KEMENTERIAN
PENDIDIKAN
MALAYSIA

KURIKULUM STANDARD SEKOLAH MENENGAH

Matematik Tambahan

Dokumen Standard Kurikulum dan Pentaksiran

Tingkatan 4 dan 5

(Edisi Bahasa Inggeris)

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Bahagian Pembangunan Kurikulum
Mei 2019

Terbitan 2019

CONTENT

RUKUN NEGARA

BAHAWASANYA Negara kita Malaysia mendukung cita-cita hendak:
Mencapai perpaduan yang lebih erat dalam kalangan seluruh masyarakatnya;
Memelihara satu cara hidup demokratik;
Mencipta satu masyarakat yang adil di mana kemakmuran negara
akan dapat dinikmati bersama secara adil dan saksama;
Menjamin satu cara hidup yang liberal terhadap tradisi-tradisi
kebudayaannya yang kaya dan berbagai corak;
Membina satu masyarakat progresif yang akan menggunakan
sains dan teknologi moden;

MAKA KAMI, rakyat Malaysia, berikrar akan menumpukan seluruh tenaga dan usaha kami untuk mencapai cita-cita tersebut berdasarkan atas prinsip-prinsip yang berikut:

KEPERCAYAAN KEPADA TUHAN
KESETIAAN KEPADA RAJA DAN NEGARA
KELUHURAN PERLEMBAGAAN
KEDAULATAN UNDANG-UNDANG
KESOPANAN DAN KESUSILAAN

FALSAFAH PENDIDIKAN KEBANGSAAN

“Pendidikan di Malaysia adalah suatu usaha berterusan ke arah lebih memperkembangkan potensi individu secara menyeluruh dan bersepadu untuk melahirkan insan yang seimbang dan harmonis dari segi intelek, rohani, emosi dan jasmani, berdasarkan kepercayaan dan kepatuhan kepada Tuhan. Usaha ini adalah bertujuan untuk melahirkan warganegara Malaysia yang berilmu pengetahuan, berketerampilan, berakhlak mulia, bertanggungjawab dan berkeupayaan mencapai kesejahteraan diri serta memberikan sumbangan terhadap keharmonian dan kemakmuran keluarga, masyarakat dan negara”

Sumber: Akta Pendidikan 1996 (Akta 550)

DEFINISI KURIKULUM KEBANGSAAN

3. Kurikulum Kebangsaan

(1) Kurikulum Kebangsaan ialah suatu program pendidikan yang termasuk kurikulum dan kegiatan kokurikulum yang merangkumi semua pengetahuan, kemahiran, norma, nilai, unsur kebudayaan dan kepercayaan untuk membantu perkembangan seseorang murid dengan sepenuhnya dari segi jasmani, rohani, mental dan emosi serta untuk menanam dan mempertingkatkan nilai moral yang diingini dan untuk menyampaikan pengetahuan.

Sumber: Peraturan-Peraturan Pendidikan (Kurikulum Kebangsaan) 1997
[PU(A)531/97.]

KATA PENGANTAR

Kurikulum Standard Sekolah Menengah (KSSM) yang dilaksanakan secara berperingkat mulai tahun 2017 akan menggantikan Kurikulum Bersepadu Sekolah Menengah (KBSM) yang mula dilaksanakan pada tahun 1989. KSSM digubal bagi memenuhi keperluan dasar baharu di bawah Pelan Pembangunan Pendidikan Malaysia (PPPM) 2013-2025 agar kualiti kurikulum yang dilaksanakan di sekolah menengah setanding dengan standard antarabangsa. Kurikulum berasaskan standard yang menjadi amalan antarabangsa telah dijelmakan dalam KSSM menerusi penggubalan Dokumen Standard Kurikulum dan Pentaksiran (DSKP) untuk semua mata pelajaran yang mengandungi Standard Kandungan, Standard Pembelajaran dan Standard Prestasi.

Usaha memasukkan standard pentaksiran dalam dokumen kurikulum telah mengubah lanskap sejarah sejak Kurikulum Kebangsaan dilaksanakan di bawah Sistem Pendidikan Kebangsaan. Menerusinya murid dapat ditaksir secara berterusan untuk mengenal pasti tahap penguasaannya dalam sesuatu mata pelajaran, serta membolehkan guru membuat tindakan susulan bagi mempertingkatkan pencapaian murid.

DSKP yang dihasilkan juga telah menyepadukan enam tunjang Kerangka KSSM, mengintegrasikan pengetahuan, kemahiran dan nilai, serta memasukkan secara eksplisit Kemahiran Abad Ke-21 dan Kemahiran Berfikir Aras Tinggi (KBAT). Penyepaduan tersebut dilakukan untuk melahirkan insan seimbang dan harmonis dari segi intelek, rohani, emosi dan jasmani sebagaimana tuntutan Falsafah Pendidikan Kebangsaan.

Bagi menjayakan pelaksanaan KSSM, pengajaran dan pembelajaran guru perlu memberi penekanan kepada KBAT dengan memberi fokus kepada pendekatan Pembelajaran Berasaskan Inkuiri dan Pembelajaran Berasaskan Projek, supaya murid dapat menguasai kemahiran yang diperlukan dalam abad ke-21.

Kementerian Pendidikan Malaysia merakamkan setinggi-tinggi penghargaan dan ucapan terima kasih kepada semua pihak yang terlibat dalam penggubalan KSSM. Semoga pelaksanaan KSSM akan mencapai hasrat dan matlamat Sistem Pendidikan Kebangsaan.

Dr. MOHAMED BIN ABU BAKAR
Pengarah
Bahagian Pembangunan Kurikulum
Kementerian Pendidikan Malaysia

INTRODUCTION

A country's development and progress especially in the industry requires scientific and technology competency, hence the quality of science and mathematics education is an important element in the country's education system to ensure that Malaysian community is prepared to face the challenges of a developed nation.

Additional Mathematics is a key driver of various science and technology development. In addition, most mathematical theories used in business formulae and models use the statistical basis and calculus found in Additional Mathematics.

Additional Mathematics is an elective subject learned at upper secondary level to meet the needs of pupils who are inclined towards science and technology related careers such as engineering, medicine and architecture or in the field of business administration such as statisticians, actuaries and quantity surveyors. The content of Additional Mathematics curriculum takes into account the continuity of the Mathematics curriculum from primary to secondary school level and to a higher level.

Benchmarking of the Additional Mathematics curriculum has been carried out to ensure that the Additional Mathematics curriculum in Malaysia is relevant and at par with other countries. In addition, emphasis is given to problem-solving heuristic in the teaching and learning (T&L) process to enable pupils to acquire ability and confidence in using mathematics in new and different situations.

Besides catering for the need of developing the country, the development of Additional Mathematics KSSM also takes into account the factors that contribute to the formation of logical, critical, analytical, creative and innovative individuals to create a k-economy, highly skilled and resilient society. This step is in line with the need of providing adequate mathematical knowledge and skills to ensure that our country is able to compete globally and to cope with the challenges of the 21st century together with the movement and challenges of the 4.0 Industrial Revolution.

AIM

KSSM Additional Mathematics aims to enhance pupils' mathematical *fikrah* so that they are able to internalise and apply mathematics responsibly and effectively and to solve problems that are more complex. It also aims to ensure that pupils are sufficiently prepared to further their studies and are able to function effectively in their career, especially those leading to science, technology, engineering and mathematics (STEM).

OBJECTIVES

KSSM Additional Mathematics enables pupils to achieve the following objectives:

1. Further develop competency in the areas of algebra, geometry, calculus, trigonometry and statistics.

2. Strengthening the mathematical process skills.

3. Further develop the critical and creative thinking skills and to reason out logically.

4. Making reasonable inferences and generalisations based on situations and various conditions.

5. Relating mathematical learning and ideas to real-life situations.

6. Applying mathematical knowledge and skills in translating and solving more complex problems.

7. Using heuristics and various problem solving strategies that require higher-order thinking skills.

8. Debate solutions using accurate and effective mathematical language and representation.

9. Using technology in building concepts, mastering skills, investigating and exploring mathematical ideas and solving problems.

10. Practicing moral values, having positive attitudes towards mathematics and appreciate its importance and beauty.

THE FRAMEWORK OF SECONDARY SCHOOL STANDARD-BASED CURRICULUM

KSSM is developed based on six fundamental pillars: Communication; Spiritual, Attitude and Values; Humanities; Personal Competence; Physical Development and Aesthetics; and Science and Technology. These six pillars are the main domains that support one another, integrated with critical, creative and innovative thinking. The integration aims to produce human capital who appreciate values based on spiritual practices, knowledge, personal competence, critical and creative thinking as well as innovative thinking as shown in Figure 1. The Additional Mathematics curriculum is developed based on the six pillars of the KSSM Framework.

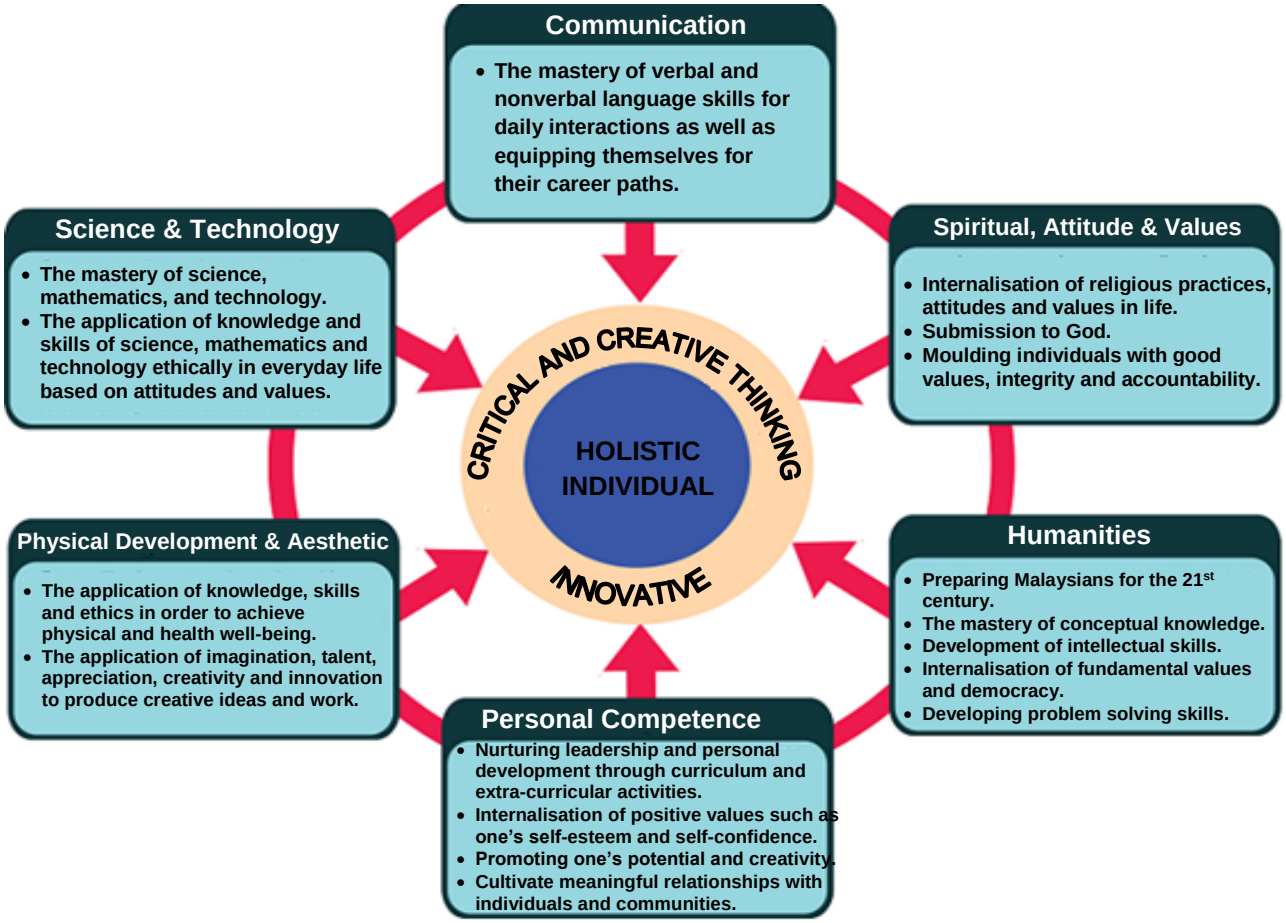


Figure 1: The Framework of Secondary School Standard-Based Curriculum

FOCUS

KSSM Additional Mathematics focuses on developing individuals with mathematical *fikrah*. The Additional Mathematics Curriculum Framework as illustrated in Figure 2, is fundamental to the implementation of the curriculum in the classroom.

