MATHEMATICS SYLLABUS FOR TTCs

OPTION: SCIENCE AND MATHEMATICS EDUCATION

YEAR 1, 2 & 3

FOREWORD

Rwanda Education Board is honoured to avail the Mathematics Syllabus for Teacher Training Colleges (TTCs) in the SME option. This document serves as official guide to teaching and learning of Mathematics in TTCs, Pre-primary and Primary education.

The Rwandan education philosophy is to ensure that young people at every level of education achieve their full potential in terms of relevant knowledge, skills and appropriate attitudes that prepare them to be well integrated in society and exploit employment opportunities.

The ambition to develop a knowledge-based society and the growth of regional and global competition in the labor market has necessitated the shift from knowledge to competence based curriculum in TTCs. The TTC curriculum was revised to align it to the Competence-Based Curriculum for basic education to prepare teachers who are competent and confident to implement CBC in pre-primary and primary education. The rationale of the changes is to ensure that TTC leavers are qualified for job opportunities and further studies in Higher Education in different programs under education career advancement.

I wish to sincerely express my appreciation to the people who contributed towards the development of this syllabus, particularly, Consultants, REB staff, UR-CE Lecturers, TTC Tutors, Teachers from general education and experts from Local and international Organizations for their technical support. A word of gratitude goes to the Head Teachers and TTCs principals who availed their staff for various revision activities.

Special appreciation goes to the Development Partners such as UNICEF, USAID/Soma Umenye, Save the Children and Right To Play for their financial support.

Dr. NDAYAMBAJE Irénée

Director General REB.

ACKNOWLEDGEMENT

I wish to sincerely express my special appreciation to the people who played a major role in development of Mathematics syllabus in LE option. It would not have been successful without the support from different education stakeholders. My thanks first go to the leadership of UR-CE who started the review of the TTC curriculum in 2015.

I wish also to thank Rwanda Education Board (REB) leadership who continued and supervised the curriculum review process. I wish to extend my appreciation to Consultants, REB staff, Lecturers from UR-CE, TTC principals, TTC Directors of Studies deputy principals, tutors, teachers from secondary general Education and whose efforts during the revision process were much valuable.

Special thanks go to UNICEF who funded the development, designing finalization and printing of this syllabus.

I owe gratitude to different education partners more especially USAID-Soma Umenye, Save the Children, Right To Play, Help a Child, Aegis Trust,Humanity and Inclusion, Flemish Association for Development Cooperation and Technical Assistance (VVOB), Voluntary Service Overseas (VSO), Teach Rwanda and IEE for their technical support

Joan Murungi,

Head of **Curriculum Teaching and Learning Resources Department/REB**

TABLE OF CONTENTS

1. GENERAL INTRODUCTION

1.1. RWANDA EDUCATION SECTOR OBJECTIVES

The Education Sector objectives are the reference point for the inclusion of education issues into other Rwandan policy documents. These objectives are aligned with those recommended in the Eastern African Curriculum Framework proposals. The Government of Rwanda through law number 36/2018 of 29th June, 2018, determining the organization of education, revised the objectives of the sector. They are to:

1. Provide Rwandans with adequate skills at all levels of general, professional as well as technical and vocational education;
2. Offer quality courses and education at all levels;
3. Promote science, technology and research in order to equip many Rwandans with capacity to speed up national development;
4. Promote the culture of peace, tolerance, justice, respect for human rights, solidarity, democracy and that of avoiding any form of discrimination or favoritism;
5. Provide each Rwandan with an integrated education based on ethical values, science and social welfare and directed towards building a nation to ensure its sustainable development.
6. Install into Rwandans the love of a job well done, the value of hard work, punctuality and promotion of competence.
7. Train Rwandans to have freedom of thought, be innovative, have abilities to acquire and be analytical towards other people's opinions and to communicate his or her own ideas, to be patriotic and encourage him or her to be updated on the situation prevailing elsewhere;
8. Eliminate all grounds and obstacles that hinder the development of girls and women education as well as of any other groups that need special attention.

These objectives and associated strategies are the backbone for developments in education including the curriculum and assessment policy and the curriculum framework.

1.2. LEVEL COMPETENCES OF PRE-PRIMARY AND PRIMARY TEACHER EDUCATION IN THE REPUBLIC OF RWANDA

As stated earlier, Pre-primary and Primary Teacher Education is under the responsibility of Rwanda Education Board. The following are the competences of Teacher Education. By the time a student teacher is exiting the college after three years he or she should:

- be a qualified teacher who can compete not only locally but regionally and internationally;
- have professional ethics and develop an inquiring mind for innovative education;
- be prepared adequately for efficiency in education, administration, management, evaluation and measurement;
- be competent, reliable, honest and responsible;
- be equipped with potentials that enable him/her to explore the learners' abilities and interests;
- be able to develop the child's ability in critical thinking, free expression and ideas.

1.3. BACKGROUND TO CURRICULUM REVIEW

The Mathematics syllabus is developed for TTC student-teachers in the option of Science and Mathematics Education where Mathematics is a core subject.

The motive of reviewing the syllabus was to ensure that the syllabus is responsive to the needs of the student-teacher and to shift from objective and knowledge-based learning to competence-based learning. Another reason was to align the draft TTC curriculum to the CBC in general education. Emphasis in the review was put more on skills and competences as well as the coherence within the existing content by drawing on the previous syllabus and benchmarking with syllabi elsewhere with best practices.

The Mathematics syllabus guides the interaction between the tutor and student -teachers in the learning processes and highlights the competences a student teacher should acquire during and at the end of each unit of learning. Student- teachers will have the opportunity to apply Mathematics in different contexts, and see its importance in daily life. Tutors help the student- teachers appreciate the relevance and benefits for studying Mathematics from pre-primary /primary to tertiary levels.

The learning of student teacher is influenced by many factors such as curriculum relevancy, necessary and sufficient pedagogical approach by tutors, assessment strategies and sufficient instructional materials. With review of the Mathematics syllabus, these factors have been aligned with the competence-based curriculum for general education. This will lead to having qualified and competent teachers who are ready to implement the competence based curriculum for pre/primary education and perform well in higher education or any fields that require some knowledge of mathematics. This implies equipping student teachers with relevant knowledge, skills, attitude and values necessary to make them competitive on local, regional and global job market. This revised syllabus will allow future teachers to contribute to the development of equity and quality education at pre/primary levels and then it will enable student teachers to go for further studies.

1.4. RATIONALE OF TEACHING AND LEARNING MATHEMATICS

Mathematics subject in the option of Science and Mathematics Education (SME) is designed to provide to students mathematical concepts related to abstraction, modelling and logic, counting and calculation, measurement and the systematic study of functions. Concepts related to statistics, basics of arithmetic, functions, equations and calculus which are applicable in solving real life problems were also provided.

The syllabus concentrates on mathematical concepts that are useful tools for a student-teacher who intends to: teach in primary school, collaborate with others to solve real life problems in knowledge based economy society and undertake further studies at higher education. Topics were chosen to help the student-teacher perform well every Mathematics lessons of secondary education and find that mathematical knowledge is an essential tool for learning other subjects such as natural sciences, engineering, medicine, finance and social sciences. The content of this syllabus will help student teacher to enhance critical thinking and problem solving skills and enable him/her to be systematic, creative and self-confident. Student -teachers will be equipped with knowledge, skills, values and attitudes necessary to succeed in an era of rapid technological growth and socio-economic development as well as in effective teaching of Mathematics in Primary Education or pursuing tertiary education.

1.4.1. MATHEMATICS AND SOCIETY

Mathematics plays an important role in society through abstraction and logic, counting, manipulation, calculation, measurement, cutting, classifying, systematic study of shapes and motion. It is also used in natural sciences, engineering, medicine, finance and social sciences. The applied Mathematics like statistics and probability play an important role in game theory, in the national census process, in scientific research, etc. In addition, some crosscutting issues such as financial awareness are incorporated into some of the Mathematics units to improve social and economic welfare of Rwandan society.

Mathematics is key to the Rwandan education ambition of developing a knowledge-based and technology-led economy since it provides to student teachers all required knowledge and skills to be used in different learning areas. Therefore, Mathematics is an important tool in supporting other subjects. This TTC Mathematics syllabus is intended to address gaps in the current Mathematics syllabus which lacks adequate and appropriate knowledge, skills, attitude and values.

1.4.2. MATHEMATICS AND STUDENT TEACHERS

Student- teachers need enough basic mathematical competences to be effective members of Rwandan society including the ability to estimate, analyze, interpret statistics, assess probabilities, and read the commonly used mathematical representations and graphs. Statistics and probability play an important role in game theory, in the national census process, in scientific research while Trigonometry theories play a big role in construction and air navigation. Therefore, Mathematics equips student teachers with knowledge, skills and attitudes necessary to enable them to succeed in an era of rapid technological growth and socio-economic development. Mastery of basic Mathematical ideas and calculations makes student teachers being confident in problem solving. It enables the student teachers to be systematic, creative and self-confident in using mathematical language and techniques to reason; think critically; develop imagination, initiative and flexibility of mind. In this regard, learning of Mathematics needs to include practical problem-solving activities with opportunities for student teachers to plan their own investigations in order to develop their mathematical competences and confidence.

As new technologies have had a dramatic impact on all aspects of life, wherever possible in Mathematics, student- teachers should gain experience of a range of ICT equipment and applications.

1.5. PROFESSIONAL STANDARDS AND COMPETENCES

1.5.1. COMPETENCES

Competence is defined as the ability to perform a particular task successfully resulting from having gained an appropriate combination of knowledge, skills, attitudes and values. The present syllabus gives the opportunity to student teachers to develop different broad Mathematics competences as well as the generic competences.

Broad subject competences are highlighted and broken into key competences for each year, these are further broken into key unit competences which are finally split into learning objectives knowledge, skills, attitudes and values) in every learning unit.

Taking into account the rationale behind the overall TTC curriculum review as well as the parameters and constraints of the local context, student- teachers will be equipped with professional standards and generic competences.

For student teachers, professional standards are acquired through generic competences and professional practices that are emphasized and reflected in the learning process. The Mathematics tutors will ensure that student -teachers are exposed to tasks that help them acquire these competences.

1.5.2. TEACHING PROFESSIONAL STANDARDS

These refer to the characteristics that all teachers globally should have. All teachers in Rwanda should have the six characteristics listed below:

i) The teacher has knowledge of CBC and how to implement it.

The teacher has understanding of CBC and how it works. He/she has knowledge of basic and generic competences and is able to integrate the cross cutting issues within and across subject area.

ii) The teacher as an educator

The professional teacher enhances and stimulates cognitive, social-emotional, physical and moral development of the children. She/he therefore has a thorough understanding of the child's background, interests, motivations and problems and can adjust her/his actions and the learning environment to the different needs of the student teachers. A competent educator is a role model, showing desired behavior and values. She/he guides and coaches her/his student teachers to become social, self-confident, independent, responsible, open-minded and innovative people and act like a role model. In order to be educator, the student teacher must be supported in developing cooperation, inter personal and life skills.

iii) The teacher as a subject expert

The professional Mathematics teacher stimulates the student's critical thinking, problem solving and creativity. She/he uses teaching/learning methods and techniques that are appropriate to Mathematics in primary education; she/he applies Mathematics content, plan lessons integrating play-based strategies in teaching/learning. The teacher in primary education has a thorough Mathematics knowledge that enables him/her to develop the teaching/learning materials, lesson planning, to deliver the lesson and connect with her/his daily life activities in primary education using correctly the language of instruction. The teacher as Mathematics expert in upper primary education stimulates English in the teaching/learning process by considering the transition from Kinyarwanda to English as medium of Instruction in upper primary.

