General Certificate of Education
Advanced Level
(Grade 12 and 13)

COMBINED MATHEMATICS

SYLLABUS
(Effective from 2017)

Department of Mathematics
Faculty of Science and Technology
National Institute of Education
Maharagama
SRI LANKA

Combined Mathematics
Grade 12 and 13 - syllabus

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1.0 INTRODUCTION

The aim of education is to turn out creative children who would suit the modern world. To achieve this, the school curriculum should be revised according to the needs of the time.

Thus, it had been decided to introduce a competency based syllabus in 2009. The earlier revision of the G.C.E. (Advanced Level) Combined Mathematics syllabus was conducted in 1998. One of the main reason for the need to revise the earlier syllabus had been that in the Learning - Teaching- Assessment process, competencies and competency levels had not been introduced adequately. It has been planned to change the existing syllabus that had been designed on a content based approach to a competency based curriculum in 2009. In 2007, the new curriculum revision which started at Grades 6 and 10 had introduced a competency based syllabi to Mathematics. This was continued at Grades 7 and 11 in 2008 and it continued to Grades 8 and 12 in 2009. Therefore, a need was arisen to provide a competency based syllabus for Combined Mathematics at G.C.E.(Advanced Level) syllabus the year 2009.

After implementing the Combined Mathematics syllabus in 2009 it was revisited in the year 2012. In the following years teachers view's and experts opinion about the syllabus, was obtained and formed a subject comittee for the revision of the Combined Mathematics syllabus by acommodating above opinions the committee made the necessary changes and revised the syllabus to implement in the year 2017.

The student who has learnt Mathematics at Grades 6-11 under the new curriculum reforms through a competency based approach, enters grade 12 to learn Combined Mathematics at Grades 12 and 13 should be provided with abilities, skills and practical experiences for his future needs. and these have been identified and the new syllabus has been formulated accordingly. It is expected that all these competencies would be achieved by pupils who complete learning this subject at the end of Grade 13.

Pupils should achieve the competencies through competency levels and these are mentioned under each learning outcomes

It also specifies the content that is needed for the pupils to achieve these competency levels. The number of periods that are needed to implement the process of Learning-Teaching and Assessment also mentioned in the syllabus.

Other than the facts mentioned regarding the introduction of the new curriculum, what had already been presented regarding the introduction of Combined Mathematics Syllabus earlier which are mentioned below too are valid.

- To decrease the gap between G.C.E. (Ordinary Level) Mathematics and G.C.E. (Advanced Level) Combined Mathematics.
- To provide Mathematics knowledge to follow Engineering and Physical Science courses.
- To provide a knowledge in Mathematics to follow Technological and other course at Tertiary level.
- To provide Mathematics knowledge for commercial and other middle level employment.
- To provide guidance to achieve various competencies on par with their mental activities and to show how they could be developed throughout life.

2.0 Common National Goals

The national system of education should assist individuals and groups to achieve major national goals that are relevant to the individual and society.

Over the years major education reports and documents in Sri Lanka have set goals that sought to meet individual and national needs. In the light of the weaknesses manifest in contemporary educational structures and processes, the National Education Commission has identified the following set of goals to be achieved through education within the conceptual framework of sustainable human development.

I Nation building and the establishment of a Sri Lankan identity through the promotion of national cohesion, national integrity, national unity, harmony and peace, and recognizing cultural diversity in Sri Lanka's plural society within a concept of respect for human dignity.

II Recognizing and conserving the best elements of the nation's heritage while responding to the challenges of a changing world.

III Creating and supporting an environment imbued with the norms of social justice and a democratic way of life that promotes respect for human rights, awareness of duties and obligations, and a deep and abiding concern for one another.

IV Promoting the mental and physical well-being of individuals and a sustainable life style based on respect for human values.

V Developing creativity, initiative, critical thinking, responsibility, accountability and other positive elements of a well-integrated and balance personality.

VI Human resource development by educating for productive work that enhances the quality of life of the individual and the nation and contributes to the economic development of Sri Lanka.

VII Preparing individuals to adapt to and manage change, and to develop capacity to cope with complex and unforeseen situations in a rapidly changing world.

VIII Fostering attitudes and skills that will contribute to securing an honourable place in the international community, based on justice, equality and mutual respect.

National Education Commision Report (2003) - December

3.0 Basic Competencies

The following Basic Competencies developed through education will contribute to achieving the above National Goals.

(i) Competencies in Communication

Competencies in Communication are based on four subjects: Literacy, Numeracy, Graphics and IT proficiency.

Literacy : Listen attentively, speck clearly, read for meaning, write accurately and lucidly and communicate ideas effectively.

Numeracy : Use numbers for things, space and time, count, calculate and measure systematically.

Graphics : Make sense of line and form, express and record details, instructions and ideas with line form and color.

IT proficiency : Computeracy and the use of information and communication technologies (ICT) in learning, in the work environment and in personal life.

(ii) Competencies relating to Personality Development

- General skills such as creativity, divergent thinking, initiative, decision making, problem solving, critical and analytical thinking, team work, inter-personal relations, discovering and exploring;
- Values such as integrity, tolerance and respect for human dignity;
- Emotional intelligence.

(iii) Competencies relating to the Environment

These competencies relate to the environment : social, biological and physical.

Social Environment : Awareness of the national heritage, sensitivity and skills linked to being members of a plural society, concern for distributive justice, social relationships, personal conduct, general and legal conventions, rights, responsibilities, duties and obligations.

Biological Environment : Awareness, sensitivity and skills linked to the living world, people and the ecosystem, the trees, forests, seas, water, air and life-plant, animal and human life.