Four key elements that contribute to the development of human capital possessing mathematical *fikrah* are:

(i) Learning Areas

(ii) Values

(iii) Skills

(iv) Mathematical Processes

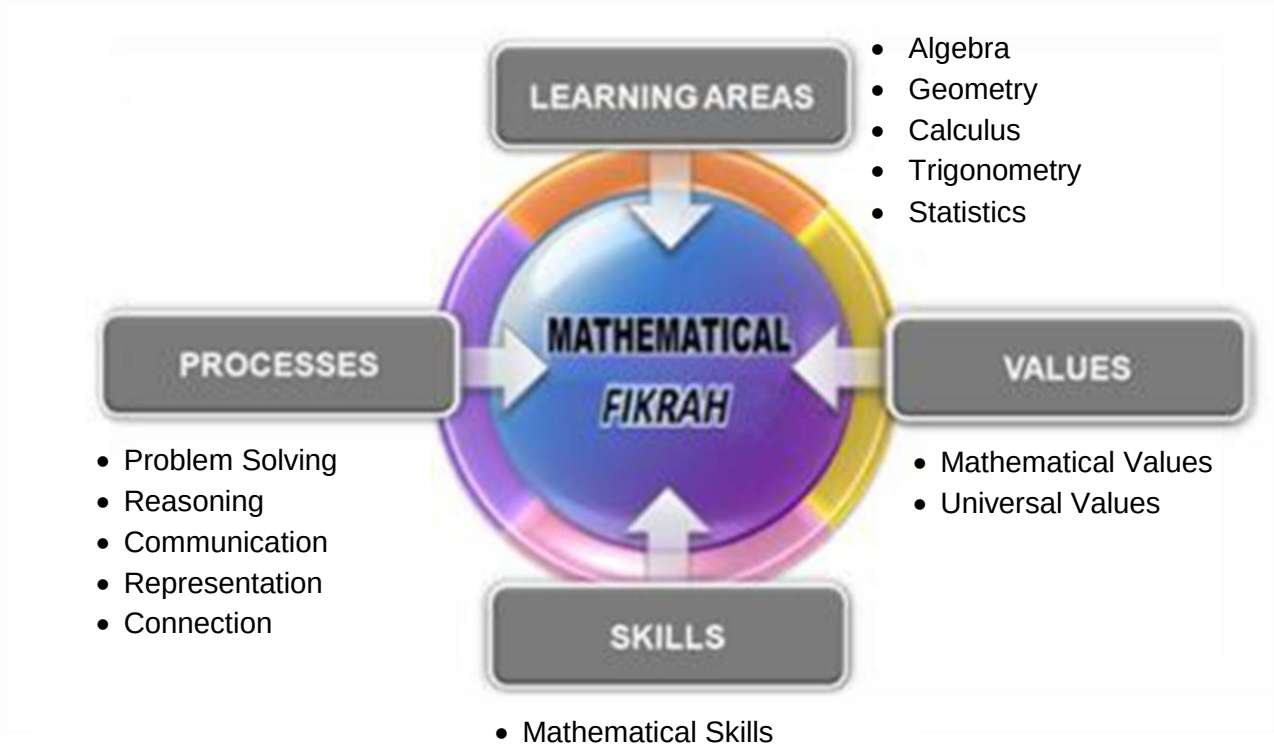


Figure 2: KSSM Additional Mathematics Framework

Mathematical *Fikrah*

According to the Fourth Edition of Kamus Dewan (2005), *fikrah* has the same meaning as the power of thinking and thought. In the context of mathematics education, mathematical *fikrah* refers to the desired quality of pupils to be developed through the national mathematics education system. Pupils who acquired mathematical *fikrah* are capable of doing mathematics, understanding mathematical ideas, and applying the knowledge and skills of mathematics responsibly in daily lives, guided by good attitudes and values.

Mathematical *fikrah* also intends to produce individuals who are creative, innovative and well-equipped to the needs of the 21st century, as the country is highly dependent on the ability of human capital to think and generate new ideas.

Learning Area

The content of KSSM Additional Mathematics covers five inter-related main learning areas namely:

- Algebra
- Geometry
- Calculus
- Trigonometry
- Statistics

Mathematical Processes

Mathematical processes that support effective and thoughtful learning of Additional Mathematics are:

- Problem Solving
- Reasoning
- Communication
- Connection
- Representation

The five mathematicals processes are inter-related and should be implemented accross the curriculum integratedly.

Problem solving is the heart of mathematics. Hence, problem solving skills need to be developed comprehensively, integrated and across the KSSM Additional Mathematics curriculum. In accordance with the importance of problem solving, mathematical processes are the backbone of the T&L of mathematics and should be able to produce pupils who are capable of using a variety of problem solving strategies, higher-order thinking skills, and who are creative and innovative. Teachers need to design T&L sessions that make problem solving as the focus of discussion. Activities carried out should engage pupils actively by posing a variety of

questions and tasks that contain not only routine questions but non-routine questions. Problem solving involving non-routine questions basically demands thinking and reasoning at a higher level, and should be cultivated by the teachers in order to prepare pupils who are able to compete at a global level.

The following steps should be emphasised so that pupils are able to solve problems systematically and effectively:

- Understanding and interpreting the problems
- Devising problem solving strategies
- Implementing the strategies
- Doing reflection

The application of various general strategies in problem solving, including the steps involved has to be used widely. Among the strategies commonly used are drawing diagrams, identifying patterns, making tables/charts or systematic lists, using algebra, trying simpler cases, reasoning out logically, using trial and improvement, making simulation, working backwards as well as using analogies.

The following are some of the processes that need to be emphasised through problem solving that is the development of pupils' capacity in:

- Formulating mathematical situations involving various contexts such as personal, community, scientific and occupation.

- Using and applying concepts, facts, procedures and reasoning in solving problems.

- Interpreting, evaluating and reflecting on the solutions or decisions made and determining whether they are reasonable.

Reflection is an important step in problem solving. Reflection allows pupils to see, understands and appreciates perspectives from different angles as well as enables pupils to consolidate their understanding of the concepts learned.

Reasoning is an important basis for understanding mathematics more effectively and meaningfully. The development of mathematical reasoning is closely related to pupils' intellectual development and communication. Reasoning not only develops the capacity of logical thinking but also increases the capacity of critical thinking which is fundamental in understanding mathematics in

depth and meaningfully. Therefore, teachers need to provide spaces and opportunities through designing T&L activities that require pupils to do mathematics and be actively involved in discussing mathematical ideas.

The elements of reasoning in the T&L prevent pupils from perceiving mathematics as just a set of procedures or algorithms that should be followed to obtain a solution without understanding the mathematical concepts in depth. Reasoning not only changes pupils' paradigm from emphasising on the importance of procedural knowledge but also gives thought and intellectual empowerment when pupils are guided and trained to make and validate conjectures, provide logical explanations, analyse, evaluate and justify the mathematical activities. Such training would enhance pupils' confidence and courage, in line with the aim of developing powerful mathematical thinkers.

Communication in mathematics is the process of expressing ideas and understanding through verbal, visual or written form using numbers, notations, symbols, diagrams, graphs, pictures or words. Communication is an important process in learning mathematics because mathematical communication helps pupils to clarify and reinforce their understanding of mathematics. Through communication, mathematical ideas can be better expressed and understood. Communication in mathematics, whether verbally, in written form or using symbols and visual representations (charts, graphs, diagrams, etc), help pupils to understand and apply mathematics more effectively.

Teachers should be aware of the opportunities that exist during T&L sessions to encourage pupils to express and present their mathematical ideas by using appropriate questioning techniques. Communication that involves a variety of perspectives and points of view helps pupils to better improve their mathematical understanding whilst enhancing their self-confidence.

The significant aspect of mathematical communication is the ability to provide effective explanation as well as to understand and apply the correct mathematical notations. Pupils should use the mathematical language and symbols correctly to ensure that mathematical ideas can be explained precisely.

Effective communication requires an environment that is always sensitive to the needs of pupils so that they feel comfortable while speaking, asking and answering questions, explaining and justifying their views and statements to their classmates and teachers. Pupils should be given the opportunities to communicate

actively in a variety of settings, for example while doing activities in pairs, groups or while giving explanation to the whole class.

Representation is an important component of mathematics and often used to represent real-world phenomena. Therefore, there must be a similarity between the aspects of the world that is being represented and the world that it is representing. Representation can be defined as any notations, letters, images or concrete objects that symbolise or represent something else.

At secondary school level, representing ideas and mathematical models generally make use of symbols, geometry, graphs, algebra, diagrams, concrete representations and dynamic software. Pupils must be able to change from one form of representation to another and recognise the relationship between them, and use various representations, which are relevant and required to solve problems.

The use of various representations helps pupils to understand mathematical concepts and relationships, communicate their thinking, reasoning and understanding; recognise the relationship between mathematical concepts and use mathematics to model situations, physical and social phenomena. When pupils are able to represent concepts in different ways, they will be flexible in their thinking and understand that there are varieties of ways to represent mathematical ideas that enable problems to be easily solved.

Connection between areas in mathematics such as counting, geometry, algebra, measurement and statistics is important for pupils to learn concepts and skills integratedly and meaningfully. By recognising how the concepts or skills in different areas are related to each other, mathematics will be seen and studied as a discipline that is comprehensive, connected to each other and allowing the abstract concepts to be more easily understood.

When mathematical ideas are connected to daily life experiences within and outside the classroom, pupils will be more aware of the use, the importance, the strength and the beauty of mathematics. Besides, they are also able to use mathematics contextually in other disciplines and in their daily lives. Mathematical models are used to describe real-life situations mathematically. Pupils will realise that this method can be used to find solutions to problems or to predict the possibility of a situation based on the mathematical models.

In implementing the KSSM Additional Mathematics, the opportunities to make connections should be established so that

pupils can relate conceptual knowledge to procedural knowledge and be able to relate topics within the Additional Mathematics and relate mathematics to other fields in general. This will enhance pupils' understanding of mathematics, making it clearer, more meaningful and interesting.

Mathematical Process Standards

Table 1 shows the mathematical process standards to be achieved by pupils through the implementation of this curriculum.

Table 1: Mathematical Process Standards

PROBLEM SOLVING
• Understand the problems. • Extract relevant information in a given situation and organise information systematically. • Plan various strategies to solve problems. • Implement the strategies according to the plan. • Generate solutions that meet the requirements of the problems. • Interpret the solutions. • Review and reflect upon the solutions and strategies used.

REASONING
• Recognise reasoning and proving as fundamentals to mathematics. • Recognise patterns, structures, and similarities within real-life situations and symbolic representations. • Choose and use various types of reasoning and methods of proving. • Create, investigate and verify mathematical conjectures. • Develop and evaluate mathematical arguments and proofs. • Make and justify the decisions made.

COMMUNICATION IN MATHEMATICS
• Organise and incorporate mathematical thinking through communication to clarify and strengthen the understanding of mathematics. • Communicate mathematical thoughts and ideas clearly and confidently. • Use the language of mathematics to express mathematical ideas precisely. • Analyse and evaluate mathematical thinking and strategies of others.

REPRESENTATION
• Illustrate mathematical ideas using various types of representations. • Make interpretations from given representations. • Choose appropriate types of representations. • Use various types of mathematical representations to: i) simplify complex mathematical ideas ii) assist in problem solving iii) build models and interpret mathematical phenomena iv) make connections between various types of representations.
CONNECTION
• Identify and use the connection between mathematical ideas. • Understand how mathematical ideas are inter-related and form a cohesive unity. • Relate mathematical ideas to daily life and other fields.

Skills in Mathematics Education

The skills that must be developed and instilled among pupils through this subject include Mathematical Skills, 21st Century Skills and Higher-Order Thinking Skills (HOTS).

The mathematical skills refer to the skills of measuring and constructing, estimating and rounding, collecting and handling data, representing and interpreting data, recognising relationships and representing mathematically, translating real-life situations into mathematical models, using precise language of mathematics, applying logical reasoning, using algorithms and relationships, using mathematical tools, solving problems, making decisions and others. In addition, the curriculum also demands the development of pupils' mathematical skills related to creativity, the needs for originality in their thinking and the ability to see things around them with new and different perspectives in order to develop creative and innovative individuals. The use of mathematical tools strategically, accurately and effectively is strongly emphasised in the T&L of mathematics. The mathematical tools include papers and pencils, rulers, protractors, compasses, calculators, electronic spreadsheets, dynamic software and others.

The rapid progress of various technologies in today's life has resulted in the use of technologies as an essential element in the T&L of mathematics. Effective teachers will maximise the potential and technological capabilities so that pupils can develop understanding and increase their proficiency and interest in mathematics. Due to the capacity and effectiveness of technology in the teaching of mathematics content, teachers need to embrace

the use of technology, particularly graphing calculators, computer software like Geometer's Sketchpad, Geogebra, electronic spreadsheets, learning software (courseware), the Internet and others.