The teacher as subject expert knows and uses appropriate Mathematics methods/techniques to assess students and give constructive feedback to the whole class. The teacher is able to link the content of Mathematics with other subjects and connect it with real life situations. This enables student teacher to acquire critical and problem solving skills as well as the mathematical concepts and skills enabling him/her to pursue tertiary education easily.

iv) The teacher as a communicator

The professional teacher displays a good example in his/her way of expressing him/herself, stimulates and enhances positive and clear communication between him/herself and the students, between the students, college community and the wider society. A good communicator is open-minded and respects diversity within and around the college. This requires teacher to communicate in official languages.

v) The teacher as a guide and an organizer

The professional teacher facilitates the holistic development of all student teachers, taking into account the differences between them. S/he ensures that the learning environment (class, playground, etc.) is well maintained and conducive for expected learning outcomes. This requires a teacher to be equipped with managerial skills.

vi) The teacher as an innovator, researcher and reflective practitioner

The professional teacher looks for ways to improve his/her teaching, and the wellbeing and results of his/her student teachers. S/he is a reflective practitioner and knows how to perform small-scale reflective action.

The acquisition of such skills will require teacher to update knowledge and skills with minimum external support and to cope with evolution of knowledge advances for personal fulfilment in areas that need improvement and development, thus becoming a lifelong learner.

1.5.3. BROAD MATHEMATICS COMPETENCES

At the end of the three years the student teacher should be able to:

- Work in systematic way to develop clear, logical, coherent and creative reasoning and imagination;
- Express clearly, comprehensibly, correctly and precisely in verbal and/or in written form, all the reasons and calculations leading to the required result whenever finding a solution to any given exercise;
- Apply mathematical concepts, principles and processes in real life situations/ experiences or problem solving as well as applying them to other subjects.
- Use ICT tools (such as calculators and mathematical software) in teaching and learning Mathematics in sense of research and creativity to explore Mathematical concepts and facts;

- Use the acquired Mathematical knowledge and skills to teach at primary Education or pursue further studies;
- Describe, explain, present, analyze, interpret, draw logical conclusions, and make predictions and decisions on scientific data.

1.5.4. MATHEMATICS AND DEVELOPING COMPETENCES

The national policy documents based on national aspirations identify some 'basic competences' alongside the 'generic competences" that will develop higher order thinking skills and help student teacher learn subject content and promote application of acquired knowledge and skills.

Through observations, constructions, using symbols, applying and generalizing mathematical ideas and presentation of information during the learning process, the student teachers will not only develop deductive and inductive skills but also acquire cooperation and communication, critical thinking and problem solving skills. This will be realized when student-teachers make presentations leading to inferences and conclusions at the end of learning unit. This will be achieved through student teachers' group work and cooperative learning which in turn will promote interpersonal relations and teamwork.

The acquired knowledge in learning Mathematics should develop a responsible citizen who adapts to scientific reasoning and attitudes and develops confidence in reasoning independently. The student-teacher should show concern of individual attitudes, environmental protection and comply with the scientific method of reasoning. The scientific method should be applied with the necessary rigor, intellectual honesty to promote critical thinking while systematically pursuing the line of thought.

2. PEDAGOGICAL APPROACH

The change to a competence-based curriculum is about transforming learning, ensuring that learning is deep, enjoyable and habit-forming.

2.1. ROLE OF THE STUDENT TEACHER

In the competence-based syllabus, the student teacher is the principal actor of his/her education. He/she is not an empty bottle to fill. Taking into account the initial capacities and abilities of the student teacher, the syllabus suggests under each unit, some activities of the student teacher and they all reflect active participation of the student teacher in the learning process.

The teaching and learning processes will be tailored towards creating a student's friendly environment basing on the capabilities, needs, experience and interests.

The following are some of the roles or the expectations from the student teachers:

- Student teachers construct the knowledge either individually or in groups in an active way. From the learning theory, student teachers move in their understanding from concrete through pictorial to abstract. Therefore, the opportunities should be given to student teachers to manipulate concrete objects and to use models.
- Student teachers are encouraged to use hand-held calculator. This stimulates Mathematics as it is really used, both on job and in scientific applications. Frequent use of calculators can enhance student teachers' understanding and mastering of arithmetic.
- Student teachers work on one competence at a time to form concrete units with specific learning objectives (knowledge, skills and attitude).
- Student teachers will be encouraged to do research and present their findings through group work activities.
- A student teacher is cooperative: student teachers work in heterogeneous groups to increase tolerance and understanding.
- Student teachers are responsible for their own participation and ensure the effectiveness of their work.

2.2. ROLE OF THE TUTOR

In the competence-based syllabus, the tutor is a facilitator, organizer, advisor, a conflict solver, ...

The specific duties of the tutor in a competence-based approach are the following, Tutor is:

- A facilitator, his/her role is to provide opportunities for student teachers to meet problems that interest and challenge them and that, with appropriate effort, they can solve. This requires an elaborated preparation to plan the activities, the place they will be carried, the required assistance;
- An organizer: his/her role is to organize the student- teachers in the classroom or outside and engage them through participatory and interactive methods through the learning processes as individuals, in pairs or in groups. To ensure that the learning is personalized, active and participative, co-operative the teacher/tutor must identify the needs of the student teachers, the nature of the learning to be done, and the means to shape learning experiences accordingly;
- An advisor: he/she provides counseling and guidance for student-teachers in need. He/she comforts and encourages student teachers by valuing their contributions in the class activities;

- A conflict-solver: most of the activities are performed in groups. The members of a group may have problems such as attribution of tasks; they should find useful and constructive the intervention of the teacher as a unifying element.
- Asked for help only when the whole group agrees to ask a question
- Ethical and preaches by examples by being impartial, by being a role-model, by caring for individual needs, especially for slow student teachers and those with physical impairments, through a special assistance by providing remedial activities or reinforcement activities. One should notice that this list is not exhaustive.

2.3. SPECIAL NEEDS EDUCATION AND INCLUSIVE APPROACH

All Rwandans have the right to access education regardless of their different needs. The underpinnings of this provision would naturally hold that all citizens benefit from the same menu of educational programs. The possibility of this assumption is the focus of special needs education. The critical issue is that we have student teachers who are totally different in their ways of living and learning as opposed to the majority. The difference can either be emotional, physical, sensory and intellectual learning challenged.

These student teachers equally have the right to benefit from the free and compulsory basic education in the nearby ordinary/mainstream colleges. Therefore, the college's role is to enroll them and also set strategies to provide relevant education to them. The tutor therefore is requested to consider each student teacher's needs during teaching and learning process. Assessment strategies and conditions should also be standardized to the needs of these student teachers. Detailed guidance for each category of student teachers with special education needs is provided for in the guidance for teachers. The Mathematics tutor is advised to work closely with the tutor of special need education to provide appropriate support to any identified student -teacher's needs.

2.4. SKILLS LABORATORY IN MATHEMATICS

Mathematics is a practical subject in which student teachers can learn and explore various mathematical concepts and how to teach them using a variety of practical activities and materials. The skill lab in teaching practices can be done through the Teaching Resources Center existing in TTCs. The use of skills Laboratory in Mathematics teaching helps to integrate pedagogical theory and practical work in mathematics teaching and learning where student teachers develop competences for teaching and apply acquired skills at school level before going to teach learners.

Skills lab ensures teachers are accountable to completing all the learning activities and projects as outlined in the syllabus.

The basic characteristics of Skills Lab are:

- Students work in small groups (manageable teams)
- Assessment takes place through portfolio activities
- Students talk more than teachers (10% tutor talk time and the rest is for the students)
- Students receive constructive feedback on their work (Tutor gives quality feedback on student presentations).
- Skills lab consists of three components: build, practice and present.

Skills Lab in Mathematics teaching makes a moment in which the student teacher is active, discusses and argues her/his own choices, builds meanings, learns to collect data and to compare them with the models.

This learning must be done through practice, discussion, exploration, development of thinking about the practice and way for building knowledge into learners.

Practical activities to be done in the mathematics teaching lab will provide a controlled setting for making various experiments in mathematics teaching methods. It has advantageous of providing self-evaluation of one's performance. It will allow student teachers to practice any one skill on their own, and then combine it with others when it has been mastered.

Role of the tutor is to prepare practical activities, to set groups of students and assign them their roles and responsibilities.

The tutor has to explore students' works: to analyze how and why the same final answer or product can be the result of different process or constructions followed by students, to mark and provide feedback and remediation to students.

He/she uses appraisal guide to rate the lesson taught by students and then discuss it with them for more improvement.

Role of the student teacher is to read carefully instructions related to the activity, apply the mathematics process in doing practical activity as provided, conduct micro-teaching, observe lessons taught by the colleagues during microteaching and give them the feedback.

The student teacher must have time to practice all the teaching skills before going to teach at primary school.

These skills include: lesson and unit planning, questioning, reinforcement, probing, explaining, stimulus variation, introducing a lesson, illustrating with examples, using a chalk board, demonstration, silence and non-verbal cues, using audio-visual aids, production of teaching and learning materials and the skill of improvisation.

Therefore, when doing practical activities in the Mathematics teaching, students build the knowledge and understanding, practice acquired skills, produce teaching materials, discuss teaching techniques and communicate the findings from their researches to colleagues and to the tutor. The following are tasks for the students: group building, communicate and discuss, argue correctly, understand views and arguments of others, get to know the community and learners, carry out exploration and needs assessment, coaching and guidance on managing challenging situations, investigation, task setting and question formulation, guessing problems and work collaboratively with peers to solve them, self-development on observation and inquiry, use scientific method and scientific research, develop a sense of taking responsibility for one's own learning, represent and build models of relationships among objects and events.

In this regard, mathematics teaching skills lab activities are the time when student teachers combine the teaching related competencies acquired to make learning more practical. Thus, in every unit, this syllabus suggests practical and learning activities that the tutor may adapt and give to students to ensure practical applications of the competencies acquired.

3. ASSESSMENT APPROACH

Assessment is the process of evaluating the teaching and learning processes through collecting and interpreting evidence of individual student teacher's progress in learning and to make a judgment about a student teacher's achievements measured against defined standards. Assessment is an integral part of the teaching learning process. In the new competence-based curriculum assessment must also be competence-based; whereby a student teacher is given a complex situation related to his/her everyday life and asked to try to overcome the situation by applying what he/she learned.

3.1. TYPES OF ASSESSMENTS

There are two major types of assessment namely formative and summative assessments. Any form of assessment should reflect the three domains of learning, which are Cognitive, Psychomotor and Affective.

- Knowledge and understanding: Does the student- teacher demonstrate an understanding of the Mathematics concept? Has the student- teacher mastered the Mathematics concepts? Indicators: correctness of answers, coherence of ideas, logical reasoning, use correctly mathematical symbols and concepts, etc.
- Practical skills: How does the student-teacher perform on aptitude and practical tests? Indicators: accuracy, using appropriate methods, quality product, speed and efficiency, coherence.

- Attitude and values: How does the student-teacher respond to a task or a situation? What is the student-teacher's behavior? How the student-teacher persists on solving a given problem?

3.1.1. FORMATIVE ASSESSMENT

Formative assessment helps to check the efficiency of the process of learning. It is done within the teaching/learning process.

Continuous assessment involves formal and informal methods used by schools to check whether learning is taking place. When a tutor is planning his/her lesson, he/she should establish criteria for performance and behavior changes at the beginning of a lesson. Then, at the end of every unit, the tutor should ensure that all the student teachers have mastered the stated key unit competences basing on the criteria stated, before going to the next unit. The tutor will assess how well each student teacher masters both the subject and the generic competences described in the syllabus as well as the professional practices. From this, the tutor will gain a picture of the all-round progress of the student teacher. The tutor will use one or a combination of the following techniques: observation, pen and paper, and oral questioning.