Physical Environment : Awareness, sensitivity and skills linked to space, energy, fuels, matter, materials and their links with human living, food, clothing, shelter, health, comfort, respiration, sleep, relaxation, rest, wastes and excretion.

Included here are skills in using tools and technologies for learning, working and living.

(iv) Competencies relating to Preparation for the World of Work.

Employment related skills to maximize their potential and to enhance their capacity

to contribute to economic development,

to discover their vocational interests ad aptitudes,

to choose a job that suits their abilities, and

to engage in a rewarding and sustainable livelihood.

(v) Competencies relating to Religion and Ethics

Assimilating and internalizing values, so that individuals may function in a manner consistent with the ethical, moral and religious modes of conduct in everyday living, selecting that which is most appropriate.

(vi) Competencies in Play and the Use of Leisure

Pleasure, joy, emotions and such human experiences as expressed through aesthetics, literature, play, sports and athletics, leisure pursuits and other creative modes of living.

(vii) Competencies relating to ' learning to learn'

Empowering individuals to learn independently and to be sensitive and successful in responding to and managing change through a transformative process, in a rapidly changing, complex and interdependent world.

4.0 AIMS OF THE SYLLABUS

(i) To provide basic skills of mathematics to continue higher studies in mathematics.

(ii) To provide the students experience on strategies of solving mathematical problems.

(iii) To improve the students knowledge of logical thinking in mathematics.

(iv) To motivate the students to learn mathematics.

This syllabus was prepared to achieve the above objectives through learning mathematics. It is expected not only to improve the knowledge of mathematics but also to improve the skill of applying the knowledge of mathematics in their day to day life and character development through this new syllabus.

When we implement this competency Based Syllabus in the learning - teaching process.

- Meaningful Discovery situations provided would lead to learning that would be more student centred.
- It will provide competencies according to the level of the students.
- Teacher's targets will be more specific.
- Teacher can provide necessary feed back as he/she is able to identify the student's levels of achieving each competency level.
- Teacher can play a transformation role by being away from other traditional teaching methods.

When this syllabus is implemented in the classroom the teacher should be able to create new teaching techniques by relating to various situations under given topics according to the current needs.

For the teachers it would be easy to assess and evaluate the achievement levels of students as it will facilitate to do activities on each competency level in the learning- teaching process.

In this syllabus, the sections given below are helpful in the teaching - learning process of Combined Mathematics.

5.0 Relationship between the Common National Goals and the Competencies of the Syllabus.

Competencies of the Syllabus - Combined Mathematics I	Common National Goals							
	i	ii	iii	iv	v	vi	vii	viii
1. Analysis the system of real number.			✓	✓	✓	✓	✓	✓
2. Analysis single variable functions.	✓	✓	✓	✓	✓	✓	✓	✓
3. Analysis quadratic functions.	✓		✓	✓	✓	✓	✓	✓
4. Manipulates polynomal functions.	✓	✓	✓	✓	✓	✓	✓	✓
5. Functions and polynomal.	✓		✓	✓	✓	✓	✓	✓
6. Manipulate index laws and logarithmiale laws.		✓	✓	✓	✓	✓	✓	✓
7. Solves inequalities involing real numbers.	✓		✓	✓	✓	✓	✓	✓
8. Uses relations involving angular measures.	✓	✓	✓	✓	✓	✓	✓	✓
9. Intepretes trignometric functions.	✓		✓	✓	✓	✓	✓	✓
10. Manipulates trignometric Identities.		✓	✓	✓	✓	✓	✓	✓
11. Applies sine rule and cosine rule to solve problems.	✓		✓	✓	✓	✓	✓	✓
12. Solves problems involnig inverse trignometric funtions.	✓	✓	✓	✓	✓	✓	✓	✓
13. Determines the list of a function.	✓	✓	✓	✓	✓	✓	✓	✓

Competencies of the Syllabus - Combined Mathematics I	Common National Goals							
	i	ii	iii	iv	v	vi	vii	viii
14. Differentiates functions using suitable methods.		✓	✓	✓	✓	✓	✓	✓
15. Analysis the behaviour of functions using derivatives.			✓	✓	✓	✓	✓	✓
16. Find indefinite inregrals of functions.	✓		✓	✓	✓	✓	✓	✓
17. Uses the rectangular system of Cartesian axes and geometrical results.		✓	✓	✓	✓	✓	✓	✓
18. Investigates the straight line in terms of cartersial co-ordiuates.		✓	✓	✓	✓	✓	✓	✓
19. Applies the principle of mathematical induction as a type of proof for mathematical results.	✓	✓	✓	✓	✓	✓	✓	✓
20. Finds the sum of finite series.	✓	✓	✓	✓	✓	✓	✓	✓
21. Investigates infinite series.		✓	✓	✓	✓	✓	✓	✓
22. Explores the binomial expansion for positive integral indices.	✓	✓	✓	✓	✓	✓	✓	✓
23. Interprets the system of complex numbers.	✓		✓	✓	✓	✓	✓	✓
24. Uses permutation and combination as mathematical modeles for counting.	✓	✓	✓	✓	✓	✓	✓	✓
25. Manipulates matrices.	✓	✓	✓	✓	✓	✓	✓	✓
26. Interprets the Cartesian equation of circles.	✓	✓	✓	✓	✓	✓	✓	✓
27. Explores propertide of circles.	✓	✓	✓	✓	✓	✓	✓	✓