However, technology must be used wisely. Scientific calculator for example is not to be used to the extent that the importance of mental calculations and basic computations is neglected. Efficiency in carrying out the calculations is important especially in the lower level and pupils should not totally rely on calculators. For example, although the graphing calculator helps pupils to visualise the nature of a function and its graph, fundamentally the use of papers and pencils is still the learning outcome to be achieved by all pupils. Similarly, in seeking the roots of the quadratic equations, the basic concept must first be mastered by pupils. Technology should be used wisely to help pupils form concepts, enhance understanding, visualise concepts and others, while enriching pupils learning experiences.

Specifically, the skills in using technology that need to be nurtured in the pupils through Additional Mathematics are the pupils' ability in:

- Using technology to explore, carry out research, construct mathematical modelling and hence form deep understanding of the mathematical concepts.
- Using technology to help in calculations to solve problems effectively.
- Using technology, especially electronic and digital technology to find, manage, evaluate and communicate information.
- Using technology responsibly and ethically.

The use of technology such as dynamic software, scientific and graphing calculators, the Internet and others need to be integrated into the T&L of mathematics to help pupils form deep understanding of concepts especially abstract concepts.

Values in Mathematics Education

Values are affective qualities intended to be formed through the T&L of mathematics using appropriate contexts. Values are usually taught and learned implicitly through the learning sessions. Moral values being instilled will manifest good attitudes. The application of values and attitudes in the T&L of mathematics are intended to produce individuals who are competent in terms of knowledge and skills as well as having good characters. Embracing moral values

would produce a virtuous young generation with noble personal qualities and good attitudes.

Values that need to be developed in pupils through the T&L of Additional Mathematics are:

- Mathematical values - values within the knowledge of mathematics which include emphasis on the properties of the mathematical knowledge; and
- Universal values - universal noble values that are applied across all the subjects.

The development of values through the T&L of mathematics should also involve the elements of divinity, faith, interest, appreciation, confidence, competence and tenacity. Belief in the power and greatness of God can basically be nurtured through the content of the curriculum. The relationship between the content learned and the real world enables pupils to see and validate the greatness and the power of the creator of the universe.

The elements of history and patriotism should also be inculcated through relevant topics to enable pupils to appreciate mathematics as well as to boost their interest and confidence in mathematics. Historical elements such as certain events involving mathematicians or a brief history of a concept or symbol are also emphasised in this curriculum.

21st CENTURY SKILLS

One of the aims of KSSM is to produce pupils who possess the 21st Century Skills by focusing on thinking skills, living skills and career, guided by the practice of moral values. The 21st Century Skills aim to produce pupils who have the characteristics specified in the pupils' profile as in Table 2, so that they are able to compete at a global level. The mastery of the Content Standards and the Learning Standards in the Additional Mathematics curriculum contributes to the acquisition of the 21st Century Skills among the pupils.

Table 2: Pupils' Profile

PUPILS' PROFILE	DESCRIPTION
Resilient	Pupils are able to face and overcome difficulties and challenges with wisdom, confidence, tolerance, and empathy.
Competent Communicator	Pupils voice out and express their thoughts, ideas and information confidently and creatively, in verbal and written form, using various media and technology.

PUPILS' PROFILE	DESCRIPTION
Thinker	Pupils think critically, creatively and innovatively; are able to solve complex problems and make ethical decisions. They think about learning and themselves as learners. They generate questions and be open towards other individual's and communities' perspectives, values, and traditions. They are confident and creative in handling new learning areas.
Team Work	Pupils can co-operate effectively and harmoniously with others. They shoulder responsibilities together as well as respect and appreciate the contributions from each member of the team. They acquire interpersonal skills through collaborative activities, and this makes them better leaders and team members.
Inquisitive	Pupils develop natural inquisitiveness to explore new strategies and ideas. They learn skills that are necessary for inquiry-learning and research, as well as display independent traits in learning. The pupils continuously enjoy life-long learning experience.
Principled	Pupils have a sense of integrity and sincerity, equality, fairness and respect the dignity of individuals, groups and community. They are responsible for their actions, consequences and decisions.
Informed	Pupils obtain knowledge and develop a broad and balanced understanding across various disciplines of knowledge. They explore knowledge efficiently and effectively in terms of local and global contexts. They understand issues related to ethics or laws regarding information acquired.
Caring	Pupils show empathy, compassion and respect towards the needs and feelings of others. They are committed to serve the society and ensure the sustainability of the environment.
Patriotic	Pupils demonstrate their love, support and respect for the country.

HIGHER-ORDER THINKING SKILLS

Higher-Order Thinking Skills (HOTS) are explicitly stated in the curriculum so that teachers are able to translate into their T&L to promote a structured and focused thinking among students. Explanation of HOTS focuses on four levels of thinking as shown in Table 3.

Table 3: Level of Thinking in HOTS

LEVEL OF THINKING	EXPLANATION
Applying	Using knowledge, skills and values in different situations to perform a task.
Analysing	Breaking down information into smaller parts in order to understand and make connections between these parts.
Evaluating	Making considerations and decisions using knowledge, experience, skills, and values as well as giving justification.
Creating	Producing creative and innovative ideas, products or methods.

HOTS is the ability to apply knowledge, skills and values to reason out and make reflection to solve problems, make decisions, innovate and able to create something. HOTS includes critical and creative thinking, reasoning and thinking strategies.

Critical thinking skills is the ability to evaluate a certain idea logically and rationally in order to make fair judgments using logical reasoning and evidences.

Creative thinking skills is the ability to produce or create something new and worthy using authentic imagination and thinking out of the ordinary.

Reasoning skills is an individual ability to make logical and rational considerations and evaluations.

Thinking strategies is a structured and focused way of thinking to solve problems.

HOTS can be applied in classrooms through reasoning, inquiry-based learning, problem solving and projects. Teachers and pupils need to use thinking tools such as thinking maps and mind maps as well as high-level questioning techniques to encourage pupils to think.

TEACHING AND LEARNING STRATEGIES

Good T&L of Additional Mathematics demands teachers to carefully plan activities and to integrate diversified strategies that enable pupils to not only understand the content in depth, but challenge them to think at a higher level.

The T&L of Additional Mathematics emphasises active pupils'

participation, which among others, can be achieved through:

- Inquiry-based learning, which includes investigation and exploration of mathematics.
- Problem-based learning.
- The use of technology in concept building.

Inquiry-based is a T&L strategy that emphasises experiential learning. Inquiry generally means to seek information, to question and to investigate real-life phenomena. Discovery is a major characteristic of inquiry-based learning. Learning through discovery occurs when the main concepts and principles are investigated and discovered by pupils themselves. Through the activities, pupils will investigate a phenomenon, analyse patterns and thus form their own conclusions. Teachers then guide pupils to discuss and understand the concept of mathematics through the inquiry results. KSSM Additional Mathematics emphasizes deep conceptual understanding, efficiency in manipulation, the ability to reason and communicate mathematically. Thus, the T&L that involves inquiry, exploration and investigation of mathematics should be conducted wherever appropriate. Teachers need to design T&L activities that provide space and opportunities for pupils to make conjectures, reason out, ask questions, make reflections and thus form concepts and acquire knowledge on their own.

A variety of opportunities and learning experiences, integrating the use of technology, and problem solving that involves a balance of both routine and non-routine questions are also emphasised in the T&L of Additional Mathematics. Non-routine questions requiring higher-order thinking are emphasised in order to achieve the vision of producing human capital who can think mathematically, creatively as well as innovatively, being able to compete in the era of globalisation and to meet the challenges of the 21st century.

Additional Mathematics is a discipline of knowledge consisting of concepts, facts, characteristics, rules, patterns and processes. Thus, the strategies used in the T&L of Additional Mathematics require diversity and balance. The traditional strategy is sometimes still necessary when teaching a procedural-based content. On the other hand, certain content requires teachers to provide learning activities that enable pupils to discover the concept on their own. Thus, structured questioning techniques are needed to enable pupils to discover the rules, patterns or the properties of mathematical concepts.

The use of teaching aids and carrying out tasks in the form of presentations or project works need to be incorporated into the learning experiences in order to develop pupils who are competent

in applying knowledge and skills of mathematics in solving problems that involve everyday situations as well as to develop soft skills among them.

Thoughtful learning of mathematics should be incorporated into T&L practices. Thus, T&L strategies should be pupil-centred to enable them to interact and acquire the learning skills through their own experiences. Approaches and strategies of learning, such as inquiry-discovery, mathematical exploration and investigation and pupil-centred activities with the aid of mathematical tools that are appropriate, comprehensive and effective can make the learning of Additional Mathematics useful and challenging, which in turn will form the basis for deep understanding of concepts.

Teachers need to diversify the methods and strategies of T&L to meet the needs of pupils with various abilities, interests and preferences. The active involvement of pupils in meaningful and challenging T&L activities should be designed specifically to cater to their needs. Every pupil should have an equal opportunity to form conceptual understanding and procedural competence. Therefore, teachers should be mindful in providing the ecosystem of learning and intellectual discourse that require pupils to collaborate in solving meaningful and challenging tasks.

Creativity and innovation are key elements in the development of a knowledgable society in the 21st century. Both of these elements will significantly contribute to the social and individual prosperity of a country. Malaysia needs creative and innovative human capital in order to compete in todays' world which is increasingly competitive and dynamic. Education is seen as a mean in developing skills of creativity and innovation among the people.

Creativity and innovation are interrelated. In general, creativity refers to the ability to produce new ideas, approaches or actions. Innovation is the process of generating creative ideas in a certain context. Creativity and innovation capabilities are the skills that can be developed and nurtured among pupils through the T&L in the classroom. Mathematics is the science of patterns and relations which has aesthetic values that are closely related to the natural phenomena. Hence, mathematics is the cornerstone and the catalyst for the development of creativity and innovative skills among pupils through suitable tasks and activities.

Teachers need to design T&L activities that encourage and foster creativity and innovation. Among the strategies that can be used, is to involve pupils in complex cognitive activities such as:

- The implementation of tasks involving non-routine questions requiring diversified problem-solving strategies and high level of thinking.
- The use of technology to explore, build conceptual understanding and solve problems.
- Fostering a culture in which pupils showcase creativity and innovation in a variety of forms.
- Design T&L that provides space and opportunities for pupils to do mathematics and build understanding through inquiry-based exploration and investigation activities.

Other diversified T&L approaches and strategies such as mastery learning, contextual learning, constructivism, project-based learning, problem-based learning and so on should be implemented in accordance to the needs and appropriateness.

STEM (Science, Technology, Engineering and Mathematics) APPROACH

STEM approach is the T&L method which applies integrated knowledge, skills and values of STEM through inquiry, problem solving or project in the context of daily life, environment and local as well as global community, as shown in Diagram 3.

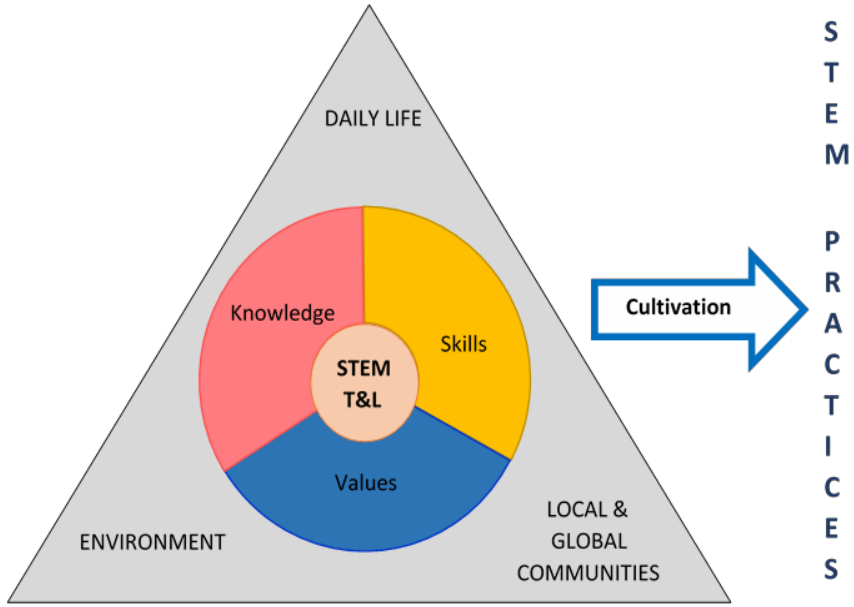


Diagram 3: STEM as T&L Approach

Contextual and authentic T&L of STEM are able to encourage in-depth learning among pupils. Pupils can work in groups or

individually according to their ability to cultivate the STEM practices as follows:

1. Questioning and identifying problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analysing and interpreting data
5. Using mathematical and computational thinking
6. Developing explanation and designing solutions
7. Engaging in argument and discussion based on evidence
8. Acquiring information, evaluating and communicating about the information.

