintain and repair engineering artefacts	Toolkits, components, maintenance manuals, diagnostic tools, simulation software, online resources, virtual labs, multimedia resources, and engineering science textbooks	18

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Form IV

Table 6: *Detailed Contents for Form IV*

Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
1.0 Apply knowledge and skills of Engineering Science in various contexts	0.1 Demonstrate mastery of basic concepts, principles and terminologies of Engineering Science	(a) Describe the concepts and principles of projectile motion *(projectile motion, equation of a projectile motion, projectile range and maximum height, time of flight of a projectile*)	**Brainstorming:** Guide students in groups to brainstorm on the concepts and principles of projectile motion **Hands-on activities:** Guide students in small groups through hands-on activities to investigate the relationship between various parameters related to projectile motion **Interactive simulation:** Guide students using interactive simulation to visualise and investigate the relationship between various parameters related to projectile motion **Circle the Sage:** Guide students through Circle the	The concepts and principles of projectile motion are described correctly	Balls, flip charts, marker pens, multimedia resources, simulation software, protractors, arrows, catapults, small sized stones, and engineering science textbooks	42

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			Sage to explore various applications of projectile motion			
		(b) Explore the concepts and principles of sound waves (*Waves, sound, speed of sound in air, properties of sound, echo, musical sounds, resonance*)	**Targeted questions:** Guide students through targeted questions to explore the concepts and principles of sound waves **Interactive simulation and animation:** Guide students through interactive simulation and animation to visualise the concepts and principles of sound waves **Hands-on activities:** Guide students in manageable groups through hands-on activities to explore the concepts of waves, sound, speed of sound in air, properties of sound, echo, musical sounds, resonance	The concepts and principles of sound waves are adequately explored	Musical instruments, whistles, turning forks, cans, models of the human eye and ear, table of audibility range, pieces of wood, musical notes, diatonic scales, membranes, sonometers, cathode ray oscilloscopes, microphones, flip charts, multimedia resources, simulation	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			Field visit: Arrange field visits and guide students to explore different concepts of sound waves		software, and engineering science textbooks	
		(c) Explain the concepts and principles of optics (*Introduction to light, reflection of light, mirrors, refraction of light, lenses, total internal reflection, optical fibres, dispersion of light, colour, optical instruments*)	**Brainstorming:** Guide students in small groups to brainstorm on the concepts and principles of light **Hands-on activities:** Guide students in manageable groups through hands-on activities to familiarise them with the concepts of reflection of light, mirrors, refraction of light, lenses, total internal reflection, optical fibres, dispersion of light, colour, optical instruments **Circle the Sage:** Guide students through Circle the Sage to explore various concepts and applications of light	The concepts and principles of optics are clearly explained	Sources of light, pieces of cardboard, white screens, tennis balls, oiled papers, ray boxes, glass blocks, papers, rulers, optical pins, thumb pins, plane mirrors, protractors, opaque materials, transparent materials, translucent materials, charts, electric bulbs, candles, matches,	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			ICT-based learning approach: Guide students through ICT learning approach to visualise different concepts and principles of light **Practical work:** Guide students through experimentation to investigate the relationship between different parameters in optics		kerosene lamps, shining plane surfaces, and engineering science textbooks	
		(d) Describe the concepts and principles of electromagnetism (*concept of electromagnetism, magnetic field due to current-carrying conductor, electromagnetic induction, induced electromotive*	**Brainstorming:** Guide students in manageable groups to brainstorm on the concepts and principles of electromagnetism **Hands-on activities:** Guide students in small groups through hands-on activities to explore the concepts and principles of the magnetic field due to current-carrying conductor,	The concepts and principles of electromagnetism are clearly described	Iron fillings, sources of electricity, compass needles, cardboards, different types of magnets, connecting wires, batteries, flip charts, marker pens, magnets,	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		force, mode of operation of AC, DC and transformers)	electromagnetic induction, induced electromotive force, mode of operation of AC, DC and transformers **Interactive simulation:** Guide students using interactive simulation to visualise and investigate the relationship between various parameters related to electromagnetism **Think-ink-pair-share:** Guide students through think-ink-pair-share to describe various concepts and principles of electromagnetism		iron nails, office pins, DC sources, ferrous materials, and engineering science textbooks	
	0.2 Demonstrate mastery of measurements and symbols in Engineering Science	(a) Relate measuring instruments used in engineering science to physical quantities corresponding to *projectile motion, sound*	**Think-ink-pair-share:** Guide students through think-ink-pair-share to relate various measuring instruments to physical quantities and symbols used in engineering science	Appropriate measuring instruments are correctly related to physical quantities	Various appropriate measuring instruments, online resources, virtual labs, multimedia	41