5.0 Relationship between the Common National Goals and the Competencies of the Syllabus.

Competencies of the Syllabus - Combined Mathematics II	Common National Goals							
	i	ii	iii	iv	v	vi	vii	viii
1. Manipulates voctors.	✓	✓	✓	✓	✓	✓	✓	✓
2. Uses systems of coplanar forces.	✓	✓	✓	✓	✓	✓	✓	✓
3. Applies the newtonian model to descrbe the instantaneous motion in a plane.	✓	✓	✓	✓	✓	✓	✓	✓
4. Applies mathematical models to analyse random events.	✓	✓	✓	✓	✓	✓	✓	✓
5. Applies scientific tools to develop decision making skills	✓	✓	✓	✓	✓	✓	✓	✓

6.0 A Basic Course for G.C.E (Advanced Level)
Combined Mathematics

This section contains the basic concepts necessary for those who are starting to learn combined mathematics subjects in the G.C.E (A/L) classes. By strengthning this subject area knowledge and skills of the students, we can make them to understand the combined mathematics comfortablly. The number of periods proposed to this basic concepts will not fall in the number of periods of combined mathematics. Therefore note that, to teach these concepts teachers should allowcate some periods before starting combined mathematics is expected.

Competency	Competency Level	Content	Learning outcome	No. of Periods
1. Review of Basic Algebra.	1.1 Expands algebric expressions	• Expansion of $(a \pm b)^2, (a \pm b)^3$ and $(a \pm b \pm c)^2$, $(a \pm b \pm c)^3$	• Applies the formula to simplify algebraic expression in the form $(a \pm b)^2, (a \pm b)^3, (a \pm b \pm c)^2$ $(a \pm b \pm c)^3$	04
	1.2 Factorises algebraic expres sions	• Factorisation for $a^2 - b^2, a^3 \pm b^3$	• Factorises algebraic expression by using the formulas for $a^2 - b^2, a^3 \pm b^3$	02
	1.3 Simplifies algebraic fractions	• Addition, Subtraction, Multiplication and Division of Algebraic fractions.	• Simplifies expressions involving Algebraic fractions.	04
	1.4 Solves Equations	• Equations with algebraic fractions, simultaneous equations up to three unknowns , quadratic simultianeous equations with two variabess.	• Solves equations by using factorisation formulaes involved expansion	04
	1.5 Simplifies expressions involving indices and logarithims	• Rules of indicies fundamental properties of logarithies • Rules of logarithms	• Simplifies expressions involves indices. • Solve equations with indices. • Simplifies logarithims expressions. • Solves equations with logarathims	02

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	1.6 Describes and uses the properties of proportions	• Ratios as a proportion $\frac{a}{b} = \frac{c}{d} \Rightarrow a : b = c : d$ Properties of proportion	• Explains relationship between ratio and proportion • Describes properties of ratio • Solves problems using proporties of proportions	02
2. Analyses plane geom-etry	2.1 Identifies theorems involving rectangles in circle and uses is Geometry problems.	• Pyhtagoras theorem acute angled theorem obtuse angled theorem applloniuis theorem.	• Describes the theorem when two chords intersect. and the theorem involved alternate segments. • Uses the above theorems to solve problems.	04
	2.2 Applies pythagoras theorem and its extensions in prob lems.	• Pythagoras theorem and its converse • Apollinius theorem.	• States the pythogorus them theorems to prove statements. • Uses the theorem to solve problems	04
	2.3 Applies angular bisector theorem of a triangular geometry problems.	• Angular bisector theorem • Theorem of a triangular	• Uses the theorem for solves problems	02
	2.4 Uses theorems on area similar triangles	• The areas of similar triangles are propotional to the square of the corresponding sides.	• Describes the theorem and uses it to solve problems. • Uses it to solve problems	03
	2.5 Analysis the centres of a triangles	• Circum centre, Incentre, outer centreOrthocentre, Centroid	• Definies the 4 centres of a triangles and uses it in problems. • Uses the above centres to solve problems	02

7.0 PROPOSED TERM WISE BREAKDOWN OF THE SYLLABUS

Grade 12

Competency Levels	Subject Topics	Number of Periods
First Term		
Combined Mathematics I		
1.1, 1.2	Real numbers	02
2.1, 2.2	Functions	04
8.1, 8.2	Angular measurements	02
17.1, 17.2	Rectangular cartesian system, Straight line	03
9.1, 9.2, 9.3, 9.4	Circular functions	12
11.1	sine rule, cosine rule	01
4.1, 4.2, 4.3	Polynomials	07
10.1, 10.2, 10.3, 10.4	Trigonometric identities	14
5.1	Rational functions	06
6.1	Index laws and logarithmic laws	01
7.1, 7.2, 7.3	Basic properties of inequalities and solutions of inequalities	14
9.5	Solving trigonometric equations	04
Combined Mathematics II		
1.1, 1.2, 1.3, 1.4	Vectors	14
2.1, 2.2, 2.3	Systems of coplanar forces acting at a point	11
Second Term		
Combined Mathematics I		
3.1, 3.2	Quadratic functions and quadratic equations	25
12.1, 12.2, 12.3	Inverse trigonometric functions	08
11.2	sine rule, cosine rule	06

Competency Levels	Subject Topics	Number of Periods
13.1, 13.2, 13.3, 13.4, 13.5, 13.6,	Limits	18
13.7, 13.8		
Combined Mathematics II		
2.4, 2.5, 2.6, 2.7	System of coplanar forces acting on a rigid body	23
3.1, 3.2, 3.3	Motion in a straight line	23
	Third Term	
Combined Mathematics I		
14.1, 14.2, 14.3, 14.4, 14.5, 14.6,	Derivatives	30
14.7, 14.8		
15.1, 15.2, 15.3, 15.4	Applications of derivatives	15
Combined Mathematics II		
3.7	Projectiles	10
2.8	Equilibirium of three coplanar forces	08
2.9	Friction	10
3.4, 3.5, 3.6	Relative mortion	22
3.8	Newton's laws of motion	17