3.1.2. SUMMATIVE ASSESSMENTS

When assessment is used to record a judgment of a competence development or performance of the student teacher, it serves a summative purpose. Summative assessment gives a picture of a student teacher's competence or progress at any specific moment. The main purpose of summative assessment is to evaluate whether competences have been achieved and to use the results for ranking or grading of student teachers, for deciding on progression, for selection into the next level of education and for certification. This assessment should have an integrative aspect whereby a student must be able to show mastery of all competences. It can be internal College based assessment or external assessment in the form of national examinations. College based summative assessment should take place once at the end of each term and once at the end of the year. College summative assessment average scores for the subjects which are examined at the national level will be weighted and included in the final national examinations grade. For the subjects that are not examined externally, the grade should be part of the continuous assessment reflected in the student's transcript.

3.2. RECORD KEEPING

This is gathering facts and evidence from assessment instruments and using them to judge the student's performance by assigning an indicator against the set criteria or standard. Whatever assessment procedures used generate data in the form of scores which will be carefully be recorded and stored in a portfolio. The latter is used in deciding remedial actions, alternative instructional strategy and as well as feed back to the student teacher. The records also are important to parents to check the learning progress and to advice accordingly. Finally, the records are very essential to the final assessment of professional practice of the student teacher at the end of the college.

This portfolio is a folder (or binder or even a digital collection) containing the student teacher's work as well as the student teacher's evaluation of the strengths and weaknesses of the work. Portfolios reflect not only work produced (such as papers and assignments), but also it is a record of the activities undertaken over time as part of student learning. Besides, it will serve as a verification tool for each student teacher that he/she attended the whole learning before he/she undergoes the summative assessment for the subject.

3.3. ITEM WRITING IN SUMMATIVE ASSESSMENT

Before developing a question paper, a plan or specification of what is to be tested or examined must be elaborated to show the units or topics to be tested on, the number of questions in each level of revised Bloom's taxonomy and the marks allocation for each question. In a competence-based curriculum, questions from higher levels of Bloom's taxonomy should be given more weight than those from knowledge and comprehension level.

Before developing a question paper, the item writer must ensure that the test or examination questions are tailored towards competence based assessment by doing the following:

- Identify topic areas to be tested on from the subject syllabus.
- Outline subject-matter content to be considered as the basis for the test.
- Identify learning outcomes to be measured by the test.
- Prepare a table of specifications.
- Ensure that the verbs used in the formulation of questions do not require memorization or recall answers only but also testing broad, subject and generic competences as stated in the syllabus.

4. RESOURCES

4.1. MATERIALS NEEDED FOR IMPLEMENTATION

The following list shows the main materials/equipments needed in the learning and teaching process:

- Materials to encourage group work activities and presentations: Computers (Desktops & laptops) and projectors; Manila papers and markers, textbooks and handouts
- Materials for drawing & measuring geometrical figures/shapes and graphs: Geometric instruments, ICT tools such as Geogebra, Microsoft student ENCARTA, ...
- Materials for enhancing research skills: Textbooks and internet (the list of the textbooks to consult is given in the reference at the end of the syllabus and those books can be found in printed or digital copies).
- Materials to encourage the development of Mathematical models: scientific calculators, Geogebra Software, Math type, Matlab, different math mobile applications etc

The technology used in teaching and learning of Mathematics has to be regarded as tools to enhance the teaching and learning process and not to replace tutors.

4.2. HUMAN RESOURCE

The effective implementation of this curriculum needs a joint collaboration of educators at all levels. Given the material requirements, tutors are expected to accomplish their noble role as stated above. The staff in charge of education at District and sector level should ensure overall support to TTCs for a successful implementation. On the other hand, TTC principles and TTC deputy principals are required to make a close follow-up and assess the teaching and learning of this subject due to their profiles in the schools. These combined efforts will ensure bright future careers and lives for student teachers as well as the contemporary development of the country.

In a special way, the tutor of Mathematics at TTC level should have a firm understanding of mathematical concepts and pedagogical content of teaching Mathematics at primary and secondary levels. He/she should be qualified in Mathematics and have a firm ethical conduct. The tutor should possess the qualities of a good facilitator, organizer, problem solver, listener and adviser. He/she is required to have basic skills and competence of guidance and counselling because students may come to him or her for advice.

5. SYLLABUS UNITS

5.1. MATHEMATICS UNITS FOR YEAR 1

5.1.1. KEY COMPETENCES AT THE END OF YEAR 1

After completion of year one Science Mathematics Education, the Mathematics syllabuses will enable the student-teacher to:

1. Classify sets of numbers into naturals, integers, rational and irrationals basing on their properties and solve related problems.
2. Solve problems that involve the sets of numbers using Venn diagrams and set operations
3. Apply ratios and proportions properties to solve related problems including problems in real life involving multiplier proportion change..
4. Perform operations on polynomials and solve related problems.
5. Use Mathematical logic as a tool of reasoning and argumentation in daily life situations.
6. Solve algebraically or graphically problems involving linear and quadratic equations, parametric equations or inequalities.
7. Solve problems related to powers, indices, radical and common logarithms.
8. Determine an equation of a line and a circle.
9. Apply trigonometric concepts in solving problems on triangles.
10. Extend understanding, analysis and interpretation of data arising from problems and questions in daily life to standard deviation.
11. Use concepts and definitions of functions to determine the domain of polynomial functions and represent them graphically in simple cases.(plotting linear and quadratic functions).

5.1.2 SYLLABUS UNITS FOR YEAR ONE

<table>
<tr><td colspan="3">Subject: Mathematics</td><td>YEAR: One</td><td>Option: SME</td></tr>
<tr><td colspan="3">Topic Area: ARITHMETIC</td><td colspan="2">Sub Topic: SETS</td></tr>
<tr><td colspan="4">UNIT 1: SET OF NUMBERS</td><td>No. of periods:14</td></tr>
<tr><td colspan="5">Key unit competence: To be able to Classify numbers into naturals, integers, rational and irrationals.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr>
<td>– Identify sets of numbers (natural, integers, rational and real) and relationship between them.
– -Illustrate different sets of numbers on number line.
– Show that irrational numbers cannot be expressed exactly as decimal</td>
<td>– Carry out mathematical operations on set of numbers
– Work systematically to determine the operation properties of sets numbers.
– Determine the hierarchy of sets on numbers and explain its relationship with operations.</td>
<td>– Appreciate that rational numbers can be represented exactly as a fraction or a decimal which may terminate or occur.
– Appreciate that the number line is incomplete without the irrational numbers which cannot be written exactly as a decimal</td>
<td>Classification of numbers
– Natural numbers
• Definition
• Sub sets of natural numbers (Counting numbers, even numbers, odd numbers, prime numbers, …)
• Operations and properties on natural numbers
– Integers
• Definition
• Sub sets of integers (positive integers and negative integers)
• Operations and properties on integers
– Rational
• Definitions (fractions, terminating decimal, repeating decimal…)</td>
<td>– In groups, different numbers written on manila papers, flash cards, student-teachers are given the tasks to classify them into natural, rational, irrational and integers.
– In groups, student teachers are asked to do word problems related to set of numbers and present their findings.</td>
</tr>
</table>

			• Operations and properties on rational numbers – Irrational • Definition • Operations and properties on natural numbers – Real numbers • Definition • Operations and properties on real numbers – Presentation of sets of numbers on number line	
Assessment criteria: Classify numbers into naturals, integers, rational and irrationals using properties				
Link to other subjects: Integrated science, General Science and Mathematics, EST, Mathematics for Primary.				
Resources: text books, manila papers calculators, papers.				

<table>
<tr><td colspan="3">Subject: Mathematics</td><td>YEAR: One</td><td>OPTION: SME</td></tr>
<tr><td colspan="3">Topic Area: ARITHMETIC</td><td colspan="2">Sub Topic: SETS</td></tr>
<tr><td colspan="4">Unit 2: SET THEORY</td><td>No. of periods: 12</td></tr>
<tr><td colspan="5">Key unit competence: Solve problems that involve Set operations using Venn diagram.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr><td>– Represent a mathematical problem using a Venn diagram</td><td>– Perform union, intersection, difference; and symmetrical difference on sets
– Use Venn diagram to represent a mathematical problem
– Interpret, model and solve a mathematical problem</td><td>– Develop clear, logical and coherent thinking skills in solving real life problem involving sets.
– Appreciate the importance of representing and solving a mathematical problem set using Venn diagrams</td><td>– Venn diagrams and operations on sets : union, intersection, difference, symmetrical difference
– Analysis , interpretation and presentation of a problem using Venn diagram
– Modeling and solving problems involving set operations with Venn diagram.</td><td>– In groups, student- teachers observe information given in the Venn diagram analyzes, interpret using set language and solve related problems.
– In groups, student-teachers are given learning situation involving set, discuss and present it using Venn diagram; form an equation and solve problems related to sets.</td></tr>
<tr><td colspan="5">Assessment criteria: Model and solve a mathematical problems related to sets using Venn diagrams</td></tr>
<tr><td colspan="5">Link to other subjects: subjects where classification in needed such as biology, geography, physics, financial educations.</td></tr>
<tr><td colspan="5">Resources: Manila papers, flash cards.</td></tr>
</table>

Subject: Mathematics			**YEAR: One**	**OPTION: SME**
Topic Area: ARITHMETIC			**Sub Topic:**	
UNIT 3: PROBLEM ON RATIOS AND PROPORTIONS				**No. of periods: 14**
Key unit competence: Apply ratios and proportions to solve related problems.				
Learning objectives			**Content**	**Teaching/ Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define ratio and proportion. – Express ratios in their simplest form. – Identify a direct and indirect proportion – Differentiate direct from indirect proportion.	– Compare quantities using proportions – Share quantities in a given proportion or ratio. – Apply ratio and unequal share to solve given problems. – Solve real life problems involving direct and indirect proportions using tables and graphs. – Interpret ratio and proportions in practical contexts.	– Appreciate the importance of multiplication when working with ratio and proportion	– Equal and unequal share – Ratio, Direct and indirect proportion. – Calculation of proportional change using multiplier. – Compound proportional change or continued proportions. – Problems involving direct and indirect proportions	– In groups, student teachers solve problems involving direct and indirect proportion, ratios and share adjust recipe amounts for different numbers of people – In pairs, match different representations of ratios and proportions including simplest form then presentation. – In groups, interpret and explain the ratio and proportion in maps and scale drawings/ models – In pairs, solve problems in practical contexts involving direct and indirect proportion using tables of values and graphs
Assessment criteria: Solve problem involving ratio and proportion in a variety of contexts.				
Link to other subjects: Subjects that require proportional reasoning such as integrated sciences, computers science, economics, personal finances.				
Resources: Calculators and digital materials such as computers, software, interactive multi-media content.				