CROSS-CURRICULAR ELEMENTS

Cross–curricular Elements (EMK) are value-added elements applied in the T&L process other than those specified in the Content Standards. These elements are applied to strengthen the skills and competency of the intended human capital, capable of dealing with the current and future challenges. The elements in the EMK are as follows:

1. Language

- The use of proper language of instruction should be emphasised in all subjects.
- During the T&L of every subject, aspects of pronunciation, sentence structure, grammar and vocabulary should be emphasised to help pupils organise ideas and communicate effectively

2. Environmental Sustainability

- Developing awareness and love for the environment needs to be nurtured through T&L process in all subjects.
- Knowledge and awareness on the importance of the environment would shape pupils' ethics in appreciating nature.

3. Moral Values

- Moral values are emphasised in all subjects so that pupils are aware of the importance of such values; hence practice them.
- Moral values include aspects of spirituality, humanity and citizenship that are being practised in daily life.

4. Science and Technology

- Increasing the interest in science and technology can improve literacy in science and technology among pupils.
- The use of technology in teaching can help and contribute to a more efficient and efffective learning.

- Integration of science and technology in T&L covers four main matters:
  (i) Knowledge of science and technology (facts, principles, concepts related to science and technology)
  (ii) Scientific skills (thinking processes and certain manipulative skills)
  (iii) Scientific attitude (such as accuracy, honesty, safety)
  (iv) The use of technology in T&L learning activities

5. Patriotisme

- The spirit of patriotism is to be fostered through all subjects, extra-curricular activities and community services.
- Patriotisme develops the spirit of love for the country and instils a sense of pride of being Malaysians amongst pupils

6. Creativity and Innovation

- Creativity is the ability to use imagination to collect, assimilate and generate ideas or create something new or original through inspiration or combinations of existing ideas.
- Innovation is the application of creativity through modification, improving and practising the ideas.
- Creativity and innovation go hand in hand are needed in order to develop human capital that can face the challenges of the 21st century.
- Elements of creativity and innovation should be integrated into the T&L.

7. Entrepreneurship

- Inculcation of entrepreneurial elements aims to establish the characteristics and the practice of entrepreneurship so that it becomes a culture among pupils.
- Features of entrepreneurship can be applied in T&L through activities that could foster attitudes such as diligence, honesty, trustworthy, responsibility and to develop creative and innovative minds to market the ideas.

8. Information and Communication Technology (ICT)

- Application of ICT elements into the T&L ensure that pupils can apply and consolidate the knowledge and basic ICT skills learnt.
- Application of ICT encourages pupils to be creative and makes T&L more interesting and fun as well as improving the quality of learning.

- ICT should be integrated in the lesson based on appropriate topics to be taught to further enhance pupils'understanding of the content.
- One of the emphases in ICT is computational thinking that can be applied in all subjects. Computational thinking is a skill for using logical reasoning, algorithms, resolutions, pattern recognition, scaling and evaluation in the process of solving computer-assisted problems.

9. Global Sustainability

- Global Sustainability elements aim to produce pupils who have sustainable thinking and are responsive to the environment in their daily lives by applying the knowledge, skills and values acquired through the elements of Sustainable Consumption and Production, Global Citizenship and Unity.
- Global Sustainability elements are significant in preparing pupils to face the challenges and current issues at different levels: local, national and global.
- These elements are taught both directly and indirectly in the relevant subjects.

10. Financial Education

- Application of financial education elements aims at shaping the future generation that is capable of making wise financial decision, practise financial management ethically and possess skills in managing financial affairs responsibly
- Elements of financial education can be applied in T&L directly or indirectly. Direct application is done through the topics that contain explicit financial elements such as the calculation of simple interest and compound interest. Indirect application is integrated through other titles across the curriculum. Exposure to financial management in real-life is important as to provide pupils with the knowledge, skills and values that can be applied effectively and meaningfully.

CLASSROOM ASSESSMENT

Classroom assessment is a process of obtaining information about pupils' progress, which is planned, carried out and reported by the teachers concerned. This ongoing process is to enable teachers to determine the level of pupils' performance.

Classroom assessment can be carried out by teachers formatively and summatively. Formative assessments are carried out alongside the T&L processes, while summative assessments are carried out at the end of a learning unit, term, semester or year.

Teachers need to plan, construct items, administer, mark, record and report pupils' performance level in the subjects taught based on the DSKP.

In order to ensure that assessment helps to improve the ability and performance of pupils, teacher should carry out the assessment that has the following features:

- Using various assessment methods such as observation, oral and writing.
- Taking into account the knowledge, skills and values that are intended in the curriculum.
- Allowing pupils to exhibit various learning capabilities.
- Assessing the level of pupils' performance based on Learning Standards and Performance Standards.
- Taking follow-up actions for improvement and consolidation purposes.
- Holistic, that is taking into account various levels of cognitive, affective and psychomotor.
- Fair to all pupils.

General Performance Level

Performance level is a form of achievement statement that shows the progress of pupils' learning. There are six levels of performance that indicate level of performance arranged in hierarchy. This level of performance takes into account the knowledge, skills and mathematical processes specified in the curriculum. The Performance Standards (SPi) for each topic is constructed based on the General Performance Level as in Table 4. The purpose of SPi is to help teachers to make professional judgement in determining the level of performance that needs to be reported in a given duration or time frame.

Table 4: Statements of General Performance Level of KSSM Additional Mathematics.

LEVEL	INTERPRETATION
1	Demonstrate basic knowledge such as stating a certain mathematical idea either verbally or non-verbally.
2	Demonstrate understanding such as explaining a certain mathematical concept either verbally or non-verbally.
3	Apply understanding of concepts and ideas in mathematics such as performing calculations, constructing tables and drawing graphs

LEVEL	INTERPRETATION
4	Apply suitable knowledge and skills when using algorithms, formulae, procedures or basic methods in the context of problem solving involving simple routine problems.
5	Apply suitable knowledge and skills in new situations such as performing multi-step procedures, using representations based on different sources of information and reason out directly in the context of solving complex routine problems.
6	Apply suitable knowledge and skills such as using information based on investigation and modelling in solving complex problems situations; reason out at high level, form new approaches and strategies in the context of solving non-routine problems creatively.

Teachers can record pupils progress in teacher's record books, exercise books, note books, checklist, tables or others.

Assessment of Values

Elements of attitudes and values that need to be displayed and practised by pupils are assessed continuously through various media such as observations, exercises, presentations, pupils' verbal responses, collaborative activities and others. The achievement report of these elements may be done during mid-year and year-end to observe pupils' progress and help them to improve the practice of good values, based on Table 5.

Table 5: Level of Values Internalisation in Mathematics Education

VALUE IN MATHEMATICS EDUCATION	INTERNALISATION LEVEL
Interested in learning mathematics	**Low:** 1, 2 or 3 of all the standards listed are observed. **Medium:** 4, 5 or 6 of all the standards listed are observed. **High** 7, 8 or 9 of all the standards listed are observed
Appreciate the aesthetic values and the importance of mathematics	
Confident and patient in learning mathematics.	
Willingness to learn from mistakes.	
Working towards accuracy.	
Practising self-access learning.	
Dare to try something new.	
Working systematically.	
Using mathematical tools accurately and effectively.	

The level of values internalisation in mathematics education is categorised into three levels, which are low, medium and high. Teachers need to assess these elements holistically and comprehensively through detailed observation as well as using professional judgements to determine the level of values internalisation of each pupil.

Performance Level According to Learning Areas and Overall Performance Level

Performance Level according to learning areas and Overall Performance Level should be determined at the end of certain learning period as needed. These levels comprise the aspects of content, skills and mathematical processes, which are emphasised in the curriculum, including higher-order thinking skills. Teachers need to evaluate pupils collectively, comprehensively and holistically, taking into consideration pupils' activities on a continuous basis through various media such as achievement in examination, topical tests, observations, exercises, presentations, pupils' verbal responses, group work, projects and so on. Elements, which are emphasised in the Performance Level according to learning areas and Overall Performance Level, should be developed in an integrated manner among the pupils through various tasks. Therefore, teachers have to use their wisdom in making professional judgement to determine pupils' Performance Level according to learning areas and overall performance level as in Table 6.

Table 6: Performance Level According to Learning Areas and Overall Performance Level

PERFORMANCE LEVEL	CONTENTS, SKILLS AND MATHEMATICAL PROCESSES
1	Pupils are able to: • answer questions where all related information are given and questions are clearly defined. • identify information and carry out routine procedures according to clear instructions.
2	Pupils are able to: • recognise and interpret situations directly. • use single representation. • use algorithms, formulae, procedures or basic methods. • make direct reasoning and interpret the results obtained.
3	Pupils are able to: • perform procedures that are stated clearly, including multi-steps procedures.

PERFORMANCE LEVEL	CONTENTS, SKILLS AND MATHEMATICAL PROCESSES
	• apply simple problem-solving strategies. • interpret and use representations based on different sources of information. • make direct reasoning. • communicate briefly when giving interpretations, results and reasoning.
4	Pupils are able to: • use explicit models effectively in concrete complex situations. • choose and integrate different representations and relate to real world situations. • use skills and reasonings flexibly based on deep understanding and communicate with explanations and arguments based on interpretations, discussions and actions.
5	Pupils are able to: • develop and use models for complex situations. • identify constraints and make specific assumptions. • apply suitable problem-solving strategies. • work strategically using in-depth thinking skills and reasoning. • use various suitable representations and display in-depth understanding. • reflect on results and actions. • formulate and communicate with explanations and arguments based on interpretations, discussions and actions.
6	Pupils are able to : • conceptualise, make generalisations and use information based on investigations and modelling of **complex situations**. • relate **information sources and different representations** and flexibly change one form of representations to another. • possess high level of mathematical thinking and **reasoning skills**. • demonstrate in-depth understanding, form new approaches and strategies to **handle new situations**. • **Formulate** and **communicate with explanations and arguments** based on interpretations, discussions, reflections and actions accurately.

Based on the statements in Table 6, it is clear that teachers should use tasks with various levels of difficulty and complexity which are able to access various elements and pupils' performance level. Holistic assessments are needed in developing pupils with global skills. Content performance has to be supported by pupils' ability to achieve and apply processes, hence display the ability in solving complex problems especially those involving real-life situations. It is important that teachers carry out comprehensive assessments and provide fair and just report of each pupil's performance level.

CONTENT ORGANISATION

Implementation of KSSM Additional Mathematics is in accordance with the current *Surat Pekeliling Ikhtisas*. The minimum time allocation for KSSM Additional Mathematics for Form 4 and 5 is 96 hours each year.

KSSM Additional Mathematics consists of three components: Content Standards (SK), Learning Standards (SP) and Performance Standards (SPi). The interpretation of each part is as in Table 7.

Table 7: Interpretation of Content Standard, Learning Standard and Performance Standard

CONTENT STANDARD	LEARNING STANDARD	PERFORMANCE STANDARD
Specific statement on what pupils should know and be able to do in a certain schooling period which encompasses the aspects of knowledge, skills and values.	Criterion set or indicators of the quality of learning and achievement that can be measured for each Content Standard.	A set of general criteria that shows the levels of performance that pupils should display as an indicator that they have mastered a certain matter.

In the content organisation, there is a Note column. This column contains the limitations and scope of SK and SP, suggested activities, information or notes that support teachers' understanding and mathematical processes that need to be implemented to achieve the SP. Teachers can carry out additional activities other than those suggested according to creativity and the needs to achieve the SP.

The contents of KSSM Additional Mathematics are organised and arranged in independent and complete subunits based on modular approach. The modular approach in T&L enables teachers to arrange the topics and the standards (SK or SP) according to

pupils' ability and the number of hours allocated. This approach can be implemented in two forms as follows:

- Linear modular approach - SK or SP is delivered according to the sequence in DSKP.
- Non-linear modular approach - SK or SP is delivered unsequentially.

Additional Mathematics Learning Packages

The scope of contents of Form 4 and Form 5 Additional Mathematics is compiled in two learning packages namely the Core Package and the Elective Package. The Core Package must be learned by all pupils taking Additional Mathematics.

For the Elective Package, the topic of Solution of Triangles is offered to pupils who are inclined towards STEM area. The use of trigonometry in this topic in finding the relationship between the length of sides and measurements of angles in triangles, has applications in engineering, physics, astronomy, navigation and so forth.

The topic of Index Number is offered to pupils who are inclined towards social science. Index Number is used primarily in trading, industry and so forth.