Grade 13

Competency Levels	Subject Topics	Number of Periods
First Term		
Combined Mathematics I		
18.1, 18.2, 18.3, 18.4, 18.5	Straight line	16
16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9	Intergration	28
Combined Mathematics II		
2.10	Jointed rods	10
2.11	Frame works	10
3.11, 3.12, 3.13	Impulse and collision	16
3.9, 3.10	Work, power, energy,	10
3.14, 3.15, 3.16	Circular rotion	20
Second Term		
Combined Maths I		
26.1, 27.1, 27.2, 27.3, 27.4, 27.5	Circle	15
24.1, 24.2, 24.3, 24.5	Permutations and Combinations	15
19.1	Principle of Mathematical Induction	05
20.1, 20.2, 21.1, 21.2	Series	18

Competency Levels	Subject Topics	Number of Periods
Combined Mathematics II		
4.1, 4.2	Probability	10
3.17, 3.18, 3.19	Simple harmonic motion	18
2.12, 2.13, 2.14, 2.15, 2.16, 2.17	Center of mass	20
Third Term		
Combined Mathematics I		
22.1, 22.2, 22.3	Binomial expansion	12
23.1, 23.2, 23.3, 23.4, 23.5, 23.6	Complex numbers	18
25.1, 25.2, 25.3, 25.4	Matrices	14
Combined Mathematics II		
4.3, 4.4, 4.5	Probability	18
5.1, 5.2, 5.3, 5.4, 5.5, 5.6 5.7, 5.8, 5.9.	Statistics	18

Grade 12

Subject	Number of Periods	Total
First Term		
Combined Mathematics I	70	
Combined Mathematics II	24	94
Second Term		
Combined Mathematics I	57	
Combined Mathematics II	46	103
Third Term		
Combined Mathematics I	45	
Combined Mathematics II	67	112

Grade 13

Subject	Number of Periods	Total
First Term		
Combined Mathematics I	44	
Combined Mathematics II	66	110
Second Term		
Combined Mathematics I	53	
Combined Mathematics II	48	101
Third Term		
Combined Mathematics I	44	
Combined Mathematics II	36	80

8.0 Detailed Syllabus - COMBINED MATHEMATICS - I

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
1. Analyses the system of real numbers.	1.1 Classifies the set of real numbers.	• Historical evolution of the number system • Notations for sets of numbers □ , □ $^+$,□ , □ ', □ , □ $^+$ • Geometrical representation of real numbers ü Number line.	□ Explains the evolution of the number systems • Introduces notations for sets of numbers □ Represents a real number geometrically	01
	1.2 Uses surds or decimals to describe real numbers .	• Decimal representation of a real number ü Decimals, infinite decimals, recurring decimals, and non-recurrring decimals • Simplification of expressions involving surds	□ Classifies decimal numbers □ Rationalises the denominator of expressions with surds	01
2. Analyses single variable functions.	2.1 Review of functions.	• Intuitive idea of a function ü Constants, Variables ü Expressions involving relationships between two variables ü Functions of a single variable ü Functional notation ü Domain, codomain and range ü One - one functions ü Onto functions ü Inverse functions	□ Explains the intuitive idea of a function □ Recognizes constants, variables □ Relationship between two variables □ Explains inverse functions □ Explain Domain, Codomain □ Explains One - one functions explains onto functions	02

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	2.2 Reviews types of functions.	• Types of functions ú Constant function, linear function, piece-wise function, modulus (absolute value) function function • Graph of a function • Composite functions	Recognizes special functions Sketches the graph of a functions Finds composite functions	02
3. Analyses quadratic functions.	3.1 Explores the properties of quadratic functions.	• Quadratic functions Definition of a quadratic function $f(x) \equiv ax^2 + bx + c;\ a,\ b,\ c \in$; and $a \neq 0$ ú Completing the square ú Discriminent • Properties of a quadratic function ú Greatest value, least value ú Existence / non-existence of real zeros ú Graphs of quadratic functions	Introduces quadratic functions Explains what a quadratic function is Sketches the properties of a quadratic function Sketches the graph of a quadratic function Describes the different types of graphs of the quadratic function Describes zeros of quadradic functions	10
	3.2 Interprets the roots of a quadratic equation.	• Roots of a quadratic equation ú Sum and product of the roots ú Equations whose roots are symmetric expressions of the roots of a quadratic equation ú Nature of roots using discriminant ú Condition for two quadratic equations to have a common root ú Transformation of quadratic equations	Explains the Roots of a quadratic equation Finds the roots of a quardatic equation Expresses the sum and product of the roots of quadratic equation in terms of its coefficient Describes the nature of the roots of a quardatic equation Finds quadratic equations whose roots are symmetric expressions of α and β	15

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
			Solves problems involving quadratic functions and quadratic equations Transforms roots to other forms	
4. Manipulates Polynomial functions.	4.1 Explores polynomials of a single variable.	• Polynomials of single variable polynomials ú Terms, coefficients, degree, leading term, leading coefficient	Defines a polynomial of a single variable Distinguishes among linear, quadratic and cubic functions States the conditions for two polynomials to be identical	01
	4.2 Applies algebraic operations to polynomials.	• Addition, subtraction, multiplication, division and long division	Explains the basic Mathematical operations on polynomials Divides a polynomial by another polynomial	01
	4.3 Solves problems using Remainder theorem, Factor theorem and its converse.	• Division algorithm • Remainder theorem • Factor theorem and its converse • Solution of polynomial equations	States the algorithm for division States and prove remainder theorem States Factor theorem Expresses the converse of the Factor theorem Solves problems involving Remainder theorem and Factor theorem. Defines zeros of a polynomial Solves polynomial equations (Order ≤ 4)	05