<table>
<tr><td colspan="3">Subject: Mathematics</td><td>YEAR: One</td><td>Option : SME</td></tr>
<tr><td colspan="3">Topic Area: ALGEBRA</td><td colspan="2">Sub Topic: POLYNOMIALS</td></tr>
<tr><td colspan="4">UNIT 4: OPERATION ON POLYNOMIALS.</td><td>No. of periods: 14</td></tr>
<tr><td colspan="5">Key unit competence: Perform operations on polynomials and solve related problems.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr><td>– Define polynomial
– Classify polynomial by degree and number of terms.
– Recognize operation properties on polynomials
– Give common factor of algebraic expressions.</td><td>– Perform operation of polynomials
– Expand algebraic expression by removing brackets and collecting like terms.
– Carry out given operation on polynomials using properties
– Factorize a given algebraic expression using appropriate methods</td><td>– Appreciate the role of numerical value of polynomial and algebraic identities in simplifying mathematical expressions.
– Develop critical thinking and reasoning
– Ability to classify and follow orders to perform a given task.</td><td>– Degree of a polynomial
– Comparison of polynomials.
– Operations on polynomials and properties.
– Factorizing and expanding polynomials.</td><td>– Using hand-out, manila papers, flash cards; In groups' student teachers classify polynomials according to their degree or to the number of terms; Discuss and perform operations on polynomials, expand and factorize given mathematical expressions and make presentation to the whole class.</td></tr>
<tr><td colspan="5">Assessment criteria: Add and subtract polynomials of any degree, Multiply and divide polynomial of any degree by a binomial</td></tr>
<tr><td colspan="5">Link to other subjects: Integrated science, General Science and Mathematics, EST, Mathematics for Primary.</td></tr>
<tr><td colspan="5">Resources: textbook, papers, calculators, manila papers, flash card, hand out.</td></tr>
</table>

Subject: Mathematics			**YEAR: One**	**OPTION: SME**
Topic Area: ALGEBRA			**Sub Topic: POLYNOMIALS**	
UNIT 5: LINEAR AND QUADRATIC EQUATION/ INEQUALITIES				**No. of periods: 24**
Key unit competence: Solve algebraically or graphically linear, quadratic equations or inequalities.				
Learning objectives			**Content**	**Teaching/ Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– List and clarify the steps in modeling a problem by linear or quadratic equations and inequalities.	– Solve linear and quadratic equations or inequalities – Solve parametric equations and inequalities – Solve mathematical problems involving linear and quadratic equations	Appreciate the use of linear and quadratic equations in modelling and solving daily life mathematical problem.	– Linear and quadratic equations, equations reducible to quadratic – Linear and quadratic inequalities (algebraically and graphically) – Solving word problems involving linear or quadratic equations (problem involving supply and demand, linear motions, …) – Solving and discussing parametric equations	In groups, student teachers: – Discuss and use factorization or any other method to solve given quadratic equations and inequalities. – Model given mathematic problems using quadratic equations and solve them. – Discuss and solve a given equation reducible to quadratic equation by using any method (determinant , factorization or Synthetic division where applicable) – Find out steps of solving a given parametric equation and discuss the solutions.
Assessment criteria: Graphically or algebraically solve problems involving linear or quadratic equations/inequalities				
Link to other subjects: Subjects where polynomials are important such as integrated science.				
Resources: Textbook, manila papers, calculators, mathematical software like GeoGebra, mal math.				

Subject: Mathematics			YEAR : One		OPTION: SME
Topic Area: ALGEBRA			**Sub Topic: POLYNOMIALS**		
UNIT 6: PROBLEMS ON POWERS, INDICES ,RADICAL S AND COMMON LOGALITHMS					**No. of periods: 18**
Key unit competence: Solve problems related to powers, indices, radical and common logarithms.					
Learning objectives			**Content**	**Teaching/ Learning Activities**	
Knowledge and understanding	**Skills**	**Attitudes and values**			
– Define powers/ exponents or indices, radicals, and decimal logarithm – Identify the properties of powers/ exponents or indices, radicals, and decimal logarithm	– Simplify indices in radicals – Perform operations on indices and radicals – Transform a logarithmic expression to equivalent power or radical form and vice versa.	– Appreciate the importance and the use of properties of operations on powers or indices, radicals and common logarithms	– Powers and radicals • Definition of powers/ indices and radicals. • Properties of indices and radicals • Operations on indices and radicals – Decimal logarithm • Definition • Properties • operations	– In pairs, student teachers think themselves two numbers or more having different powers but the same base, multiply and divide them. Then draw conclusion. – Individually, student teachers simplify powers by rationalizing the denominators – In groups, express each of the given powers as the square root of a single number, discuss and reduce power to the simplest possible power form.	
Assessment criteria: Solve problems related to powers, indices, radical and common logarithms basing on properties.					
Link to other subjects: Integrated Science, Entrepreneurship, Social studies.					
Resources: Graph papers, manila papers, digital technology including Scientific calculators.					

<table>
<tr><td colspan="2">Subject: Mathematics</td><td colspan="2">YEAR: One</td><td>OPTION: SME</td></tr>
<tr><td colspan="3">Topic Area: ALGEBRA</td><td colspan="2">Sub Topic: MATHEMATICAL LOGIC</td></tr>
<tr><td colspan="4">UNIT 7: Propositional and predicate logic</td><td>No. of periods:18</td></tr>
<tr><td colspan="5">Key unit competence: Use Mathematical logic as a tool of reason and argumentation in daily situation.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr><td>– Give example of a logical statement or proposition.
– Draw the truth table of a proposition
– Convert into logical formula composite propositions and vice versa.
– Draw the truth table of a composite proposition.</td><td>– Use mathematical logic to infer conclusion from given proposition.
– Use correctly logical statements, propositions, connectives and quantifiers in daily life
– Show that a given logic statement is tautology or a contradiction</td><td>– Demonstrate the usefulness of mathematical logic in daily life.
– Develop and show mutual respect.</td><td>– Logical statement or proposition
– Propositional logic
• Logical connectives
• Composite proposition
• Truth tables
• Tautologies
• Contradictions
– Quantifier
• Existential
• Universal</td><td>– In groups, student teachers are given scenarios to be discussed and deduce if given statement is a proposition or not.
– In pairs, student teachers perform research about propositional logic, predicates, and quantifier and present their findings to the whole class.</td></tr>
<tr><td colspan="5">Assessment criteria: Use correctly logical connectives, quantifiers in logical statement and draw truth table of a simple or composite proposition.</td></tr>
<tr><td colspan="5">Link to other subjects: integrated Science</td></tr>
<tr><td colspan="5">Resources: Text book, hound out, Manila papers, ICT tools.</td></tr>
</table>

<table>
<tr><td colspan="3">Subject: Mathematics</td><td colspan="1">YEAR: One</td><td>Option: SME</td></tr>
<tr><td colspan="3">Topic Area: TRIGONOMETRY</td><td colspan="2">Sub Topic: TRIGONOMETRIC CIRCLE, RATIOS AND IDENTITIES</td></tr>
<tr><td colspan="4">UNIT 8: APPLICATION OF TRIGONOMETRIC CONCEPTS IN SOLVING PROBLEMS</td><td>No. of periods: 36</td></tr>
<tr><td colspan="5">Key unit competence: Apply trigonometric concepts in solving problems on triangles and real life situation.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr><td>– Convert radians to degree and vice versa.
– Define sine, cosine, and tangent (cosecant, secant and cotangent) of any angle
– Know trigonometric ratios of special angles (30^0, 45^0, 60^0).
– Differentiate between complementary angles, supplementary angles and co-terminal angles</td><td>– Use trigonometry, including the sine and cosine rules, to solve problems involving triangles</td><td>– Appreciate the relationship between the trigonometric values for different angles
– Appreciate the use of trigonometry in daily life situation</td><td>Trigonometric concepts:
– Angles measurement
• Radian
• Degree
– Units conversion
– Unit circle
– Trigonometric ratios
• Definition
• Trigonometric ratio of special angles
– Trigonometric identities
• Reduction to functions of positive acute angles
• Triangles and Applications (Bearing, Air Navigation, Inclined plane).</td><td>In groups student teachers:
– Using protractor and compass, construct special angles (30^0, 45^0, 60^0) on a unit circle, then determine the cosine and sine of each angle and deduce that each value is less than 1
– Use unit circle to establish relationship between trigonometric ratios and angles in different quadrants (complementary angles, supplementary angles , opposite angles,…)
– Make a research on trigonometric identities and present findings to the whole class.
– Make a research on the applications of trigonometry and present findings to the whole class.</td></tr>
<tr><td colspan="5">Assessment criteria: Solve correctly a triangle based on trigonometric ratios and identities.</td></tr>
<tr><td colspan="5">Link to other subjects: Integrated sciences, social studies.</td></tr>
<tr><td colspan="5">Resources: Geometric instruments (ruler, T-square, compass), graph paper, digital technology including calculators</td></tr>
</table>

Subject: Mathematics			YEAR: One	OPTION: SME
Topic Area: GEOMETRY			**Sub Topic: EUCLIDIAN PLANE GEOMETRY**	
UNIT 9: POINTS, STRAIGHT LINES AND CIRCLE IN 2D				**No. of periods: 24**
Key unit competence: Determine an equation of a line and a circle				
Learning objectives			**Content** **Knowledge and understanding**	**Teaching/ Learning Activities** **Skills**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define the coordinate of a point in 2D. – Define a straight line and circle.	– Calculate the distance between two points and mid-Point of a segment in 2D. – Determine equations of a straight line. – Apply knowledge to find the center, radius, and diameter from the equation of a circle.	– Appreciate that a point is a fixed position in a plane. – Be accurate in representations and calculations. – Manifest a team spirit and think critically in problem solving related to the position of straight lines in 2D.	– Location of a point in 2D – Mid-point and Distance between two points in 2D – Determination of equation of a straight line (vector equation, parametric equation, Cartesian equation) given: • 2 points. • Direction vector • Gradient. – Determination of equation of a circle (Cartesian and parametric form)	– In pairs, Student teachers present on graph paper some chosen points, lines and/ or circles and determine the parametric and Cartesian equations of a line or a circle.
Assessment criteria: Determine the equation of straight lines and circles in 2D.				
Link to other subjects: Integrated Science, Entrepreneurship, Social studies.				
Resources: Graph papers, manila papers, digital technology including calculators, mathematical set(ruler, T-square, protractor)				

<table>
<tr><td colspan="3">Subject: Mathematics</td><td>YEAR: One</td><td>Option: SME</td></tr>
<tr><td colspan="3">Topic Area: STATISTICS AND PROBABILITY</td><td colspan="2">Sub Topic: DESCRIPTIVE STATISTICS.</td></tr>
<tr><td colspan="4">UNIT 10: PARAMETERS OF CENTRAL TENDENCES AND DISPERSION</td><td>No. of periods: 24</td></tr>
<tr><td colspan="5">Key unit competence: Extend understanding, analysis and interpretation of data arising from problems and questions in daily life to the standard deviation.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr><td>– Define the variance, standard deviation and the coefficient of variation.</td><td>– Calculate and interpret Measures of central tendency
– Determine the measures of dispersion of a given statistical series.
– Apply and explain the standard deviation as the more convenient measure of the variability in the interpretation of data.
– Express the coefficient of variation as a measure of the spread of a set of data as a proportion of its mean.
– Interpret critically data and infer conclusions.</td><td>– Appreciate the importance of measures of dispersion in the interpretation of data.
– Show concern on how to use the standard deviation as measure of variability of data.</td><td>– Collection and presentation of grouped and ungrouped data.
– Central tendencies (mean, median, mode)
– Graphical representation of grouped and ungrouped data
– Measure of dispersion (range, variance, Standard Deviation and coefficient of variation)
– Application of statistics in daily life.</td><td>– In pairs, student teachers are encouraged to collect, analyze their own data from real life.
– In groups, student teacher will be given a task and be asked to:
– Discuss about the measures of dispersion, interpret them and present their findings.
– Represent data on graph paper, interpret them and infer conclusions.
– Make a research on given problems arising from various situations in daily life, investigate them by introducing the standard deviation, and represent their findings.</td></tr>
<tr><td colspan="5">Assessment criteria: Determine variance, standard deviation and coefficient of variation as measures of dispersion and use them to Analysis and interpret data arising from problems and questions in daily life</td></tr>
<tr><td colspan="5">Link to other subjects: Integrated science, entrepreneurship.</td></tr>
<tr><td colspan="5">Resources: Geometric instruments (ruler-square), digital technologies such as calculators, manila papers, flash cards.</td></tr>
</table>