For the Elective Package of KSSM Additional Mathematics Form 5, the topic Kinematics of Linear Motion is offered to students who are inclined towards the STEM field. The understanding of Kinematics is the foundation for the understanding of the real world. Through this topic, pupils learn about the movement and changes in position and velocity of an object. The relationship between differentiation and integration is essential towards the understanding and ability of pupils in this topic. The application of Kinematics is prevailing in various areas such as Physics, astronomy, transportation and sport.

The topic of Linear Programming is offered to pupils who are inclined towards social science. The application of this topic is widely used in various areas such as business, industry, management, agricultural, education, pollution control and transportation. Optimisation process that is learned in this topic will enable pupils to solve problems and make decisions which are essential in learning mathematics.

The Core Package and the Elective Package for Additional Mathematics for Form 4 and 5 contain learning area and topics as shown in table 8. Pupils can choose to learn either one or both topics offered according to their abilities and future field inclination.

Table 8: Form 4 and 5 KSSM Additional Mathematics Content

PACKAGE	LEARNING AREA	TOPICS IN FORM FOUR	TOPICS IN FORM FIVE
Core	Algebra	• Functions • Quadratic Functions • Systems of Equations • Indices, Surds and Logarithms • Progressions • Linear Law	
	Geometry	• Coordinate Geometry • Vectors	• Circular Measure
	Calculus		• Differentiation • Integration
	Trigonometry		• Trigonometric Functions
	Statistics		• Permutation and Combination • Probability Distribution
Elective	Trigonometry (Application of Science and Technology)	• Solution of Triangles	
	Statistics (Application of Social Science)	• Index Numbers	
	Calculus (Application of Science and Technology)		• Kinematics of Linear Motion
	Algebra (Application of Social Science)		• Linear Programming

Content Standard, Learning Standard and Performance Standard

Form 4

LEARNING AREA

ALGEBRA

TOPIC

1.0 FUNCTIONS

1.0 FUNCTIONS

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
1.1 Functions	Pupils are able to: 1.1.1 Explain function using graphical representations and notations.	Notes: Real-life situations need to be involved throughout the topic. Function notations: $f : x \to 2x$ or $f(x) = 2x$, x as an object and $2x$ as an image. The following functions need to be emphasised and associated with graphical representation: (a) function which is undefined at certain values. Example: $f(x) = \frac{3}{x-1}, x \neq 1$ (b) absolute value function. Example: $f(x) = \lvert x \rvert$. $\lvert x \rvert = \begin{cases} x & , x \geq 0 \\ -x & , x < 0 \end{cases}$ Vertical line test can be used to determine whether the relation is a function.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	1.1.2 Determine domain and range of a function.	Notes: The terms domain, codomain and range need to be introduced. Exploratory activities involving various functions to identify the domain and range of a function need to be carried out. Discrete, continuous and absolute value functions need to be involved. Graphs of absolute value function in a particular domain need to be sketched.
	1.1.3 Determine the image of a function when the object is given and vice versa.	Notes: Absolute value function is involved.
1.2 Composite Functions	Pupils are able to: 1.2.1 Describe the outcome of composition of two functions.	Notes: Exploratory activities using dynamic geometry software to understand composite functions need to be carried out.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	1.2.2 Determine the composite functions. 1.2.3 Determine the image of composite functions given the object and vice versa. 1.2.4 Determine a related function given composite function and another function. 1.2.5 Solve problems involving composite functions.	Notes: Representation of composite functions using arrow diagram needs to be discussed. Composition is limited to two algebraic functions. Notes: $f^2(x), f^3(x), f^4(x), ..., f^n(x)$ for certain functions need to be involved.
1.3 Inverse Functions	Pupils are able to: 1.3.1 Describe inverse of a function.	Notes: Functions are limited to single functions. The symbol of inverse function, f^{-1} is introduced. Exploratory activities using digital technology to identify the connection between graph of function and its inverse need to be carried out.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	1.3.2 Make and verify conjectures related to properties of inverse functions.	Notes: Exploratory activities need to be carried out to make and verify that the properties of inverse functions are: (a) Only one to one function has an inverse function. (b) f and g are inverse functions of each other if and only if (i) $fg(x) = x$, x in domain of g, and (ii) $gf(x) = x$, x in domain of f. (c) If f and g are inverse functions of each other, then (i) Domain of f = range of g, and (ii) Domain of g = range of f (iii) graph g is the reflection of graph f on the line $y = x$. (d) If point (a, b) is on the graph f, then point (b, a) is on the graph g. Horizontal line test can be used to test the existence of inverse functions.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	1.3.3 Determine the inverse functions. .	Notes: Inverse functions are limited to algebraic functions. $ff^{-1}(x) = f^{-1}f(x) = x$ need to be involved.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of functions.
2	Demonstrate the understanding of functions.
3	Apply the understanding of functions to perform simple tasks.
4	Apply appropriate knowledge and skills of functions in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of functions in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of functions in the context of non-routine problem solving in a creative manner.

LEARNING AREA

ALGEBRA

TOPIC

2.0 QUADRATIC FUNCTIONS

2.0 QUADRATIC FUNCTIONS

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
2.1 Quadratic Equations and Inequalities	Pupils are able to: 2.1.1 Solve quadratic equations using the method of completing the square and formula.	Notes: The use of dynamic geometry software to explore the solution of quadratic equations needs to be involved. Derivation of formula from completing the square method needs to be discussed. The use of calculator is only allowed in checking the answers.
	2.1.2 Form quadratic equations from given roots.	Notes: If α and β are roots of the quadratic equation, then $(x-\alpha)(x-\beta)=0$ or $x^2-(\alpha+\beta)x+\alpha\beta=0$. The relationship between quadratic equation in general form and $x^2-(\alpha+\beta)x+\alpha\beta=0$ needs to be discussed.
	2.1.3 Solve quadratic inequalities.	Suggested Activities: The following methods of solutions can be explored: (a) graphs sketching method

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
		(b) number lines (c) tables
2.2 Types of Roots of Quadratic Equations	Pupils are able to: 2.2.1 Relate types of roots of quadratic equations to the discriminant value. 2.2.2 Solve problems involving types of roots of quadratic equations.	Notes: Real roots and no real roots cases need to be discussed. Suggested activities: Imaginary roots such as $i = \sqrt{-1}$ can be discussed.
2.3 Quadratic Functions	Pupils are able to: 2.3.1 Analyse and make generalisation about the effects of changes of a, b and c in $f(x) = ax^2 + bx + c$ towards the shape and position of the graph. 2.3.2 Relate the position of the graph of quadratic functions with type of roots.	Notes: Exploratory activities using dynamic software or graphing calculators need to be carried out. Notes: Dynamic software or graphing calculators can be used.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	2.3.3 Relate the vertex form of quadratic functions, $f(x)=a(x-h)^2+k$ with other forms of quadratic functions.	Notes: Graph sketching needs to be involved. Completing the square method needs to be involved.
	2.3.4 Analyse and make generalisation about the effects of changes of a, h dan k in quadratic functions $f(x)=a(x-h)^2+k$ towards the shape and position of the graphs.	Notes: Exploratory activities by using dynamic software or graphing calculators need to be carried out. The relationship between the value of h and of k with the axis of the symmetry, the minimum value and maximum value need to be explored. A symmetrical axis can also be determined by using $x=-\frac{b}{2a}$
	2.3.5 Sketch graphs of quadratic functions.	
	2.3.6 Solve problems involving quadratic functions.	Notes: Problems involving maximum and minimum values need to be involved. Real-life situations need to be involved.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of quadratic functions.
2	Demonstrate the understanding of quadratic functions.
3	Apply the understanding of quadratic functions to perform simple tasks.
4	Apply appropriate knowledge and skills of quadratic functions in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of quadratic functions in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of quadratic functions in the context of non-routine problem solving in a creative manner.

LEARNING AREA

ALGEBRA

TOPIC

3.0 SYSTEMS OF EQUATIONS

3.0 SYSTEMS OF EQUATIONS

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
3.1 Systems of Linear Equations in Three Variables	Pupils are able to: 3.1.1 Describe systems of linear equations in three variables.	Notes: Real-life situations need to be involved throughout this topic. The use of geometric software is encouraged throughout this topic. Systems of three linear equations involving three variables need to be emphasised. Suggested Activities: Three-dimensional plane can be introduced. Comparison with systems of linear equations in two variables can be discussed.
	3.1.2 Solve systems of linear equations in three variables.	Notes: Elimination and substitution methods need to be involved. No solution cases need to be discussed.
	3.1.3 Solve problems involving systems of linear equations in three variables.	

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
3.2 Simultaneous Equations involving One Linear Equation and One Non-Linear Equation	Pupils are able to: 3.2.1 Solve simultaneous equations involving one linear equation and one non-linear equation.	Notes: Involve only two variables. Elimination, substitution and graphical representation methods need to be involved.
	3.2.2 Solve problems involving simultaneous equations; one linear equation and one non-linear equation.	Notes: Solutions do not involve equations that exceed second degree.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of systems of equations.
2	Demonstrate the understanding of systems of equations.
3	Apply the understanding of systems of equations to perform simple tasks.
4	Apply appropriate knowledge and skills of systems of equations in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of systems of equations in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of systems of equations in the context of non-routine problem solving in a creative manner.

LEARNING AREA

ALGEBRA

TOPIC

4.0 INDICES, SURDS AND LOGARITHMS

4.0 INDICES, SURDS AND LOGARITHMS

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
4.1 Laws of Indices	Pupils are able to: 4.1.1 Simplify algebraic expressions involving indices using the laws of indices. 4.1.2 Solve problems involving indices.	Notes: Real-life situations need to be involved.
4.2 Laws of Surds	Pupils are able to: 4.2.1 Compare rational numbers and irrational numbers, and hence relate surds to irrational numbers.	Notes: Exploratory activities need to be involved. Examples of rational numbers in the form of recurring decimals: (a) 0.3333333... (b) 0.14141414... (c) 3.4566666... Examples of rational numbers in the form of terminating decimals: (a) 0.5 (b) 0.175 (c) 5.8686

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
		Examples of irrational numbers in the form of non recurring and infinite decimals: (a) $\sqrt{2}$ = 1.414213623... (b) π = 3.1415926535... (c) e = 2.71828182845... Conversion of recurring decimal to fractional form needs to be discussed. Surd as an irrational number in the form of root, $\sqrt[n]{a}$ needs to be emphasised. The statement of “Not all the roots are surds” needs to be discussed. Pronunciation of surd needs to be emphasised. Example: $\sqrt[3]{4}$ is read as “surd 4 order 3”. The difference between $\sqrt[n]{a}$ and $n\sqrt{a}$ needs to be emphasised.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	4.2.2 Make and verify conjectures on (i) $\sqrt{a}\times\sqrt{b}$ (ii) $\sqrt{a}\div\sqrt{b}$ and hence make generalisation.	Notes: Limit to square root only. Law 1: $\sqrt{a}\times\sqrt{b}=\sqrt{ab}$ Law 2: $\sqrt{a}\div\sqrt{b}=\sqrt{\frac{a}{b}}$
	4.2.3 Simplify expressions involving surds.	Notes: Examples of expressions: (a) $\sqrt{90}$ (b) $3\sqrt{2}+5\sqrt{2}$ (c) $\sqrt{18}-\sqrt{8}$ (d) $\sqrt{2}\times\sqrt{3}+\sqrt{6}$ (e) $\frac{\sqrt{18}}{3}$ Expressions involving surds as denominators are excluded. The differences between similar surds and not similar surds need to be emphasised.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	4.2.4 Simplify expressions involving surds by rationalising the denominators.	Notes: Two types of denominators are involved: (a) $m\sqrt{a}$, m is an integer (b) $m\sqrt{a} \pm n\sqrt{b}$, m and n are integers - Rationalising using conjugate surds. Examples of expressions: (a) $\frac{2}{\sqrt{3}}$ (b) $\frac{3}{\sqrt{2}+\sqrt{5}}$ (c) $\frac{3\sqrt{20}}{6-\sqrt{5}}$
	4.2.5 Solve problems involving surds.	Notes: Indices need to be involved.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
4.3 Laws of Logarithms	Pupils are able to: 4.3.1 Relate equations in the form of indices and logarithms, and hence determine the logarithm of a number.	Notes: $N = a^x, \log_a N = x$ where $a > 0, a \neq 1$. $\therefore \log_a a^x = x$ The statement of $\log_a 1 = 0$; $\log_a a = 1$ needs to be verified. Exploratory activities involving drawing graphs of exponential and logarithm functions on the same axis need to be carried out. Digital technology can be used. Example: Graph of $y = 10^x$ and $x = \log_{10} y$ Logarithms of negative numbers and of zero need to be explored.
	4.3.2 Prove laws of logarithms.	
	4.3.3 Simplify algebraic expressions using the laws of logarithms.	