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
5. Resolves rational functions into partial fractions.	5.1 Resolves rational function into partial fractions.	• Rational functions ü Proper and improper rational functions • Partial fractions of rational functions ü With distinct linear factors in the denominator ü With recurring linear factors in the denominator ü With quadratic factors in the denominator (Up to 4 unknowns)	Defines rational functions Defines proper rational functions and improper rational functions Finds partial fractions of proper rational functions (upto 4 unknown) Partial fractions of impropper irational function (upto 4 unknowns)	06
6. Manipulates index and logarithmic laws.	6.1 Uses index laws and logarithmic laws to solve problems.	• The index laws • Logarithmic laws of base • Change of base	Uses index laws Uses logarithmic laws Uses change of base to solve problems	01

Competency	Competency Level	Contents	Learning outcomes	No. of Periods

7. Solves inequalities involving real numbers.	7.1 States basic properties of inequalities.	• Basic properties of inequalities including trichotomy law
		• Numerical inequalities
		  ◦ Representing inequalities on the real number line
		  ◦ Introducting intervals using inequalities
			• Defines inequalities
			• States the trichotomy law
			• Represents inequalities on a real number line
			• Denotes inequalities in terms of interval notation
				04

	7.2 Analyses inequalities.	• Inequalities involving simple algebraic functions
		  ◦ Manipulation of linear, quadratic and rational inequalities
		  ◦ Finding the solutions of the above inequalities
		    ◦ algebraically
		    ◦ graphically
			• States and proves fundamental results on inequalities
			• Solves inequalities involving algebric expressions
			• Solves inequalities including rational functions, algebraically and graphically
				04

	7.3 Solves inequalities involving modulus (absolute value) function.	• Inequalities involving modulli (absolute value)
		  ◦ Manipulation of simple inequalities involving modulus (absolute value) sign
		  ◦ Solutions of the above inequalities
		    ◦ algebraically
		    ◦ graphically
			• States the modulus (absolute value) of a real number
			• Sketches the graphs involving modulus functions
			• Solves inequalities involving modulus (only for linear functions)
				06

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
8. Uses relations involving angular measures.	8.1 States the relationship between radians and degres.	ú Angulur measure ú The angle and its sign convention ú Degree and radian measures	□ Introduces degrees and radians as units of measurement of angles □ Convert degrees into radian and vice-versa	01
	8.2 Solves problems involving arc length and area of a circular sector.	ú Length of a circular arc, $S = r\theta$ ú Area of a circular sector, $A = \frac{1}{2}r^2\theta$	□ Find the lenth of an arc and area of a circular sector	01
9. Interpretes trignometric funtions.	9.1 Describes basic trigonometric (circular) functions.	• Basic trigonometric functions ú Definitions of the six basic trigono-metric functions , domain and range	□ Explains trigonometric ratios □ Defines basic trigonometric circular functions □ Introduces the domains and the ranges of circular functions	04
	9.2 Derives values of basic trigonometric functions at commonly used angles.	• Values of the circular functions of the angles $0, \frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}$ and $\frac{\pi}{2}$	□ Finds the values of trigonometric functions at given angles □ States the sign of basic trigonometric function in each quadrant	01

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	9.3 Derives the values of basic trigonometric functions at angles differing by odd multiples of $\frac{\pi}{2}$ and integer multiples of π.	• Trignometric relations of the angle $-\theta,\ \frac{\pi}{2}\pm\theta, \pi\pm\theta,\ \frac{3\pi}{2}\pm\theta,\ 2\pi\pm\theta$ etc	□ Describes the periodic properties of circular functions □ Describes the trigonometric relations of $(-\theta),\ \frac{\pi}{2}\pm\theta,\ \pi\pm\theta,\ \frac{3}{2}\pi+\theta,\ 2\pi\pm\theta$ in terms of θ □ Finds the values of circular functions at given angles	03
	9.4 Describes the behaviour of basic trigonometric functions graphically.	• Graphs of the basic trigonometric functions and their periodic properties	□ Represents the circular functions graphically □ Draws graphs of combined circular functions	04
	9.5 Finds general solutions.	• General solutions of the form $\sin\theta=\sin\alpha,\ \cos\theta=\cos\alpha$ and $\tan\theta=\tan\alpha$	□ Solves trigonometric equations	04

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
10.Manipulates trigonometric identities.	10.1 Uses Pythagorean identities.	• Pythagorean identities ú Trigonometric identities	Explains an identity Explains the difference between identities and equations Obtains Pythagorian Identities Solves problems involving Pythagorian identities	04
	10.2 Solves trigonometric problems using. sum and difference formulae.	• Sum and difference formulae ú Applications involving sum and difference formulae	Constructs addition formulae Uses addition formulae	02
	10.3 Solves trigonometric problems using product-sum and sum-product formulae.	• Product- sum, sum-product formulae ú Applications involving product-sum, and sum - product formulae	Manipulates product - sum, and Sum - product formulae Solves problems involving sum - product, product - sum formulae	05
	10.4 Solves trigonometric problems using Double angles, Triple angles and Half angles .	• Double angle, triple angle and half angle formulae • solutions of equations of the form $a\cos\theta + b\sin\theta = c$, where $a, b, c \in$	Derives trigonometric formula for double, trible and half angles Solves problems using double, tripple and half angles Solves equations of the form $a\cos\theta + b\sin\theta = c$ (only finding solutions is expected)	03