<table>
<tr><td colspan="3">Subject: Mathematics</td><td>YEAR: One</td><td>Option: SME</td></tr>
<tr><td colspan="3">Topic Area: CALCULUS</td><td colspan="2">Sub Topic: LIMITS; DIFFERENTIATION AND INTEGRATION OF REAL FUNCTIONS</td></tr>
<tr><td colspan="4">UNIT 11: POLYNOMIAL FUNCTIONS</td><td>No. of periods: 18</td></tr>
<tr><td colspan="5">Key unit competence: Use concepts and definitions of functions to determine the domain of polynomial functions, solve related problems and represent them graphically in simple cases (plotting linear and quadratic functions).</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr><td>– Define a function
– Find whether a function is even, odd, or neither.</td><td>– Determine the domain and range of a function.
– Plot linear and quadratic functions
– Interpret graphs of functions (linear and quadratic) related to practical context and make conclusions
– - Analyze, model and solve problems involving linear or quadratic functions and interpret the results.</td><td>– Appreciate the importance of linear and quadratic functions in daily life.
– Show concern of using graphs of linear and quadratic functions in solving mathematical problems</td><td>– Definition of a polynomial function
– Domain and range of a polynomial function
– Parity(even , odd) of a polynomial function
– Plotting linear and quadratic functions
– Solve problem related to linear and quadratic functions.</td><td>– In groups, using manila papers , student teachers perform the tasks below and make presentation to the whole class:
• Use the given coordinates to draw graphically linear and quadratic functions,
• Model and interpret the problems related to linear and quadratic functions.</td></tr>
<tr><td colspan="5">Assessment criteria: Plot and interpret graphs of linear and quadratic functions in relation with practical context and make conclusions</td></tr>
<tr><td colspan="5">Link to other subjects: Integrated science; Entrepreneurship.</td></tr>
<tr><td colspan="5">Resources: Graph paper, ruler, digital technology including calculators, manila papers.</td></tr>
</table>

5.2 MATHEMATICS UNIT FOR YEAR 2

5.2.1. KEY COMPETENCES AT THE END OF YEAR 2

After completion of year two Science Mathematics Education, the Mathematics syllabuses will enable the student-teacher to:

1. Extend the concept of arithmetic and geometric progression to sequences and series.
2. Extend understanding and use geometric presentations of lines and planes, locate points and determine equation of a line and plane in 3D.
3. Solve trigonometric equations, inequalities and related problems using trigonometric identities and transformation formulas.
4. Extend understanding, analysis and interpretation of bivariate data to correlation coefficients and regression lines.
5. Apply the concepts and definitions of functions to determine the domain of polynomial, rational irrational, trigonometric, functions.
6. Evaluate correctly limit of function and apply to determine asymptote of a real function.
7. Differentiate a real function and apply derivatives to sketch the graphs and solve problems involving optimization
8. Solve problem involving the system of linear equations using matrices.

5.2.2 SYLLABUS UNITS FOR YEAR TWO

Subject: Mathematics			**YEAR: Two**	**OPTION: SME**
Topic Area: ARITHMETIC			**Sub Topic: Sub Topic: SEQUENCES AND SERIES**	
UNIT 1: SEQUENCE AND SERIES				**No. of periods: 22**
Key unit competence: Extend the concept of arithmetic and geometric progression to sequences and series				
Learning objectives			**Content**	**Teaching/ Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define a sequence and determine if a given sequence increases or decreases, converges or diverges. – Define and identify arithmetic or geometric progressions and their properties. – Determine the value of term number (n), given the sum of the first "n" terms of arithmetic or geometric progressions.	– Find the value of term number "n", given the sum of the first "n" terms of arithmetic or geometric progressions. – Determine the n^{th} term and the sum of "n" first terms of arithmetic or geometric progressions and their properties	– Appreciate the relationship between the sequences and other subjects to understand occurring situations. – Appreciate the use of sequence and series in daily life.	– Generalities on sequences (increasing or decreasing sequence and convergent or divergent) – Arithmetic sequences – Geometric sequences. – Arithmetic and geometric series	– In groups student teachers are given tasks of folding a piece of paper to make them understand the meaning of geometric sequences, and think what should be the size of last folded paper as more as you continue to fold it. – In groups, student teachers investigate and discuss how the bank rates increase or decrease unexpectedly year by years.
Assessment criteria: Identify arithmetic and geometric sequence and solve problems related to arithmetic or geometric sequences and series**.**				
Link to other subjects: Social studies, entrepreneurship and Integrated Science				
Resources: Graph papers, digital technology including calculators, manila paper, flash cards.				

<table>
<tr><td colspan="2">Subject: Mathematics</td><td colspan="2">YEAR: Two</td><td>Option: SME</td></tr>
<tr><td colspan="2">Topic Area: GEOMETRY</td><td colspan="3">Sub Topic: EUCLIDIAN SPACE GEOMETRY</td></tr>
<tr><td colspan="4">UNIT 2: POINTS, STRAIGHT LINES AND PLANES IN 3D</td><td>No. of periods: 28</td></tr>
<tr><td colspan="5">Key unit competence: Extend understanding and use geometric presentations of lines and planes, locate points and determine equation of a line and plane in 3D.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr>
<td>– Define by its coordinates the position of a point in 3D.
– Define a line using points and direction vector.
– Define the position vectors of plane.</td>
<td>– Locate a point and/or a vector in 3D
– Locate the mid - point of a segment in 3D and determine the distance between two points in 3D.
– Determine equations of a straight line (vector equation, parametric equation, Cartesian equation).
– Explain the position vector of a plane
– Determine Cartesian, vector and parametric equations of a plane</td>
<td>– Appreciate the importance of the measure of angle between two line segments.
– Be accurate in calculation to determine Cartesian and/or parametric equations of a line
– Be aware of the usefulness of the equations of a plane
– Think critically in problem solving related to the equations of lines and planes.</td>
<td>– Points in 3D
• Cartesian coordinates of a point and its presentation in 3D
• Mid-point of a line segment
• Distance between two points
– Equation of Line in 3D
• Vector equation
• parametric equations
• Cartesian equation.
– Equation of a Plane in 3D
• Vector equation
• Parametric equations
• Cartesian equation
– Problems on points and straight lines in 3D:
Distance
• from a point to a line or a plane</td>
<td>-In groups student teachers represent on graph papers some points in 3D.
- Student teachers investigate lines, distance and line segments and measure angles, distance between them and present their findings.
- Student teachers represent on graph papers some chosen planes and determine its parametric or Cartesian equations and present their findings.
-In groups, student teachers discuss about the position of : Point, Line and Plane</td>
</tr>
</table>

			• between two lines • between a line and a plane • between two planes Angle • between two lines • between a line and a plane • between two planes	
Assessment criteria: Solve problems related to positions of a point or a line to the plane and angle between two lines, a line and a plane or angle between two planes.				
Link to other subjects: Integrated Science, creative performance and social studies.				
Resources: Graph papers, Geometric instruments (ruler-square, pair of compasses, protractor), scientific calculators, manila papers, flash cards.				

<table>
<tr><td colspan="2">Subject: Mathematics</td><td colspan="2">YEAR: Two</td><td>Option: SME</td></tr>
<tr><td colspan="2">Topic Area: TRIGONOMETRY</td><td colspan="3">Sub Topic: TRANSFORMATION FORMULAE AND TRIGONOMETRIC EQUATIONS</td></tr>
<tr><td colspan="4">UNIT 3: TRIGONOMETRIC EQUATIONS</td><td>No. of periods: 22</td></tr>
<tr><td colspan="5">Key unit competence: Solve trigonometric equations and related problems using trigonometric identities and transformation formulas.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr><td>– Extend the concepts of trigonometric ratios and their properties to trigonometric equations.</td><td>– Simplify the trigonometric expressions using transformation formulas.
– Use trigonometric functions and equations to model and solve any problems related to trigonometry.
– Analyze and discuss the solution of trigonometric equations.</td><td>– Appreciate the importance of trigonometric functions and equations in real life.</td><td>– Transformation formulas:
• Addition and subtraction formulas.
• Double-angle and half-angle formulas.
• Transformation of Sum into product and vice versa (Simpson's formulas)
– Trigonometric equations.
– Solve real life word problems related to trigonometry</td><td>– Guided by the tutor, using trigonometric circle , student teachers in groups will deduce addition , subtraction, double angle and Simpson's formulas;
– In pairs, student teachers solve trigonometric equations in real life problems and present their work.</td></tr>
<tr><td colspan="5">Assessment criteria: Solve correctly equations and problems related to trigonometry by analyzing and interpreting the result.</td></tr>
<tr><td colspan="5">Link to other subjects: Integrated science, social studies, ICT.</td></tr>
<tr><td colspan="5">Resources: Geometric instruments (ruler-square, pair of compasses, protractor), digital technologies such as calculators, manila papers, flash cards.</td></tr>
</table>

Subject: Mathematics			YEAR: Two		Option: SME
Topic Area: STATISTICS AND PROBABILITY			**Sub Topic: DESCRIPTIVE STATISTICS.**		
UNIT 4: BIVARIATE STATISTICS				**No. of periods: 17**	
Key unit competence**: Extend understanding, analysis and interpretation of bivariate data to correlation coefficients and regression lines.**					
Learning objectives			**Content**	**Teaching/ Learning Activities**	
Knowledge and understanding	**Skills**	**Attitudes and values**			
– Define the correlation, covariance, coefficients of correlation and regression lines. – Explain the coefficients of correlation and standard deviation as the more convenient measure of the variability in the interpretation of data.	– Determine the coefficient of correlation, covariance and regression lines of bivariate data of dispersion of a given statistical series. – Analyze, interpret data critically then infer conclusion.	– Appreciate the importance of regression lines and coefficient of correlation to infer/ predict conclusion	– Scatter diagram – Correlation – Covariance – Correlation coefficient (Pearson's correlation coefficient). – Regression line – Rank correlation coefficient (Spearman's correlation coefficient) – Application: Data analysis and Interpretation in various areas and infer/ predict conclusion.	– Student teachers discuss in their groups, the correlation between class results and rank/ place in school. They analyze the relationship between them, and check how the coefficient of correlation reflects the amount of variability that is shared between them and what they have in common. They finally infer conclusion. – In pairs student teachers plot visually data on scatter diagram and represent a correlation between two variable. Analyze the graph, infer conclusion using regression line to make predictions about the variables studied	
Assessment criteria: Compare and interpret bivariate data from correlation coefficients and regression lines.					
Link to other subjects: Social studies, Integrated science**,** ICT.					
Resources: Geometric instruments (ruler, T-square, compass), graph paper, digital technology including calculators.					