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		waves, optics and electromagnetism	**Hands-on activities:** Guide students through hands-on activities to relate measuring instruments with their corresponding physical quantities and their symbols in projectile motion, sound waves, optics and electromagnetism **Field visit:** Organise field visits and guide students explore advanced measuring instruments used in various engineering fields		resources, and engineering science textbooks	
		(b) Perform measurements in engineering science	**Demonstration:** Guide students to demonstrate the use of specific measuring instruments for various physical quantities related to various concepts in engineering science **Hands-on activities:** Guide students through	Measurements of physical quantities related to projectile motion, sound waves, optics and electromagnetism adequately performed	Various measuring instruments, online resources, virtual labs, multimedia resources, and engineering	

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			hands-on activities using measuring instruments to observe and record measurements in projectile motion, sound waves, optics and electromagnetism **Virtual lab:** Guide students through virtual lab to visualise and perform various measurements in engineering science		science textbooks	
	1.3 Use mathematics to explain principles and phenomena in Engineering Science	(a) Apply mathematical knowledge to describe the relationship between various physical quantities corresponding to different principles and phenomena (*Projectile*	**Group discussion:** Organise students in small groups and guide them to apply mathematical knowledge to describe relationships between various physical quantities corresponding to principles and phenomena in projectile motion, sound waves, optics, electromagnetism	Mathematical knowledge to describe relationships between various physical quantities corresponding to projectile motion, sound waves, optics, and electromagnetism	Online resources and engineering science books	20

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
		motion, sound waves, optics, electromagnetism)	**Problem-based approach**: Guide students to solve real-world problems using mathematical knowledge of the relationship between various physical quantities corresponding to different principles and phenomena in engineering science **Scenario:** Organise students in manageable groups and provide scenarios for them to investigate the relationships between various physical quantities corresponding to different principles and phenomena in engineering science	is correctly applied		
2.0 Deploy Engineering Science theories and principles to solve	2.1 Demonstrate knowledge and skills of Engineering Science in developing	(a) Apply the knowledge and skills of *sound waves, optics and electromagnetism* in developing	**Experimentation:** Guide students through experimentation to use knowledge and skills in sound waves, optics and electromagnetism to build	Knowledge and skills of sound waves, optics and electromagnetism correctly applied in developing	Online resources, multimedia resources, simulation software,	21

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
problems in different contexts	various engineering artefacts required by society	various engineering artefacts required by society	different engineering artefacts **Interactive Simulation:** Guide students to use interactive simulation to design and build different engineering artefacts **Project-based approach:** Guide students using knowledge and skills of engineering science to conduct a project for solving real-world engineering problems	various engineering artefacts	various instruments and components, and engineering science books	
	2.2 Demonstrate the use of knowledge and skills of Engineering Science in maintaining and repairing engineering artefacts	(a) Use the knowledge and skills of *sound waves, optics and electromagnetism* in maintaining and repairing various engineering artefacts	**Experimentation:** Guide students through experimentation to use the knowledge and skills of engineering science to maintain and repair different engineering artefacts **Hands-on activities:** Guide students in small	Knowledge and skills of sound waves, optics and electromagnetism correctly applied in the maintenance and repair of various engineering artefacts	Online resources, multimedia resources, simulation software, various instruments and components, and	16

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Main competencies	Specific competencies	Learning activities	Suggested teaching and learning methods	Assessment criteria	Suggested resources	Number of periods
			groups to use knowledge and skills of engineering science through hands-on activities to maintain and repair different engineering artefacts **ICT-based learning approach:** Guide students through the ICT learning approach to visualise and perform maintenance and repair of engineering artefacts		engineering science books	

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