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	4.3.4 Prove $\log_b a = \frac{\log_c a}{\log_c b}$ and use the relationship to determine the logarithm of a number. 4.3.5 Solve problems involving the laws of logarithms.	Notes: The relationship of $\log_a b = \frac{1}{\log_b a}$ needs to be discussed. Notes: Real-life situations need to be involved.
4.4 Applications of Indices, Surds and Logarithms	Pupils are able to: 4.4.1 Solve problems involving indices, surds and logarithms	Notes: The number of variables are limited to two. Real-life situations need to be involved. Natural logarithms need to be involved.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of indices, surds and logarithms.
2	Demonstrate the understanding of indices, surds and logarithms.
3	Apply the understanding of indices, surds and logarithms to perform simple tasks.
4	Apply appropriate knowledge and skills of indices, surds and logarithms in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of indices and logarithms in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of indices and logarithms in the context of non-routine problem solving in a creative manner.

LEARNING AREA

ALGEBRA

TOPIC

5.0 PROGRESSIONS

5.0 PROGRESSIONS

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
5.1 Arithmetic Progressions	Pupils are able to:	
	5.1.1 Identify a sequence as an arithmetic progression and provide justification.	Notes: Real-life situations need to be involved throughout this topic. Problem-based learning approach and the use of digital technology are encouraged. Exploratory activities need to be involved.
	5.1.2 Derive the formula of the n^{th} term, T_n, of arithmetic progressions, and hence use the formula in various situations.	
	5.1.3 Derive the formula of sum of the first n terms, S_n, of arithmetic progressions, and hence use the formula in various situations.	Notes: The formula of sum of the first n terms, S_n: $S_n = \frac{n}{2}[2a + (n-1)d]$ The use of these formulae needs to be involved: $S_n = \frac{n}{2}[a + l]$ $T_n = S_n - S_{n-1}$

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	5.1.4 Solve problems involving arithmetic progressions.	Notes: Generating problems or situations based on arithmetic progressions need to be involved.
5.2 Geometric Progressions	Pupils are able to: 5.2.1 Identify a sequence as a geometric progression and provide justification. 5.2.2 Derive the formula of the n^{th} term, T_n, of geometric progressions, and hence use the formula in various situations. 5.2.3 Derive the formula of sum of the first n terms, S_n, of geometric progressions, and hence use the formula in various situations.	Notes: Exploratory activities need to be involved. Notes: Sum of the first n terms of geometric progressions through algebraic representation ($S_n - rS_n$) or graphical representation to verify the formula S_n needs to be discussed. The following formula needs to be involved: $T_n = S_n - S_{n-1}$

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	5.2.4 Determine the sum to infinity of geometric progressions, S_∞ and hence use the formula in various situations.	Notes: Derivation of the formula of sum to infinity of geometric progressions, S_∞ needs to be discussed.
	5.2.5 Solve problems involving geometric progressions.	Notes: Exclude: (a) the combination of arithmetic progressions and geometric progressions. (b) the cumulative sequences such as (1), (2,3), (4,5,6), (7,8,9,10), …

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of progressions.
2	Demonstrate the understanding of arithmetic progressions and geometric progressions.
3	Apply the understanding of arithmetic progressions and geometric progressions to perform simple tasks.
4	Apply appropriate knowledge and skills of arithmetic progressions and geometric progressions in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of arithmetic progressions and geometric progressions in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of arithmetic progressions and geometric progressions in the context of non-routine problem solving in a creative manner.

LEARNING AREA

ALGEBRA

TOPIC

6.0 LINEAR LAW

6.0 LINEAR LAW

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
6.1 Linear and Non-Linear Relations	Pupils are able to: 6.1.1 Differentiate between linear and non-linear relations based on tables of data and graphs.	
	6.1.2 Draw lines of best fit for graph of linear relations with and without the use of digital technology.	Notes: The inspection method needs to be involved and the result is compared to the line obtained by using digital technology. Lines of best fit need not necessarily pass through any of the points.
	6.1.3 Form equations of lines of best fit.	
	6.1.4 Interpret information based on lines of best fit.	Notes: The following interpretations of information need to be involved: (a) Given x, find the value of y, and vice versa.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
		(b) Interpret the gradient and the *y*-intercept – Gradient as the rate of change of one variable with respect to another variable. (c) Make a projection on the value of variables.
6.2 Linear Law and Non-Linear Relations	Pupils are able to: 6.2.1 Apply linear law to non-linear relations.	Notes: The following applications need to be involved: (a) Conversion of non-linear equation to linear form. (b) Determination of the value of constants. (c) Interpretation of information includes making projections about the value of the variables.
6.3 Application of Linear Law	Pupils are able to: 6.3.1 Solve problems involving linear law.	Notes: Problem-based learning may be involved.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of lines of best fit.
2	Demonstrate the understanding of lines of best fit.
3	Apply the understanding of linear law to perform simple tasks.
4	Apply appropriate knowledge and skills of linear law in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of linear law in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of linear law in the context of non-routine problem solving in a creative manner.

LEARNING AREA

GEOMETRY

TOPIC

7.0 COORDINATE GEOMETRY

7.0 COORDINATE GEOMETRY

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
7.1 Divisor of a Line Segment	Pupils are able to: 7.1.1 Relate the position of a point that divides a line segment with the related ratio.	Notes: Explorations involving several specific cases need to be carried out. The effects of changes in ratio towards the position of a point at the same line segment and vice versa need to be involved.
	7.1.2 Derive the formula for divisor of a line segment on a Cartesian plane, and hence use the formula in various situations.	Notes: The formula for divisor of a line segment is: $\left(\frac{nx_1 + mx_2}{m+n}, \frac{ny_1 + my_2}{m+n}\right)$ The formula for midpoint is a case of $m = n$. The relationship between the formula for midpoint and the formula for divisor of a line segment needs to be discussed. Limit to the positive values of m and of n only.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	7.1.3 Solve problems involving divisor of a line segment.	Notes: Real-life situations need to be involved.
7.2 Parallel Lines and Perpendicular Lines	Pupils are able to: 7.2.1 Make and verify conjectures about gradient of: (i) parallel lines, (ii) perpendicular lines and hence, make generalisations. 7.2.2 Solve problems involving equations of parallel and perpendicular lines.	Suggested Activities: The use of dynamic software is encouraged. Notes: Investigate the relationship between the gradient of a straight line and the tangent of the angle between the line and positive direction of the x-axis needs to be conducted. Notes: Real-life situations need to be involved.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
7.3 Areas of Polygons	Pupils are able to:	
	7.3.1 Derive the formula of area of triangles when the coordinates of each vertex are known.	Notes: Exploratory activities need to be carried out to determine the area of triangles. The use of digital technology is encouraged.
	7.3.2 Determine the area of triangles by using the formula.	Notes: Derivation of the formula for area of triangles needs to be discussed and linked to the shoelace algorithm. Example: Given the triangle vertices are $(x_1, y_1), (x_2, y_2)$ and (x_3, y_3), then the formula of area of the triangle is Area = $\frac{1}{2}\left\|\begin{matrix} x_1 & x_2 & x_3 & x_1 \\ y_1 & y_2 & y_3 & y_1 \end{matrix}\right\|$ $= \frac{1}{2}\left\|(x_1y_2 + x_2y_3 + x_3y_1) - (x_2y_1 + x_3y_2 + x_1y_3)\right\|$ The box method as an alternative method to determine the area of triangles needs to be discussed.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	7.3.3 Determine the area of quadrilaterals by using the formula. 7.3.4 Make generalisation about the formula of area of polygons when the coordinates of each vertex are known, and hence use the formula to determine the area of polygons. 7.3.5 Solve problems involving areas of polygons.	Notes: The relationship between the formula of area of triangles and area of quadrilaterals needs to be discussed.
7.4 Equations of Loci	Pupils are able to: 7.4.1 Represent graphically, the locus that satisfies these conditions: (i) the distance of a moving point from a fixed point is constant, (ii) the ratio of a moving point from two fixed points is constant, and hence determine the equation of the locus.	Notes: Exploratory activities by using dynamic geometry software need to be involved. The effects of changes in ratio on the shape of the locus need to be explored. The case when the ratio of 1:1 needs to be discussed.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	7.4.2 Solve problems involving equations of loci.	Notes: Real-life situations need to be involved.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of divisor of line segments.
2	Demonstrate the understanding of divisor of line segments.
3	Apply the understanding of coordinate geometry to perform simple tasks.
4	Apply appropriate knowledge and skills of coordinate geometry in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of coordinate geometry in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of coordinate geometry in the context of non-routine problem solving in a creative manner.

LEARNING AREA

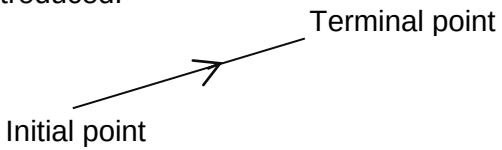
GEOMETRY

TOPIC

8.0 VECTORS

8.0 VECTORS

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
8.1 Vectors	Pupils are able to: 8.1.1 Compare and contrast between vectors and scalars, and hence identify whether a quantity is a vector or a scalar by providing justifications.	Notes: Real-life situations need to be involved. Non-vector and non-scalar situations need to be involved, for example: (a) The wind blows to the South. (b) The car is driven fast. The following differences need to be discussed: (a) displacement and distance. (b) speed and velocity. (c) weight and mass.
	8.1.2 Represent vectors by using directed line segments and vector notations, and hence determine the magnitude and direction of vectors.	Notes: The use of the following notations needs to be emphasised: Vector: $\underset{\sim}{a}$, $\overrightarrow{AB}$, **a**, **AB** Magnitude: $\lvert\underset{\sim}{\mathbf{a}}\rvert$, $\lvert\overrightarrow{AB}\rvert$, **|a|**, **|AB|**

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
		Initial point and terminal point need to be introduced.  Zero vectors, equal vectors and negative vectors need to be involved.
	8.1.3 Make and verify conjectures about the properties of scalar multiplication on vectors.	Notes: If $\underset{\sim}{a}$ is a vector and k is a scalar, then magnitude of $k\underset{\sim}{a}$ is k times the magnitude of $\underset{\sim}{a}$. If k is positive, then $k\underset{\sim}{a}$ is in the same direction as $\underset{\sim}{a}$. If k is negative, then $k\underset{\sim}{a}$ is in the opposite direction as $\underset{\sim}{a}$.
	8.1.4 Make and verify conjectures about parallel vectors.	Notes: If two vectors are parallel, then one vector is the product of a scalar with the other vector.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
		$\underset{\sim}{a}$ and $\underset{\sim}{b}$ are parallel if and only if $\underset{\sim}{a} = k\underset{\sim}{b}$, k is a constant. The following statement needs to be discussed: If $\underset{\sim}{a}$ and $\underset{\sim}{b}$ are not parallel and non-zero, and h $\underset{\sim}{a}$ = k $\underset{\sim}{b}$, then $h = k = 0$.
8.2 Addition and Subtraction of Vectors	Pupils are able to: 8.2.1 Perform addition and substraction involving two or more vectors to obtain a resultant vector.	Notes: The following cases need to be involved: (a) Parallel vectors (b) Non-parallel vectors using (i) triangle law, (ii) parallelogram law, (iii) polygon law. Substraction of vectors is an addition of negative vectors. $\underset{\sim}{a} - \underset{\sim}{b} = \underset{\sim}{a} + (-\underset{\sim}{b})$ Real-life situations need to be involved.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	8.2.2 Solve problems involving vectors.	Notes: Real-life situations need to be involved.
8.3 Vectors in a Cartesian Plane	Pupils are able to: 8.3.1 Represent vectors and determine the magnitude of the vectors in the Cartesian plane.	Notes: The following representations need to be involved: (a) $x\underset{\sim}{i}+y\underset{\sim}{j}$ (b) $\begin{pmatrix}x\\y\end{pmatrix}$ Position vectors need to be involved.
	8.3.2 Describe and determine the unit vector in the direction of a vector.	Notes: Exploratory activities need to be carried out. If $\underset{\sim}{r}=x\underset{\sim}{i}+y\underset{\sim}{j}$, then unit vector $\hat{\underset{\sim}{r}}=\frac{\underset{\sim}{r}}{\lvert\underset{\sim}{r}\rvert}$ Emphasise that the magnitude of the unit vector in the direction of a vector is 1 unit.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	8.3.3 Perform arithmetic operations onto two or more vectors.	Notes: Arithmetic operations are limited to the addition, subtraction, and multiplication of vectors by scalars. Combined arithmetic operations need to be involved. Parallel and non-parallel vectors need to be involved.
	8.3.4 Solve problems involving vectors.	Notes: Real-life situations need to be involved.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of vectors.
2	Demonstrate the understanding of vectors.
3	Apply the understanding of vectors to perform simple tasks.
4	Apply appropriate knowledge and skills of vectors in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of vectors in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of vectors in the context of non-routine problem solving in a creative manner.