<table>
<tr><td colspan="3">Subject: Mathematics</td><td colspan="2">YEAR: Two</td><td>Option: SME</td></tr>
<tr><td colspan="3">Topic Area: CALCULUS</td><td colspan="3">Sub Topic: LIMITS; DIFFERENTIATION AND INTEGRATION OF REAL FUNCTIONS</td></tr>
<tr><td colspan="5">UNIT 5: POLYNOMIAL, RATIONAL AND IRRATIONAL FUNCTIONS.</td><td>No. of periods: 12</td></tr>
<tr><td colspan="6">Key unit competence: Apply the concepts and definitions of functions to determine the domain of definition of rational and irrational functions.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td colspan="2" rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr><td>– Define the domain and range of polynomial functions
– State the properties of even and odd functions
– Identify properties of polynomial, rational and irrational functions.</td><td>– Determine compositions of functions.
– Determine the domain and range of a function.
– Model and solve problems related to functions in various practical contexts by applying different properties of functions.</td><td>– Appreciate the importance of functions in daily life.</td><td>– Generalities on numerical functions
• Properties
• Operations
– Domain of definition
• Existence condition
• Domain and range of a function.
– Symmetry of a function
• Even function
• Odd function</td><td colspan="2">– In groups, student teachers study algebraically and graphically polynomial functions which will help them to find the domain and range of functions and present their work
– In groups , student teachers model and interpret the problems related to polynomial, rational and irrational functions.</td></tr>
<tr><td colspan="6">Assessment criteria: Determine correctly the domain of definition for rational functions and irrational by establishing existence condition.</td></tr>
<tr><td colspan="6">Link to other subjects: Integrated Science,</td></tr>
<tr><td colspan="6">Resources: Geometric instruments (ruler, T-square, compass), graph paper, digital technology including calculators.</td></tr>
</table>

<table>
<tr><td colspan="3">Subject: Mathematics</td><td>YEAR: Two</td><td>Option: SME</td></tr>
<tr><td colspan="3">Topic Area: CALCULUS</td><td colspan="2">Sub Topic: LIMITS; DIFFERENTIATION AND INTEGRATION OF REAL FUNCTIONS</td></tr>
<tr><td colspan="4">UNIT 6: LIMITS OF POLYNOMIAL, RATIONNAL AND IRRATIONAL FUNCTIONS</td><td>No. of periods: 28</td></tr>
<tr><td colspan="5">Key unit competence: Evaluate correctly limit of function and deduce asymptotes of a real function.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr>
<td>– Define the concept of limit for real-valued functions of one real variable.
– State the properties of limits of functions
– Explain how to determine the asymptotes of the given function.</td>
<td>– Calculate limits of certain elementary functions.
– Solve problems involving continuity.
– Apply informal methods to explore the concept of a limit including one sided limits.
– Use the concepts of limits to determine the asymptotes to the rational and polynomial functions.</td>
<td>– Show concern for the importance, use and determination of limits of functions in daily life.
– Appreciate the use of asymptotes in daily life.</td>
<td>Limits and continuity
– Introduction to limits and continuity
– (neighbourhood of a real number, graphical interpretation of limits of function)
– Properties of limits
– Operations on limits
• Finite limits
• Infinite limits
• Limit at infinity
• Squeeze theorem
• Indeterminate cases
$\left(\frac{\infty}{\infty},\frac{0}{0},\infty-\infty,0\cdot\infty\right)$</td>
<td>– Guided by the tutor, student teachers will perform different activities such as inscribing polygons in circle and students will discover that the circle is the limiting position of an inscribed polygon when the number of sides approaches to infinity;
– Referring to examples of real life such as” the bridge in the road” students will be helped to understand the concept of “continuity” and” discontinuity”.
– Guided by the tutor, student teachers will deduce the limit notation, give properties of limits and evaluate limits of functions;</td>
</tr>
</table>

			– Continuity • Continuity of a function at a point or on interval • Properties on continuity • Point of discontinuity – Asymptotes • Definition and interpretation • Types and equations of asymptotes	– In groups of two students learners guided by the tutor will describe and remove indeterminate cases using limits. – Guided by the tutor, student teachers in groups will discover the types of asymptotes and establish the equations of asymptotes
Assessment criteria: Determine correctly limits of functions and apply them to get asymptotes and interpret the result.				
Link to other subjects: Integrated Science, Entrepreneurship, Social studies, creative performance.				
Resources: Manila papers, graph paper, geometrical materials, markers, digital technology.				

Subject: Mathematics		YEAR: Two		Option: SME
Topic Area: CALCULUS		**Sub Topic: LIMITS; DIFFERENTIATION AND INTEGRATION OF REAL FUNCTIONS**		
UNIT 7: DIFFERENTIATION				**No. of periods: 34**
Key unit competence: Differentiate a real function and apply derivatives to sketch the graphs and Solve problems involving optimization				
Learning objectives			**Content**	**Teaching/ Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define the derivative of a function – Identify techniques of differentiation to be used depending on the type of differentiable function	– Use properties of derivatives to differentiate polynomial, rational and irrational functions. – Use first principles to determine the gradient of the tangent line to a curve at a point. – Apply the concepts and techniques of differentiation to model, analyze and solve rates or optimization problems in different situations.	– Appreciate the use of gradient as a measure of rate of change. – Appreciate the importance of use of differentiation in kinematics (velocity, acceleration). – Show concern on derivatives to help in the understanding of optimization problems.	– Derivative concepts • Definition and graphical interpretation • Rules of differentiation • Derivative of elementary function – Use of differentiation for a given function • Variation of a function (increasing, decreasing interval or turning points) • Concavity (inflexion points) – Curves sketching • Table of variation • Additional points – Application of differentiation (Hospital's rules, tangent and Normal line equation, rates of change problems, optimization problems).	– Tutor will introduce the derivative using a real example like a car travelling at a constant speed, using distance and time, notice that the distance from the starting point increases at a constant rate of that speed each hour. From this example, guided by the tutor, student teachers will deduce the definition of derivative at a point; – Guided by the tutor student teachers in groups will identify the rules of differentiation for basic functions; – Guided by the tutor, student teachers in groups will apply Hospital rules to remove indeterminate forms; they will also solve problems related to derivatives.
Assessment criteria: Determine, analyze and interpret derivative of a real function and apply it to sketch an accurate curve of a given function or to solve problems related to optimization.				
Link to other subjects: Integrated Science, Entrepreneurship, Social studies, creative performance.				
Resources: Manila papers, graph paper, ruler, markers, digital technology.				

<table>
<tr><td colspan="2">Subject: MATHEMATICS</td><td colspan="2">YEAR: Two</td><td>Option: SME</td></tr>
<tr><td colspan="2">TOPIC AREA: LINEAR ALGEBRA</td><td colspan="3">SUB TOPIC: MATRICES AND SYSTEM OF LINEAR EQUATIONS</td></tr>
<tr><td colspan="4">UNIT 8: MATRIX OF ORDER 2 AND ORDER 3</td><td>No. of periods: 17</td></tr>
<tr><td colspan="5">Key unit competence: Solve problem involving the system of linear equations using matrices</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr><td>– Define the order of a matrix.
– Explain that a given square matrix of order 2 or order 3 is invertible or not.
– Explain using determinant whether a matrix of order 2 or 3 is invertible or not.
– Reorganize data into matrices</td><td>– Perform operations on matrices of order 2 or 3.
– Calculate the determinants of matrices of order 2 and 3.
– Determine the inverse of a matrix of order 2 or 3.
– Use various methods such as Cramer, Gaussian elimination, inverse matrix, and comparison to solve a system of two/three linear equations in two / three unknowns. Discuss with respect to a parameter the solutions of a system of three linear equations in three unknown</td><td>– Appreciate the importance of matrices of order 2/ 3 and their determinants in organizing data and solving a system of two/three linear equations in two / three unknowns.</td><td>Definition and Size of matrix
– Operations on matrix
• Equality of two matrices
• Addition and subtraction
• Multiplication
• Determinant of 2×2 or 3×3 matrices
– Inverse of matrix of order 2×2 or 3×3
– System of linear equations
• Solve using Cramer method
• Solve using inverse matrix
• Solve using Gaussian method (use of elementary transformations)</td><td>– Guided by the tutor, student teachers use examples like marks of student in different subjects to arrange them in table in order to understand the concept of matrix then deduce the types of matrices;
– Guided by the tutor, student teacher in their groups will perform operations on matrices;
– Guided by the tutor, student teacher will compute the determinant of matrices using different methods.
– Student teachers, in groups discuss whether a matrix of order 2 or 3 is invertible or not and present their findings.</td></tr>
<tr><td colspan="5">Assessment criteria: Solve correctly the problem involving the system of linear equations using matrices methods or Gaussian elimination.</td></tr>
<tr><td colspan="5">Link to other subjects: Integrated Science, social studies, Entrepreneurship.</td></tr>
<tr><td colspan="5">Resources: Geometric instruments (ruler, T-square, compass), graph paper, digital technology including calculators</td></tr>
</table>

5.3 MATHEMATICS UNITS FOR YEAR 3

5.3.1. KEY COMPETENCES AT THE END OF YEAR 3

After completion of year three Science Mathematics Education, the Mathematics syllabuses will enable the student-teacher to:

1. Extend understanding on sets of numbers to complex numbers and solve equations in the set of complex numbers.
2. Determine possible outcomes of a random experiment using elementary techniques of combinatory analysis
3. Determine probability of occurrence of an even from random experiment.
4. Apply Bayes' theorem in determine a probability of an event.
5. Extend the use of concepts and definitions of functions to determine the domain and sketch the graphs of logarithmic and exponential functions.
6. Define and apply integration to find area, arc length and volumes.
7. Use differential equations to solve problems that arise in a variety of practical contexts.

5.3.2. SYLLABUS UNITS FOR YEAR THREE

Subject: Mathematics			**YEAR: Three**	**Option: SME**
Topic Area: ALGEBRA			**SUB TOPIC: NUMBERS AND OPERATIONS**	
UNIT 1: COMPLEX NUMBERS				**No. of periods: 30**
Key unit competence: Extend understanding on sets of numbers to complex numbers and solve equations in set of complex numbers.				
Learning objectives			**Content**	**Teaching/ Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Identify the real part and the imaginary part of a complex number – Convert a complex number from one form to another – Represent a complex number on Argand diagram – State De Moivre's formula and Euler's formula	– Perform operations on complex numbers in algebraic form, in polar form or in exponential form using properties. – Find the modulus and the square roots of a complex number. – Solve equations in the set of complex number. – Apply De Moivre's formula and Euler's formula to transform trigonometric expressions	– Appreciate the importance of complex numbers	– Concepts of complex numbers: – Algebraic form of Complex numbers. • Definition and properties • Operations: Addition, subtraction, multiplication, powers, conjugate and division. • Modulus of a complex number. • Square roots of complex number • Equations in the set of complex numbers $\mathbb{C}\mathbb{C}$ – Geometric representation of complex numbers.	– In small groups, student teachers try to solve the following equations x^2-4=0 and x^2+4=0 and discus how to find solution for both equations. Let student teachers use the imaginary number **"i"** in solving the equation x^2+4=0 and deduce that x= 2i and x=-2i are solutions of the equation in the set of complex numbers $\mathbb{C}$ $\mathbb{C}$. – In small groups, facilitate the student teachers to calculate the modulus by explaining that the modulus value looks like the length of the vector with origin (0,0) to the affix of the complex number z.

			– Polar form of complex numbers. • Definition. • Modulus and argument of a complex number. • Operations. • De Moivre's formula. • Nth roots of a complex number. • Construction of regular polygons. – Exponential forms of complex numbers: • Definition and operations. • Euler's formula of complex numbers.	– In groups student teachers plot the image of the given complex number, and take conclusion which lead to be conjugate of the given complex number. – In small groups, student teachers establish a relationship between Cartesian plane and complex plane by considering x- axis as real axis and y-axis as the imaginary axis and plotting the following point A(-3,5) affix of Z= $-3+5i$ $-3+5i$. – In groups, student teachers construct on the Argand diagram the points representing the n^{th} roots of a complex number and deduce the names of the polygons obtained by joining the points representing the n^{th} roots.
Assessment criteria: Perform operations and convert a complex number from one form to another; solve equations in the set of complex numbers and determine n^{th} roots of a complex number.				
Link to other subjects: Integrated science, ICT				
Resources: T-square, ruler, Mathematics drawing software as GeoGebra , Mathlab, graph.				