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
11. Applies sine rule and cosine rule to solve trigonometric problems.	11.1 States sine rule and cosine rule.	• Sine rule and cosine rule	☐ Introduces usual notations for a triangle ☐ States sine rule for any triangle ☐ States cosine rule for any triangle	01
	11.2 Proves and applies sine rule and cosine rule.	• Problems involving sine rule and cosine rule	☐ Proves sine rule ☐ Prove cosine rule ☐ Solves problems involving sine rule and cosine rule	06
12. Solves problems involving inverse trigonometric functions.	12.1 Describes inverse trignometric functions.	• Inverse trignometric functions • Principal values	☐ Defines inverse trignometric functions ☐ States the domain and the range of inverse trigonometric functions	02
	12.2 Represents inverse functions graphically.	• Sketching graphs of inverse trignometric functions $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$	☐ Draws the graph of an inverse trigonometric functions	02
	12.3 Solves problems involving inverse trignometric functions.	• Problems involving inverse trigonometric functions	☐ Solves simple problems involving inverse trigonometric functions	04

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
13. Determines the limit of a function.	13.1 Explains the limit of a function.	• Intuitive idea of $\lim_{x \to a} f(x) = l$, where $a, l \in$ □	□ Explains the meaning of limit □ Distinguishes the cases where the limit of a function does not exist	02
	13.2 Solves problems using the theorems on limits.	• Basic theorems on limits and their applications	□. Expresses the theorems on limits.	03
	13.3 Uses the limit $\lim_{x \to a}\left(\frac{x^n - a^n}{x - a}\right) = na^{n-1}$ to solve problems.	• Proof of $\lim_{x \to a}\left(\frac{x^n - a^n}{x - a}\right) = na^{n-1}$, where n is a rational number and its applications	□ Proves $\lim_{x \to a}\frac{x^n - a^n}{x - a} = na^{n-1}$ where n is a rational number. □ Solves problems involving above result	03
	13.4 Uses the limit $\lim_{x \to 0}\left(\frac{\sin x}{x}\right) = 1$ to solve problems.	• Sandwich theorem (without Proof) • Proof of $\lim_{x \to 0}\left(\frac{\sin x}{x}\right) = 1$ and its applications	□ States the sandwich theorem □ Proves that $\lim_{x \to 0}\frac{\sin x}{x} = 1$ □ Solves the problems using the above result	03

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	13.5 Interprets one sided limits.	• Intuitive idea of one sided limit • Right hand limit and left hand limit: $\lim_{x \to a^+} f(x)$, $\lim_{x \to a^-} f(x)$	Interprets one sided limits Finds one sided limits of a given function at a given real number	02
	13.6 Find limits at infinity and its applications to find limit of rational functions	• Limit of a rational function as $x \to \pm\infty$ Horizontal asymptotes	Interprets limits at infinity Explains horizontal asymptotes	02
	13.7 Interprets infinite limits.	• Infinite limits Vertical asymptotes using one sided limits	Explains vertical asymptotes	01
	13.8 Interprets continuity at a point.	• Intuitive idea of continuity	Explains continuity at a point by using examples	02

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
14. Differentiates functions using suitable methods.	14.1 Describes the idea of derivative of a function.	• Derivative as the slope of tangent line • Derivative as a limit • Derivative as a rate of change	Explains slope and tangent at a point Defines the derivative as a limit Explains rate of change	06
	14.2 Determines the derivatives from the first principles.	• Derivatives from the first principles x^n, where n is a rational number Basic trigonometric functions Functions formed by elementary algebraic operations of the above	• Finds derivatives from the first principles	05
	14.3 States and uses the theorems on differentiation.	• Theorems on differentiation Constant multiple rule Sum rule Product rule Quotient rule Chain rule	States basic rules of derivative Solves problems using basic rules of derivatives	03
	14.4 Differentiates inverse trigonometric functions.	• Derivatives of inverse trigonometric functions	Finds the derivatives of inverse trignometric functions Solves problems using the derivatives of inverse trignometric functions	03

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	14.5 Describes natural exponential function and find its derivative.	• The properties of natural exponential function ú $\frac{d}{dx}\left(e^{x}\right)=e^{x}$ ú Graph of e^{x}	Defines the exponential function (e^x) Express domain and range of exponential function States that e is an irrational number Describes the properties of the e^x Writes the estimates of the value of e Writes the derivative of the exponential function and uses it to solve problems Sketches the graph of $y = e^x$	02
	14.6 Describes natural logarithmic function.	• Properties of natural logarithmic function ú Definition of natural logarithmic function, $\ln x$ or $\log_e x\,(x>0)$, as the inverse function of e^x, its domain and range ú $\frac{d}{dx}(\ln x)=\frac{1}{x}$, for $x>0$ ú Graph of $\ln x$ • Definition of a^x and its derivative	Defines the natural logarithmic function Expresses the domain and range of the logarithmic function Expresses the properties of lnx The graph of $y = lnx$ Defines the function a^x for $a > 0$ Expresses the domain and the range of $y = a^x$ Solves problems involving logarithmic function Deduces the derivative of lnx Deduces the derivative of a^x Solves problems using the derivatives of lnx and a^x	03