ELECTIVE PACKAGE

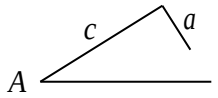
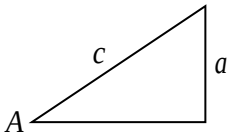
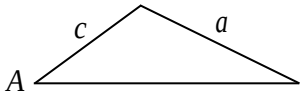
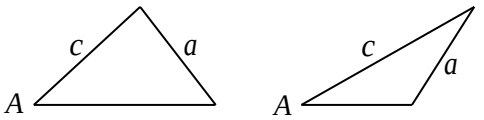
APPLICATION OF SCIENCE AND TECHNOLOGY

TOPIC

9.0 SOLUTION OF TRIANGLES

9.0 SOLUTION OF TRIANGLES

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
9.1 Sine Rule	Pupils are able to:	
	9.1.1 Make and verify conjectures on the relationship between the ratio of length of sides of a triangle with the sine of the opposite angles, and hence define the sine rule.	Notes: The use of digital technology is encouraged throughout this topic Real-life situations need to be involved throughout this topic. Exploratory activities need to be carried out. Sine Rule: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$ or $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$
	9.1.2 Solve triangles involving sine rule.	
	9.1.3 Determine the existence of ambiguous case of a triangle, and hence identify the conditions for such cases.	Notes: Exploratory activities involving the conditions for the existence of a triangle need to be carried out including the following cases:

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
		(a) No triangle exists:  $a <$ the height of a Δ (b) One triangle exists:  $a =$ the height of a Δ  $a \geq c$ (c) Two triangles exist:  the height of a $\Delta < a < c$

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	9.1.4 Solve triangles involving ambiguous cases. 9.1.5 Solve problems related to triangles using the sine rule.	
9.2 Cosine Rule	Pupils are able to: 9.2.1 Verify the cosine rule. 9.2.2 Solve triangles involving the cosine rule. 9.2.3 Solve problems involving the cosine rule.	Notes: Cosine Rule: $a^2 = b^2 + c^2 - 2bc\cos A$ $b^2 = a^2 + c^2 - 2ac\cos B$ $c^2 = a^2 + b^2 - 2ab\cos C$
9.3 Area of a Triangle	Pupils are able to: 9.3.1 Derive the formula for area of triangles, and hence determine the area of a triangle.	Notes: Exploratory activities need to be carried out.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
		Area of a triangle $= \frac{1}{2}ab \sin C$ $= \frac{1}{2}ac \sin B$ $= \frac{1}{2}bc \sin A$
	9.3.2 Determine the area of a triangle using the Heron's formula.	Notes: Heron's formula: Area of a triangle $= \sqrt{s(s-a)(s-b)(s-c)}$ where a, b and c are sides of a triangle and $s = \frac{a+b+c}{2}$
	9.3.3 Solve problems involving areas of triangles.	
9.4 Application of Sine Rule, Cosine Rule and Area of a Triangle	Pupils are able to: 9.4.1 Solve problems involving triangles.	Notes: Three-dimensional shapes need to be involved.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of sine rule and cosine rule.
2	Demonstrate the understanding of sine rule and cosine rule.
3	Apply the understanding of sine rule, cosine rule and area of a triangle to perform simple tasks.
4	Apply appropriate knowledge and skills of of solution of triangles in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of solution of triangles in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of solution of triangles in the context of non-routine problem solving in a creative manner.

ELECTIVE PACKAGE

APPLICATION OF SOCIAL SCIENCE

TOPIC

10.0 INDEX NUMBERS

10.0 INDEX NUMBERS

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
10.1 Index Numbers	Pupils are able to: 10.1.1 Define index numbers and describe the use of it.	Notes: Real-life situations and authentic data need to be involved throughout this topic. Exploratory activities involving relative changes in quantity at a specific time in comparison to the base time need to be carried out. The formula for index number, $I = \frac{Q_1}{Q_0} \times 100$ Q_0 = Quantity at the base time Q_1 = Quantity at a specific time Various types of indexes need to be involved. Examples: (a) price index (b) pollution index (c) accident index (d) commodity index (e) body mass index (BMI) (f) gold index

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	10.1.2 Determine and interpret index numbers. 10.1.3 Solve problems involving index numbers.	Suggested Activities: Contextual learning and future studies may be involved.
10.2 Composite Index	Pupils are able to: 10.2.1 Determine and interpret composite index with and without the weightage.	Notes: The meaning of weightage needs to be discussed. Various situations need to be involved. Weightage can be represented by numbers, ratios, percentages, reading on bar charts or pie charts and others. The formula for composite index, $\bar{I} = \frac{\sum I_i W_i}{\sum W_i}$ I_i = Index number W_i = Weightage

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	10.2.2 Solve problems involving index numbers and composite index.	Notes: Interpreting the index to identify the trend of a certain set of data need to be involved. Data represented in various forms need to be involved. Suggested Activities: Problem-based learning may be carried out.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of index numbers.
2	Demonstrate the understanding of index numbers.
3	Apply the understanding of index numbers to perform simple tasks.
4	Apply appropriate knowledge and skills of index numbers in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of index numbers in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of index numbers in the context of non-routine problem solving in a creative manner.

Content Standard, Learning Standard and Performance Standard

Form 5

LEARNING AREA

GEOMETRY

TOPIC

1.0 CIRCULAR MEASURE

1.0 CIRCULAR MEASURE

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
1.1 Radian	Pupils are able to: 1.1.1 Relate angle measurement in radian and degree.	Notes: Real-life situations need to be involved throughout this topic. The definition of one radian needs to be discussed. Measurement in radian can be expressed: (a) in terms of π. (b) without involving π.
1.2 Arc Length of a Circle	Pupils are able to: 1.2.1 Determine (i) arc length, (ii) radius, and (iii) angle subtended at the centre of a circle. 1.2.2 Determine perimeter of segment of a circle. 1.2.3 Solve problems involving arc length.	Notes: Derivation of the formula $s = r\theta$ needs to be discussed. The use of sine rule and cosine rule can be involved.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
1.3 Area of Sector of a Circle	Pupils are able to: 1.3.1 Determine (i) area of sector, (ii) radius, and (iii) angle subtended at the centre of a circle. 1.3.2 Determine the area of segment of a circle. 1.3.3 Solve problems involving areas of sectors.	Notes: Derivation of the formula $A = \frac{1}{2}r^2\theta$ needs to be discussed. The use of the following formulae can be involved: (a) Area of triangle = $\frac{1}{2}ab\sin C$ (b) Area of triangle $= \sqrt{s(s-a)(s-b)(s-c)}$
1.4 Application of Circular Measures	Pupils are able to: 1.4.1 Solve problems involving circular measure.	

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of circular measure.
2	Demonstrate the understanding of circular measure.
3	Apply the understanding of circular measure to perform simple tasks.
4	Apply appropriate knowledge and skills of circular measure in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of circular measure in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of circular measure in the context of non-routine problem solving in a creative manner.

LEARNING AREA

CALCULUS

TOPIC

2.0 DIFFERENTIATION

2.0 DIFFERENTIATION

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
2.1 Limit and its Relation to Differentiation	Pupils are able to: 2.1.1 Investigate and determine the value of limit of a function when its variable approaches zero.	Notes: Real-life situations need to be involved throughout this topic. Graphing calculator or dynamic geometry software needs to be used throughout this topic. Exploratory activities using table of values and graphs when the value of the variable approaches zero from two opposite directions need to be involved. The notation of $\lim_{x \to 0} f(x)$ needs to be introduced.
	2.1.2 Determine the first derivative of a function $f(x)$ by using the first principle.	Exploratory activities to determine the first derivative of a function using the idea of limit needs to be involved. When $y = f(x)$, $\frac{dy}{dx} = \lim_{\delta x \to 0} \frac{\delta y}{\delta x}$. The relation between the first derivative and the gradient of a tangent should be emphasised.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
2.2 The First Derivative	Pupils are able to:	
	2.2.1 Derive the formula of first derivative inductively for the function $y = ax^n$, a is a constant and n is an integer.	Notes: Differentiation notations $f'(x)$, $\frac{dy}{dx}$ and $\frac{d}{dx}$ ( ) where ( ) is a function of x, need to be involved.
	2.2.2 Determine the first derivative of an algebraic function.	Further exploration using dynamic geometry software to compare the graphs of $f(x)$ and $f'(x)$ (gradient function graph) can be carried out.
	2.2.3 Determine the first derivative of composite function.	Chain rule needs to be involved. The use of the idea of limit to prove the chain rule can be discussed.
	2.2.4 Determine the first derivative of a function involving product and quotient of algebraic expressions.	The use of the idea of limit to prove product rule and quotient rule can be discussed.
2.3 The Second Derivative	Pupils are able to:	Notes :
	2.3.1 Determine the second derivative of an algebraic function.	$\frac{d^2y}{dx^2} = \frac{d}{dx}\left(\frac{dy}{dx}\right)$ and $f''(x) = \frac{d}{dx}(f'(x))$ need to be emphasised.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
2.4 Application of Differentiation	Pupils are able to: 2.4.1 Interpret gradient of tangent to a curve at different points. 2.4.2 Determine equation of tangent and normal to a curve at a point. 2.4.3 Solve problems involving tangent and normal. 2.4.4 Determine the turning points and their nature. 2.4.5 Solve problems involving maximum and minimum values and interpret the solutions.	Notes: The following matters need to be involved: (a) Sketching tangent method (b) Second derivative method (c) Point of Inflection Suggested activity: Graph sketching can be involved.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	2.4.6 Interpret and determine rates of change for related quantities.	The use of chain rule needs to be emphasised.
	2.4.7 Solve problems involving rates of change for related quantities and interpret the solutions.	
	2.4.8 Interpret and determine small changes and approximations of certain quantities.	
	2.4.9 Solve problems involving small changes and approximations of certain quantities.	Problems involved are limited to two variables.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of differentiation.
2	Demonstrate the understanding of differentiation.
3	Apply the understanding of differentiation to perform simple tasks.
4	Apply appropriate knowledge and skills of differentiation in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of differentiation in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of differentiation in the context of non-routine problem solving in a creative manner.

LEARNING AREA

CALCULUS

TOPIC

3.0 INTEGRATION

3.0 INTEGRATION

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
3.1 Integration as the Inverse of Differentiation	Pupils are able to: 3.1.1 Explain the relation between differentiation and integration.	Suggested activities: The use of dynamic software is encouraged throughout this topic. Notes: Real-life situations need to be involved throughout this topic. Exploratory activities need to be carried out.
3.2 Indefinite Integral	Pupils are able to: 3.2.1 Derive the indefinite integral formula inductively. 3.2.2 Determine indefinite integral for algebraic functions.	Notes: Limited to $\int ax^n\,dx$, a is a constant, n is an integer and $n \neq -1$. The constant, c needs to be emphasised. The following integrations need to be involved: (a) $\int (ax^n)\,dx = a\int (x^n)\,dx$ (b) $\int [f(x) \pm g(x)]\,dx$ $= \int f(x)\,dx \pm \int g(x)\,dx$

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	3.2.3 Determine indefinite integral for functions in the form of $(ax+b)^n$, where a and b are constants, n is an integer and $n \neq -1$. 3.2.4 Determine the equation of curve from its gradient function.	Suggested activities: Substitution method can be involved.
3.3 Definite Integral	Pupils are able to: 3.3.1 Determine the value of definite integral for algebraic functions. 3.3.2 Investigate and explain the relation between the limit of the sum of areas of rectangles and the area under a curve.	Notes: The following characteristics of definite integral need to be emphasized: (a) $\int_a^b f(x)dx = -\int_b^a f(x)dx$ (b) $\int_a^c f(x)dx = \int_a^b f(x)dx + \int_b^c f(x)dx$, $a < b < c$. The use of diagrams needs to be emphasised. Exploratory activities need to be carried out. When n approaches ∞, δx approaches 0, area under the curve $= \lim_{\delta x \to 0} \sum_{i=1}^{n} y_i \delta x$ $= \int_a^b y dx$

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	3.3.3 Determine the area of a region.	The meaning of the positive and negative signs for the value of area needs to be discussed. Area of region between two curves needs to be involved.
	3.3.4 Investigate and explain the relation between the limits of the sum of volumes of cylinders and the generated volume by revolving a region.	When n approaches ∞, δx approaches 0, generated volume $= \lim_{\delta x \to 0} \sum_{i=1}^{n} \pi y_i^2 \delta x$ $= \int_a^b \pi y^2 dx$ When n approaches ∞, δy approaches 0, generated volume $= \lim_{\delta y \to 0} \sum_{i=1}^{n} \pi x_i^2 \delta y$ $= \int_a^b \pi x^2 dy$
	3.3.5 Determine the generated volume of a region revolved at the x-axis or the y-axis.	Generated volume for region between two curves is excluded.
3.4 Application of Integration	Pupils are able to: 3.4.1 Solve problems involving integration.	