<table>
<tr><td colspan="3">Subject: Mathematics</td><td>YEAR: Three</td><td>Option: SME</td></tr>
<tr><td colspan="3">Topic Area: STATISTICS AND PROBABILITY</td><td colspan="2">Sub Topic: COMBINATORY ANALYSIS AND PROBABILITY</td></tr>
<tr><td colspan="4">UNIT 2: ARRANGEMENT, PERMUTATION AND COMBINATION</td><td>No. of periods: 20</td></tr>
<tr><td colspan="5">Key unit competence: Apply formulae of combinatory analysis to count possible outcomes of a random experiment.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr><td>– Define the permutation and combination.
– Construct Pascal's triangle.
– Distinguish between permutations and combinations.</td><td>– Determine the number of permutations and combinations of "n" items, "r" taken at a time.
– Use counting techniques to solve related problems.
– Use properties of combinations.</td><td>– Appreciate the importance of counting techniques.
– Show concern on how to use the counting techniques.
–</td><td>– Counting techniques:
• Venn diagrams.
• Tree diagrams.
• Contingency table.
• Multiplication principles.
– Arrangement or permutations (Arrangement with or without repetition)
• Definition and properties
– Combination:
• Definition and properties
• Pascal's triangles
• Binomial expansions</td><td>– In groups, student teachers are asked to think about the following: "In how many different ways could a committee of 5 people be chosen from a class of 30 students?".
– Student teachers are asked to use letters from their proper words and create their own words e.g: use letters of "MISSISSIPPI", without prior instructions, create news words then give feedback.
– In pairs student teacher identify different formulae related to permutations and combinations and deduce Pascal's triangle.</td></tr>
<tr><td colspan="5">Assessment criteria: Determine accurately combinations or permutations of "n" items, "r" taken at a time.</td></tr>
<tr><td colspan="5">Link to other subjects: English, integrated science, social studies, entrepreneurship, Creative performance</td></tr>
<tr><td colspan="5">Resources: Manila papers, graph paper, ruler, digital components including calculators, dice, deck of playing cards, coins</td></tr>
</table>

<table>
<tr><td colspan="4">Subject: Mathematics</td><td>YEAR: Three</td><td>Option: SME</td></tr>
<tr><td colspan="4">Topic Area: STATISTICS AND PROBABILITY</td><td colspan="2">Sub Topic: COMBINATORY ANALYSIS AND PROBABILITY.</td></tr>
<tr><td colspan="5">UNIT 3: PROBABILTY</td><td>No. of periods: 20</td></tr>
<tr><td colspan="6">Key unit competence: Determine probability of occurrence of an event from random experiment and Apply Bayes’ theorem.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td colspan="2" rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr><td>– Define probability and explain probability as a measure of chance.
– Distinguish between mutually exclusive and nonexclusive events and compute their probabilities.</td><td>– Use and apply properties of probability to calculate the number of possible outcomes of occurring events under equally likely assumptions.</td><td>– Appreciate the use of probability as a measure of chance.</td><td>– Concept of Probability
• Random experiment
• Sample space
• Events(simple event, certain event, impossible event)
• Definition of a probability of event under an equally likely event
• Mutually exclusive events
– Conditional probability:
• Basic formulae and properties of conditional probability
• Independent events
• Probability by tree diagram
– Bayes theorem and its applications.</td><td colspan="2">– Student teachers discuss gambling problems and report their results to the group.
– Student teachers are given a task of sitting 3 boys and 4 girls at random in a row. In groups, they discuss the probability that all the girls are sited together then they give feedback.</td></tr>
<tr><td colspan="6">Assessment criteria: Determine correctly the probability of possible outcomes of occurring events by using counting techniques and concepts of probability and apply Bayes’ theorem.</td></tr>
<tr><td colspan="6">Link to other subjects: Integrated science, Entrepreneurship.</td></tr>
<tr><td colspan="6">Resources: Manila paper, graph paper, flash cards, ruler, digital technology including calculators, dice, deck of playing cards, coins</td></tr>
</table>

<table>
<tr><td colspan="3">Subject: Mathematics</td><td>YEAR: Three</td><td>Option: SME</td></tr>
<tr><td colspan="3">Topic Area: CALCULUS</td><td colspan="2">Sub Topic: LIMITS; DIFFERENTIATION AND INTEGRATION OF REAL FUNCTIONS</td></tr>
<tr><td colspan="4">UNIT 4: LOGARITHM AND EXPONENTIAL FUNCTION</td><td>No. of periods: 32</td></tr>
<tr><td colspan="5">Key unit competence: Extend the use of concepts and definitions of functions to determine the domain and sketch the graphs of logarithmic and exponential functions.</td></tr>
<tr><td colspan="3">Learning objectives</td><td rowspan="2">Content</td><td rowspan="2">Teaching/ Learning Activities</td></tr>
<tr><td>Knowledge and understanding</td><td>Skills</td><td>Attitudes and values</td></tr>
<tr><td>– Define logarithm or exponential function using properties of logarithms in any base.
– State and demonstrate properties of logarithms and exponentials for any base.
– Carry out operations using the change of base of logarithms.</td><td>– Use the properties of logarithms to solve logarithmic and exponential equations.
– Convert the logarithm to exponential form for any base
– Apply logarithms or exponential to solve rates problems, mortgage problems, population growth problems.</td><td>– Appreciate the use of logarithmic equations to model and solve problem involving logarithms such radioactive-decay problems, carbon dating problems, problems about alcohol and risk of car accident.</td><td>– Introducing natural logarithm function (with base e)
• Domain and range of logarithmic functions
– Properties and operations on natural logarithmic function
– Logarithmic equations
• Domain of validity
• Solutions of logarithmic equation
– Algebraic and graphical determination of limit of $f(x)=\ln x$
• Calculation of limit of logarithmic functions (with base e)
• Determination of asymptotes related to logarithmic functions (with base e)</td><td>– Student teachers use scientific calculators to evaluate logarithms and exponentials of real numbers; they conclude about the domain (the allowed input values) and the range (the set of possible outputs).
– Student teachers may use software, such as Geogebra, to graph logarithmic and exponential functions and report to class their findings about the general trend of the graphs.
– From definition of derivative, find differentiation formulas of logarithmic and exponential functions.</td></tr>
</table>

			– Differentiation of natural logarithmic functions • Definition and calculation • Increasing and/or decreasing interval and turning points • Concavity and inflection points – Graphical representation • Table of variation • Additional points • Curve plotting – Modeling and solving problems involving natural logarithms – Introducing exponential function (with base e) • Domain and range of exponential functions – Properties and operations on exponential function – Exponential equations • Domain of validity • Solutions of logarithmic equation – Algebraic and graphical determination of limit of $f(x)=e^x$ • Calculation of limit of exponential functions (with base e) • Determination of asymptotes related to exponential functions (with base e)	– Discuss in groups the applications of logarithms and exponentials in real life.

			– Differentiation of exponential functions • Definition and calculation • Increasing and/or decreasing interval and turning points • Concavity and inflection points – Graphical representation • Table of variation • Additional points – Modeling and solving problems exponents – Introducing logarithm function with any base $(a>0 \text{ and } a\neq 1)$ • Domain and range of logarithmic functions • Change of base – Properties and operations on logarithmic function – Logarithmic equations • Domain of validity • Solutions of logarithmic equation – Algebraic and graphical determination of limit of $f(x)=\log_a x$ for both cases $0<a<1$ and $a>1$ – Calculation of limit of logarithmic functions for both cases $0<a<1$ and $a>1$ – Determination of asymptotes related to logarithmic functions $(a>0 \text{ and } a\neq 1)$	

			– Differentiation of logarithmic functions • Definition and calculation • Increasing and/or decreasing interval and turning points • Concavity and inflection points – Graphical representation • Table of variation • Additional points • Curve plotting – Introducing exponential function with any base ($a > 0$ and $a \neq 1$) • Domain and range of exponential functions – Properties and operations on exponential function – Exponential equations • Domain of validity • Solutions of exponential equation – Algebraic and graphical determination of limit of $f(x) = a^x$ for both cases $0 < a < 1$ and $a > 1$ • Calculation of limit of exponential functions for any base ($a > 0$ and $a \neq 1$) • Determination of asymptotes related to exponential functions	

			– Differentiation of exponential functions • Definition and calculation • Increasing and/or decreasing interval and turning points • Concavity and inflection points – Graphical representation • Table of variation • Additional points – Modeling and solving problems involving logarithms or exponents for any base.	
Assessment criteria: Determine correctly the domain of definition of logarithmic and exponential functions based on existence conditions, sketch the corresponding graphs and solve problems involving logarithms or exponentials related to real life.				
Link to other subjects: Social Studies, Entrepreneurship, SET, ICT, Integrated Science				
Resources: Geometric instruments (ruler, T-square, compass), graph paper, digital technology including calculators, manila paper.				

Subject: Mathematics			**YEAR: Three**	**Option: SME**
Topic Area: CALCULUS			**Sub Topic: LIMITS; DIFFERENTIATION AND INTEGRATION OF REAL FUNCTIONS**	
UNIT 5: INTEGRATION				**No. of periods: 40**
Key unit competence: Determine correctly integration as the inverse of differentiation or limit of a sum and apply it to find area of plane surfaces, volumes of solid of revolution and lengths of curved lines.				
Learning objectives			**Content**	**Teaching/ Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define the differential of a function – Interpret geometrically the differential of a function – List the differentiation formulas – Clarify the relationship between derivative and anti-derivative of a function – Extend the concepts of indefinite integrals to definite integrals.	– Calculate integrals using appropriate techniques. – Use properties of integrals to simplify the calculation of integrals. – Calculate a limit of a sum to infinity as a definite integral. – Apply definite integrals to calculate the area, volume, arc length.	– ppreciate the importance of integral calculus in solving problems from daily life.	**Differentials** – Definitions and Operations on increments – Properties of differentials – Applications: • Approximation • Calculation of error **Indefinite integrals:** – Definition and properties – Techniques of integration: • Basic integration formulas (or immediate integration) • Integration by change of variable • Integration by parts • Integration of rational functions by partial fractions.	– In groups student teachers determine indefinite integrals and definite integrals using different techniques ; – Considering consecutive subintervals, student teachers calculate the areas of corresponding rectangles, and then introduce the concept of integral as sum to infinity, when the width tends to zero, in group discussion. – In groups student teachers will apply integrals in determination of length, area, and volume, by applying technique of integration and present their findings.

			Definite integrals: – Riemann sum – Definition and Properties – Techniques of integration – Applications of definite integrals: • Calculation of area of a plane surface • Calculation of volume of a solid of revolution • Calculation of length of curved lines.	
Assessment criteria: Determine correctly the integral of a given function using appropriate techniques of integration, then apply it to find area of plane surfaces, volumes of solid of revolution and lengths of curved lines.				
Link to other subjects: English, integrated science				
Resources: Manila paper, calculators, graph papers, ruler, markers, open source software like Geogebra, MalMath.				