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	14.7 Differentiates implicit functions and parametric functions.	• Intuitive idea of implicit functions and parametric functions • Diferentiation involving Implicit functions and parametric equation including parametric forms of parabola $y^2 = 4ax$, elipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ and hyperabola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ $xy = c^2$	• Defines implict functions • Finds the derivatives of implicit functions • Differentiates parametric function • Writes down the equation of the tangent and normal at a given point to a given curve	06
	14.8 Obtains derivatives of higher order.	• Successive differentiation • Derivatives of higher order	• Finds derivatives of higher order • Differentiates functions of various types • Find relationship among various orders of derivatives	02

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
15. Analyses the behaviour of a function using derivatives.	15.1 Investigates the turning points using the derivative.	• Stationary points • Increasing / decreasing functions • Maximum points (local), minimum points (local) • Point of inflection • First derivative test and second derivative test	☐ Defines stationary points of a given function ☐ Describes local (relative) maximum and local minimum ☐ Employs the first derivative test to find the maximum and minimum points of a function ☐ States that there exists stationary points which are neither a local maximum nor a local minimum ☐ Introduces points of inflection ☐ Uses the second order derivative to test whether a turning point of a given function is a local maximum or a local minimum	05
	15.2 Investigates the concavity.	• Concavity and points of inflection	☐ Uses second derivative test to find concavity	02
	15.3 Sketches curves.	• Sketching curves only (including horizontal and vertical asymptotes)	☐ Sketches the graph of a function	04
	15.4 Applies derivatives for practical situations.	• Optimization problems	☐ Uses derivatives to solve real life problems	04

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
16. Find indefinite and definite Integrales of functions.	16.1 Deduces indefinite Integral using anti-derivatives.	• Integration as the reverse process of differentiation (anti - derivatives of a function)	Finds indefinite integrals using the results of derivatives	03
	16.2 Uses theorems on integration.	• Theorems on integration	Uses theorems on integration	02
	16.3 Review the basic properties of a definite integral using the fundamental theorem of calculus.	• Fundamental Theorem of Calculus • Intuitive idea of the definite integral • Definite integral and its properties • Evaluation of definite integrals	Uses the fundamental theorem of calculus to solve problems Uses the properties of definte integral Solves problems involving definite integral	02
	16.4 Integrates rational functions using appropriate methods.	• Indefinite integrals of functions of the form $\frac{f'(x)}{f(x)}$; where $f'(x)$ is the derivative of $f(x)$ with respect to x	Uses the formula to find integrals	05
	16.5 Integrates trigonometric expressions using trigonometric identities.	• Use of partial fractions • Use of trigonometric identities	Uses of partial fractions for integration Uses trigonometric identities for integration	03

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	16.6 Uses the method of substitution for integration.	• Integration by substitution	Uses suitable substitutions to find intergrals	04
	16.7 Solves problems using integration by parts.	• Integration by parts	Uses integration by parts to solve problems	03
	16.8 Determines the area of a region bounded by curves using integration.	• Uses of integration ◦ Area under a curve ◦ Area between two curves	Uses definite integrals to find area under a curve and area between two curves	04
	16.9 Determines the volume of revolution.	• Use of the formulae $\int_a^b \pi\left(f(x)\right)^2 dx$ to find the volume of revolution	Uses integration formula to find the volume of revolution	02

dx

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
17. Uses the rectangular system of Cartesian axes and geometrical results.	17.1 Finds the distance between two points on the Cartesian plane.	• Rectangular Cartesian coordinates ú Rectangular Cartesian system ú Distance between two points	• Explains the Cartesian coordinate system • Defines the abscissa and the ordinate • Introduces the four quadrants in the cartesian coordinate plane • Finds the length of a line segment joining two points	01
	17.2 Finds Co-ordinates of the point dividing the straight line segment joining two given points in a given ratio.	• Coordinates of the point that divides a line segment joining two given points in a given ratio ú internally ú externally	• Finds Co-ordinates of the point dividing the straight line segment joining two given points internally in a given ratio • Finds Co-ordinates of the point dividing the straight line segment joining two given points externally in a given ratio	02

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
18. Interprets the straight line in terms of Cartesian co-ordinates.	18.1 Derives the equation of a straight line.	• Straight line ú Inclination (angle), gradient (slope) ú Intercepts on the x and y axes ú Various forms of equation of a straight line	Interprets the gradient (slope) of a line and the x and y intercepts Derives various forms of equation of a straight line	05
	18.2 Derives the equation of a straight line passing through the point of intersection of two given non parallel straight lines.	• Point of intersection of two non parallel straight lines • The equation of the straight line passing through the point of intersection of two given non parallel straight lines	Finds the coordinates of the point of intersection of two non parallel straight lines Finds the equation of the line passing through the intersection of two given lines	02
	18.3 Describe the relative position of two points with respect to a given straight line.	• The condition that the two given points are on the same or opposite sides of a given straight line	Finds the Condition fortwo points to be on the same side or an opposit sides of a given line	02
	18.4 Finds the angle between two straight lines.	• Angle between two straight lines • The relationship between the gradients of pairs of ú parallel lines ú perpendicular lines	Finds the angles between two given lines by using their gradients Finds condition for two lines to be parallel or perpendicular	02
	18.5 Derives the perpendicular distance from a given point to a given straight line.	• Parametric equation of a straight line • Perpendicular distance from a point to a straight line • Equations of bisectors of the angles between two intersecting straight lines	Derives parametric equation of a straight line Finds perpendicular distance from a point to a given line using parametric equation of the line Finds the equations of angular bisectors of two non parall straight lines	06