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of integration.
2	Demonstrate the understanding of integration.
3	Apply the understanding of integration to perform simple tasks.
4	Apply appropriate knowledge and skills of integration in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of integration in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of integration in the context of non-routine problem solving in a creative manner.

LEARNING AREA

STATISTICS

TOPIC

4.0 PERMUTATION AND COMBINATION

4.0 PERMUTATION AND COMBINATION

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
4.1 Permutation	Pupils are able to: 4.1.1 Investigate and make generalisation about multiplication rule.	Notes: Real-life situations and tree diagrams need to be involved throughout this topic. The calculator is only used after the students understand the concept. Multiplicaton rule: If a certain event can occur in m ways and another event can occur in n ways, then both events can occur in $m \times n$ ways.
	4.1.2 Determine the number of permutations for (i) n different objects (ii) n different objects taken r at a time. (iii) n objects involving identical objects.	The notation $n!$ needs to be involved. Formula ${}^{n}P_{r} = \frac{n!}{(n-r)!}$ needs to be emphasised.
	4.1.3 Solve problems involving permutations with certain conditions.	Cases involving identical objects or arrangement of objects in a circle limited to one condition.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
4.2 Combination	Pupils are able to: 4.2.1 Compare and contrast permutation and combination. 4.2.2 Determine the number of combinations of *r* objects chosen from *n* different objects at a time. 4.2.3 Solve problems involving combinations with certain conditions.	Notes: The relation between combination and permutation, ${}^{n}C_{r} = \frac{{}^{n}P_{r}}{r!}$ needs to be discussed.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of permutation and combination.
2	Demonstrate the understanding of permutation and combination.
3	Apply the understanding of permutation and combination to perform simple tasks.
4	Apply appropriate knowledge and skills of permutation and combination in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of permutation and combination in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of permutation and combination in the context of non-routine problem solving in a creative manner.

LEARNING AREA

STATISTICS

TOPIC

5.0 PROBABILITY DISTRIBUTION

5.0 PROBABILITY DISTRIBUTION

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
5.1 Random Variable	Pupils are able to: 5.1.1 Describe the meaning of random variable. 5.1.2 Compare and contrast discrete random variable and continuous random variable.	Notes: Real-life situations need to be involved throughout this topic. Set builder notations for discrete random variable and continuous random variable need to be involved. Example of representation for discrete random variable: $X = \{x: x = 0, 1, 2, 3\}$ Example of representation for continuous random variable: $X = \{x: x$ is the height of pupils in cm, $a_1 < x < a_2\}$ Tree diagram and probability formula need to be used to introduce the concept of probability distribution for discrete random variable. Suggested activities: Simple experiments can be involved such as tossing coins or dice to explain the concept of probability distribution for discrete random variable.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	5.1.3 Describe the meaning of probability distribution for discrete random variables. 5.1.4 Construct table and draw graph of probability distribution for discrete random variable.	Probability Distribution is a table or a graph that displays the possible values of a random variable, along with respective probabilities.
5.2 Binomial Distribution	Pupils are able to: 5.2.1 Describe the meaning of binomial distribution. 5.2.2 Determine the probability of an event for binomial distribution. 5.2.3 Interpret information, construct table and draw graph of binomial distribution.	Notes: The characteristics of Bernoulli trials need to be discussed. The relation between Bernoulli trials and Binomial distribution need to be emphasised. Tree diagram needs to be used to study the values of probability for the binomial distribution. Formula $P(X=r)={}^{n}C_{r}\,p^{r}q^{n-r}$ need not be derived. $\sum_{i=1}^{n} P(X)=1$.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	5.2.4 Determine and describe the value of mean, variance and standard deviation for a binomial distribution.	Mean as an expected average value when an event happens repeatedly needs to be emphasised.
	5.2.5 Solve problems involving binomial distributions.	Interpretation of solutions needs to be involved.
5.3 Normal Distribution	5.3.1 Investigate and describe the properties of normal distribution graph.	Notes: Sketches of graphs and the importance of the normal distribution graph features need to be emphasised. The properties of random variation and the Law of Large Numbers need to be discussed.
	5.3.2 Describe the meaning of standard normal distribution.	The importance of converting normal distribution to standard normal distribution needs to be emphasised. The relation between normal distribution graph and standard normal distribution graph need to be discussed.
	5.3.3 Determine and interprete standard score, Z.	

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	5.3.4 Determine the probability of an event for normal distribution. 5.3.5 Solve problems involving normal distributions.	The use of the Standard Normal Distribution Table needs to be emphasised. The use of calculator, mobile application or website can be involved. Skill to determine the standard score, Z when given the probability value needs to be involved.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of random variables.
2	Demonstrate the understanding of probability distribution.
3	Apply the understanding of probability distribution to perform simple tasks.
4	Apply appropriate knowledge and skills of probability distribution in the context of simple routine problem-solving.
5	Apply appropriate knowledge and skills of probability distribution in the context of complex routine problem-solving.
6	Apply appropriate knowledge and skills of probability distribution in the context of non-routine problem-solving in a creative manner.

LEARNING AREA

TRIGONOMETRY

TOPIC

6.0 TRIGONOMETRIC FUNCTIONS

6.0 TRIGONOMETRIC FUNCTIONS

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
6.1 Positive Angles and Negative Angles	Pupils are able to: 6.1.1 Represent positive angles and negative angles in a Cartesian Plane.	Notes: Angles in degrees and radians greater than 360° or 2π radian need to be involved throughout this topic. The following needs to be emphasised: (a) the position of angles in quadrants. (b) the relation between units in degrees and radians in terms of π. Suggested activities: Dynamic software can be used to explore positive angles and negative angles.
6.2 Trigonometric Ratios of any Angle	6.2.1 Relate secant, cosecant and cotangent with sine, cosine and tangent of any angle in a Cartesian plane.	Suggested activities: Exploratory activities involving the following complementary angles need to be carried out: (a) $\sin\theta = \cos(90° - \theta)$ (b) $\cos\theta = \sin(90° - \theta)$ (c) $\tan\theta = \cot(90° - \theta)$ (d) $\operatorname{cosec}\theta = \sec(90° - \theta)$ (e) $\sec\theta = \operatorname{cosec}(90° - \theta)$ (f) $\cot\theta = \tan(90° - \theta)$

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	6.2.2 Determine the values of trigonometric ratios of any angle.	Notes: The use of triangles to determine trigonometric ratios for special angles 30°, 45° dan 60° need to be emphasised.
6.3 Graphs of Sine, Cosine and Tangent Functions	Pupils are able to: 6.3.1 Draw and sketch graphs of trigonometric functions: (i) $y = a \sin bx + c$ (ii) $y = a \cos bx + c$ (iii) $y = a \tan bx + c$ where a, b and c are constants and $b > 0$. 6.3.2 Solve trigonometric equations using graphical method.	Notes: The effect of the changes in constants a, b and c for graphs of trigonometric functions need to be discussed. The absolute value of trigonometric functions needs to be involved. Suggested activities: Dynamic software can be used to explore graphs of trigonometric functions. Trigonometric equations for y that are not constants need to be involved. Sketches of graphs to determine the number of solutions need to be involved.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
6.4 Basic Identities	Pupils are able to: 6.4.1 Derive basic identities: (i) $\sin^2 A + \cos^2 A = 1$ (ii) $1 + \tan^2 A = \sec^2 A$ (iii) $1 + \cot^2 A = \operatorname{cosec}^2 A$ 6.4.2 Prove trigonometric identities using basic identities.	Notes: Exploratory activities involving basic identities using right-angled triangle or unit circle need to be carried out:
6.5 Addition Formulae and Double Angle Formulae	Pupils are able to: 6.5.1 Prove trigonometric identities using addition formulae for sin (A ± B), cos (A ± B) and tan (A ± B). 6.5.2 Derive double angle formulae for sin 2A, cos 2A and tan 2A. 6.5.3 Prove trigonometric identities using double-angle formulae.	Suggested activities: Calculator can be used to verify addition formulae. Notes: Half-angle formulae need to be discussed.
6.6 Application of Trigonometric Functions	6.6.1 Solve trigonometric equations. 6.6.2 Solve problems involving trigonometric functions.	

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of trigonometric functions.
2	Demonstrate the understanding of trigonometric functions.
3	Apply the understanding of trigonometric functions to perform simple tasks.
4	Apply appropriate knowledge and skills of trigonometric functions in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of trigonometric functions in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of trigonometric functions in the context of non-routine problem solving in a creative manner.

ELECTIVE PACKAGE

APPLICATION OF SOCIAL SCIENCE

TOPIC

7.0 LINEAR PROGRAMMING

7.0 LINEAR PROGRAMMING

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
7.1 Linear Programming Model	Pupils are able to: 7.1.1 Form a mathematical model for a situation based on the constraints given and hence represent the model graphically.	Notes: Real-life situations need to be involved throughout this topic. Exploratory activities involving optimisation need to be carried out.
7.2 Application of Linear Programming	Pupils are able to: 7.2.1 Solve problems involving linear programming graphically.	Notes: The terms of constraints, feasible region, objective function and optimum value need to be involved.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of linear programming model.
2	Demonstrate the understanding of linear programming model.
3	Apply the understanding of linear programming model to perform simple tasks.
4	Apply appropriate knowledge and skills of linear programming in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of linear programming in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of linear programming in the context of non-routine problem solving in a creative manner.

ELECTIVE PACKAGE

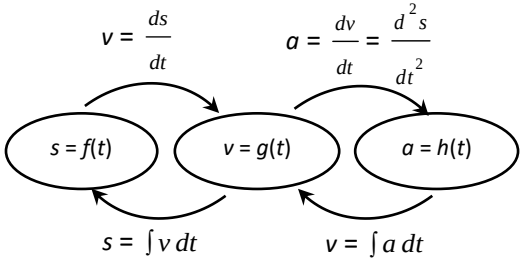
APPLICATION OF SCIENCE AND TECHNOLOGY

TOPIC

8.0 KINEMATICS OF LINEAR MOTION

8.0 KINEMATICS OF LINEAR MOTION

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
8.1 Displacement, Velocity and Acceleration as a Function of Time	Pupils are able to: 8.1.1 Describe and determine instantaneous displacement, instantaneous velocity, instantaneous acceleration of a particle.	Notes: Number lines and sketches of graphs need to be involved throughout this topic. The following need to be emphasised: (i) Representations of s = displacement, v = velocity, a = acceleration and t = time (ii) The relation between displacement, velocity and acceleration. (iii) Scalar quantity and vector quantity. (iv) The difference between • distance and displacement • speed and velocity The meaning of • positive, negative and zero displacement, • positive, negative and zero velocity, • positive, negative and zero acceleration, need to be discussed. Simulation needs to be used to differentiate between positive displacement and negative displacement.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	8.1.2 Determine the total distance travelled by a particle in a given period of time.	The displacement function is limited to linear and quadratic.
8.2 Differentiation in Kinematics of Linear Motion	Pupils are able to: 8.2.1 Relate between displacement function, velocity function and acceleration function.	Notes: The following relations need to be emphasised:  Interpretations of graphs need to be involved.
	8.2.2 Determine and interpret instantaneous velocities of a particle from displacement function.	Maximum displacement, initial velocity and constant velocity need to be emphasised.
	8.2.3 Determine and interpret instantaneous acceleration of a particle from velocity function and displacement function.	Maximum velocity, minimum velocity and constant acceleration need to be emphasized.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
8.3 Integration in Kinematics of Linear Motion	Pupils are able to: 8.3.1 Determine and interpret instantaneous velocity of a particle from accelaration function. 8.3.2 Determine and interpret instantaneous displacement of a particle from velocity function and accelaration function.	Notes: Total distance needs to be involved.
8.4 Applications of Kinematics of Linear Motion	Pupils are able to: 8.4.1 Solve problems of kinematics of linear motion involving differentiation and integration.	

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of displacement, velocity and acceleration.
2	Demonstrate the understanding of displacement, velocity and acceleration.
3	Apply the understanding of displacement, velocity and acceleration to perform simple tasks.
4	Apply appropriate knowledge and skills of kinematics of linear motion in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of kinematics of linear motion in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of kinematics of linear motion in the context of non-routine problem solving in a creative manner.

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