Subject: Mathematics			YEAR: Three	Option: SME
Topic Area: CALCULUS			**Sub Topic: DIFFERENTIAL EQUATIONS.**	
UNIT 6: DIFFERENTIAL EQUATION OF FIRST ORDER				**No. of periods: 20**
Key unit competence: Use differential equations to solve related problems that arise in daily life.				
Learning objectives			**Content**	**Teaching/ Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Extend the concepts of differentiation and integration to ordinary differential equations. – State the order and the degree of an ordinary differential equation.	– Determine whether an ordinary differential equation of first order is with separable variables, homogeneous or linear. – Use appropriate method to solve an ordinary differential equation of first order. – Use differential equations to model and solve problems in daily life	– Appreciate the use of differential equations in solving problems occurring from daily life. – Show patience, commitment and dedication when solving a differential equation or modelling a problem using differential equation	– Definition and classification of differential equations. – 1^{st} Order differential equation: • Differential equation with separable variables • Simple homogeneous differential equations • Linear differential equations • Applications – Population growth problems – Radioactive decay problems – Earthquake problems – Interest rates problems	– Form groups, student teachers differentiate and guess the power of the highest derivative. – Guide student teachers to interact about the findings, to conclude on the new concept and to write a short summary. – Student teachers use graph plotting to illustrate the general solution of a differential equation, the tutor harmonize the work. – Discuss in groups the solutions of a differential equation with respect to a parameter and present the result to the class, show ability to communicate your thinking and reasoning.
Assessment criteria: Solve correctly and use ordinary differential equations of first order to model and solve related problems.				
Link to other subjects: Integrated Science, Entrepreneurship.				
Resources: Geometric instruments, graph paper, calculators, ICT equipment.				

Subject: Mathematics			**YEAR: Three**	**Option: SME**
Topic Area: CALCULUS			**Sub Topic: DIFFERENTIAL EQUATIONS**	
UNIT 7: DIFFERENTIAL EQUATION OF SECOND ORDER				**No. of periods: 18**
Key unit competence: Use differential equations to solve related problems that arise in a variety of practical contexts.				
Learning objectives			**Content**	**Teaching/ Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Extend the concepts of differentiation and integration to ordinary differential equations. – State the order and the degree of an ordinary differential equation. – Express the auxiliary quadratic equation of a homogeneous linear differential equation of second order with constant coefficients. – Predict the form of the particular solution of an ordinary linear differential equation of second order	– Solve an ordinary linear differential equation of second order. – Use differential equations to model and solve problems in physics (simple harmonic motion), economics (point elasticity).	– When discussing in groups the solution of a differential equation, make sense of other learners' thinking, show tolerance and mutual respect	**Linear differential equations of 2^{nd} order with constant coefficients:** – Solving homogeneous linear differential equations • Definition of characteristic (or Auxiliary) equation • Solving differential equation whose Characteristic equation has two distinct roots • Solving differential equation whose Characteristic equation has a repeated root • Solving differential equation whose Characteristic equation has complex roots – Solving nonhomogeneous linear differential equations • The right hand side is a polynomial function • The right hand side is an exponential function.	– In groups student teachers • Derive the general solutions of differential equations. • Solve ordinary differential equations of first and second orders. • Use internet to find the applications of differential equations in sciences and report your findings to the class.
Assessment criteria: Solve correctly and use ordinary differential equations of second order to model and solve related problems.				
Link to other subjects: Integrated Science, Entrepreneurship.				
Resources: Geometric instruments, graph paper, calculators, ICT equipment.				

REFERENCES

1. Balakrishnan, V.K . (1995). Schaum's Outline, Combinatorics.
2. Bird, J. (2003). Engineering Mathematics (4th Edition).
3. Bronson, R. (2003). Schaum's Outline, Differential equation.
4. CrashwshaW,J.,& Chambers,J.(2001).Advanced Level Statistics with worked examples (Fourth Edition). Nelson Thornes Ltd:UK
5. Curriculum Planning and Development Division (2006). Secondary Mathematics Syllabuses. Ministry of Education: Singapore
6. National Curriculum Development Centre (2008).Mathematics teaching syllabus: Uganda Certificate of Education Senior1-4.
7. Ministry of Education and Sports: Uganda.
8. Rwanda Education Board (2015). Mathematics syllabus for advanced level S4 – S6. Kigali
9. Sanchez , A.V, & Ruiz, M.P. (2008). Competence-Based Learning : A proposal for the assessment of Generic Competences(Eds).
10. Shampiyona, A. (2005). Mathématiques 6. Imprimerie de Kigali: Kigali
11. Spiegel,M. R.; Schiller, J. & Srinivasan, A. (2009). Schaum's Outline, Probability and Statistics: Third Edition.
12. Wrede, R., Murray,D., & Spiegel, R. (2010). Schaum's Outline, Advanced calculus, 3rd Edition
13. A. J. Sadler, D. W. S. Thorning: *Understanding Pure Mathematics*, Oxford University Press 1987.
14. Arthur Adam, Freddy Goossens and Francis Lousberg (1991). *Mathematisons 65*, DeBoeck, 3rd edition.
15. David Rayner, *Higher GCSE Mathematics,* Oxford University Press 2000
16. Frank Ebos, Dennis Hamaguchi, Barbana Morrison & John Klassen (1990), *Mathematics Principles & Process,* Nelson Canada A Division of International Thomson Limited .
17. George B. Thomas, Maurice D. Weir & Joel R. Hass (2010), *Thomas' Calculus Twelfth Edition,* Pearson Education.
18. H.K. DASS... *Engineering Mathematics*. New Delhi, S.CHAND&COMPANY LTD, thirteenth revised edition 2007.
19. CrashwshaW. J., & Chambers, J. (1984).*A concise course in A-Level statistics with worked examples*, Stanley Thornes (Publishers) LTD.
20. Ngezahayo, E. P. (2016). Advanced Mathematics for Rwanda Secondary Schools. Learners' Book Senior Four. Kigali: Fountain.
21. Ngezahayo, E. P. (2017). *Advanced Mathematics for Rwanda Secondary Schools*. Learners' Book Senior Five. Kigali: Fountain.
22. Ngezahayo, E. P. (2018). *Advanced Mathematics for Rwanda Secondary Schools*. Learners' Book Senior Six. Kigali: Fountain.
23. Peter Smythe: *Mathematics HL & SL with HL options,Revised Edition*, Mathematics Publishing Pty. Limited, 2005.
24. Igbokwe DI (2000): Dominant factors and Error Types inhibiting the understanding of Mathematics. 41st Annual Conference Proceedings of STAN, 242-249.

ANNEXES

ANNEX 1: TTC SUBJECTS AND TIME ALLOCATION

SN	Subject	Number of Periods							
		ECLPE		SSE		SME		LE	
		Y1	**Y2 & 3**	Y1	Y2 & 3	Y1	Y2 & 3	Y1	Y2 & 3
1	Foundations of Education	6	6	6	5	6	5	6	5
2	English	5	5	5	4	5	4	7	7
3	Kinyarwanda	5	5	2	2	2	2	5	6
4	Mathematics	3	3	3	3	6	6	2	2
5	Integrated Science	4	4	1	1	11	0	1	1
6	Physics	0	0	0	0	0	5	0	0
7	Biology	0	0	0	0	0	5	0	0
8	Chemistry	0	0	0	0	0	5	0	0
9	Social Studies	4	4	11	0	2	2	2	2
10	History	0	0	0	5	0	0	0	0
11	Geography	0	0	0	5	0	0	0	0
12	Economics	0	0	0	5	0	0	0	0
13	Creative Performance (Music and Fine Arts)	4	4	4	4	2	2	4	4
14	Physical Education	1	1	2	1	1	1	1	1
15	Entrepreneurship	2	2	2	2	2	2	2	2
16	ICT	2	2	2	2	2	2	2	2
17	TMP	7	7	4	4	6	4	4	4
18	SNE	2	2	2	2	2	2	2	2
19	Religious Education	1	1	4	3	1	1	1	1
20	French	4	4	2	2	2	2	7	7
21	Kiswahili	1	1	1	1	1	1	5	5
22	Co-Curricular	1	1	1	1	1	1	1	1
23	Individual Study	8	8	8	8	8	8	8	8
24	School Attachment	**Year 3 (first term)**							
	TOTAL	**60**	**60**	**60**	**60**	**60**	**60**	**60**	**60**

ANNEX 2: OVERVIEW OF MATHEMATICS FOR SME

Topic area	Sub topic area	Competences		
		YEAR 1	**YEAR 2**	**YEAR 3**
I. ARITHMETIC	1.1. SETS	Classify numbers into natural, integers, rational and irrationals Solve problems that involve Set operations using Venn diagram.		
	1.2. RATIOS AND PROPORTIONS	Apply ratios and proportions properties to solve related problems including problems in real life involving multiplier proportion change.		
	1.3.SEQUENCES AND SERIES (PROGRESSIONS)		Extend the concept of arithmetic and geometric progression to sequences and series.	
II. ALGEBRA	2.1. POLYNOMIALS	Perform operations on polynomials and solve related problems.		
	2.2. ELEMENT OF LOGIC	Use Mathematical logic as a tool of reason and argumentation in daily life situation.		
	2.3. EQUATIONS AND INEQUALITIES	Solve algebraically or graphically daily life problems using linear, quadratic equations, parametric equations or inequalities.		

	2.4. POWERS ,INDICES, RADICALS AND LOGARITHMS	Solve problems related to powers, indices, radical and common logarithms.		
	2.5. COMPLEX NUMBERS.			Extend understanding on the set of numbers to complex numbers and solve equations in set of complex numbers.
III. GEOMETRY	3.1. EUCLIDIAN PLANE GEOMETRY.	Determine an equation of a line and a circle.		
	3.2 EUCLIDIAN SPACE GEOMETRY		Extend understanding and use geometric presentations of lines and planes, locate points and determine equation of a line and plane in 3D.	
IV. TRIGONOMETRY	4.1. TRIGONOMETRIC CIRCLE, RATIOS AND IDENTITIES	Apply trigonometric concepts in solving problems on triangles and real life situation.		
	4.2. TRANSFORMATION FORMULAE, TRIGONOMETRIC EQUATION		Solve trigonometric equations, and related problems using trigonometric identities and transformation formulas.	
V. STATISTICS AND PROBABILITY	5.1. DESCRIPTIVE STATISTICS.	Extend understanding, analysis and interpretation of data arising from problems and questions in daily life to the standard deviation.	Extend understanding, analysis and interpretation of bivariate data to correlation coefficients and regression lines.	

	5.2. COMBINATORY ANALYSIS AND PROBABILITY			• Apply formulae of combinatory analysis to count possible outcomes of a random experiment. • Determine probability of occurrence of an event from random experiment and Apply Bayes' theorem.
VI. CALCULUS	6.1. LIMITS; DIFFERENTIATION AND INTEGRATION OF REAL FUNCTIONS	Use concepts and definitions of functions to determine the domain of polynomial functions and represent them graphically in simple cases.(plotting linear and quadratic functions)	• Apply the concepts and definitions of functions to determine the domain of rational, irrational and trigonometric functions. • Evaluate correctly limit of function and apply them to determine asymptotes of a real function. • Differentiate a real function and apply derivatives to sketch the graphs and Solve problems involving optimization	• Extend the use of concepts and definitions of functions to determine the domain and sketch the graphs of logarithmic and exponential functions. • Determine correctly integration as the inverse of differentiation or limit of a sum and apply it to find area of plane surfaces, volumes of solid of revolution and lengths of curved lines.

	6.2. DIFFERENTIAL EQUATIONS			Use differential equations to solve related problems that arise in a variety of practical contexts.
VII. LINEAR ALGEBRA	7.1. MATRICES AND SYSTEM OF LINEAR EQUATIONS.		Solve problems involving the system of linear equations using matrices (Cramer's method, Gaussian Elimination methods and inverse matrix).	