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
19. Applies the principle of Mathematical Induction as a type of proof for Mathematical results for positive integers.	19.1 Uses the principle of Mathematical Induction.	• Method of mathematical induction ú Principle of Mathematical Induction ú Applications involving, divisibility, summation and Inequalities	States the principles of Mathematical Induction Proves the various results using principle of Mathematical Induction	05
20. Finds sums of finite series.	20.1 Describes finite series and their properties.	• Sigma notation • $\sum_{r=1}^{n}(U_r+V_r)=\sum_{r=1}^{n}U_r+\sum_{r=1}^{n}V_r$ • $\sum_{r=1}^{n}kU_r=k\sum_{r=1}^{n}U_r$; where k is a constant	Describes finite sum Uses the properties of " $\sum$ " notation	03

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	20.2 Finds sums of elementary series.	Arithmetic series and geometric series $\sum_{r=1}^{n} r,\ \sum_{r=1}^{n} r^2, \sum_{r=1}^{n} r^3$ and their applications	Finds general term and the sum of AP, GP, Proves and uses the formulae for values of $\sum_{r=1}^{n} r,\ \sum_{r=1}^{n} r^2, \sum_{r=1}^{n} r^3$ to find the summation of series	05
21 Investigates infinite series.	21.1 Sums series using various methods.	• Summation of series Method of differences Method of partial fractions Principle of Mathematical Induction	Uses various methods to find the sum of a series	08
	21.2 Uses partial sum to detemine convergence and divergence.	• Sequences • Partial sums • Concept of convergence and divergence • Sum to infinity	Interprets sequences Finds partial sum of an infinite series Explains the concepts of convergence and divergance using partial sums Finds the sum of a convergent series	03

Competency	Competency Level	Contents	Learning outcomes	No. of Periods

22. Explores the binomial expansion for positive integral indices.	22.1 Describes the basic properties of the binomial expansion.	• Binomial theorem for positive integral indices
		  - Binomial coefficients, general term
		  - Proof of the theorem using mathematical Induction
			• States binomial theorem for positive integral indices.
			• Writes general term and binomial coefficient
			• Proves the theorem using Mathematial Induction
				03

	22.2 Applies binomial theorem.	• Relationships among the binomial coefficients • Specific terms (Highest term and higest coefficienta are not expected)	• Writes the relationship among the binomial coefficients • Finds the specific terms of binomial expansions	06
23. Interprets the system of complex numbers.	23.1 Uses the Complex number system.	• Imaginary unit • Introduction of $\mathbb{C}$, the set of complex numbers • Real part and imaginary part of a complex number • Purely imaginary numbers • Equality of two complex numbers	• States the imaginary unit • Defines a complex number • States the real part and imaginary part of a complex number • Uses the equality of two complex numbers	02

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	23.2 introduces algebraic operations on complex numbers.	• Algebraic operations on complex numbers $z_1+z_2,\ z_1-z_2,\ z_1\cdot z_2,\ \dfrac{z_1}{z_2}\ (z_2\neq 0)$	Defines algebraic operations on complex numbers Uses algebraic operations between two complex numbers and verifies that they are also complex numbers Basic operations on complex numbers	02
	23.3 Proves basic properties of complex conjugate.	• Definition of $\overline{z}$ • Proofs of the following results: $\overline{z_1+z_2}=\overline{z_1}+\overline{z_2}$ $z_1-z_2=z_1-z_2$ $\overline{z_1\cdot z_2}=\overline{z_1}\cdot\overline{z_2}$ $\overline{\left(\dfrac{z_1}{z_2}\right)}=\left(\dfrac{\overline{z_1}}{\overline{z_2}}\right)$	Defines $\overline{z}$ States basic properties of complex conjugate Proves the basic properties of complex conjugate	02
	23.4 Define the modulus of a complex number.	• Definition of $\lvert z\rvert$, modulus of a complex number z • Proofs of the following results: $\lvert z_1\cdot z_2\rvert=\lvert z_1\rvert\cdot\lvert z_2\rvert$ $\left\lvert\dfrac{z_1}{z_2}\right\rvert=\dfrac{\lvert z_1\rvert}{\lvert z_2\rvert}$ if $z_2\neq 0$ $z\cdot\overline{z}=\lvert z\rvert^2$ $\lvert z_1+z_2\rvert^2=\lvert z_1\rvert^2+2\operatorname{Re}(z_1\cdot z_2)+\lvert z_2\rvert^2$ • applications of the above results	Defines the modulus $\lambda+\mu\neq 0$ of a complex number z Proves basic properties of modulus of a complex number Applies the basic properties of modulus of a complex number	04

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	23.5 Ilustrates algebraic operations geometrically using the Argand diagram.	• The Argand diagram • Representing $z = x + iy$ by the point (x, y) • Geometrical representations of $z_1 + z_2,\ z_1 - z_2,\ \overline{z},\ \lambda z$ where $\lambda \in$ • Polar form of a non zero complex number • Definition of arg(z) • Definition of Arg z, principal value of the argument z is the value of θ satisfying $-\pi < \theta \le \pi$ • Geometrical representation of ú $z_1 \cdot z_2,\ \frac{z_1}{z_2}; z_2 \neq 0$ ú $r(\cos\alpha + i\sin\alpha)$, where $\alpha \in$, $r > 0$ ú $\frac{\lambda z_1 + \mu z_2}{\lambda + \mu}$, where $\lambda,\ \mu \in$ and $\lambda + \mu \neq 0$	Represents the complex number on Argand diagram Contstructs points representing z_1+z_2, $\overline{z}$ and λz where $\lambda \in$ Expresses a non zero complex number in pola Form $z = r(\cos\theta + i\sin\theta)$: $r > 0,\ \theta \in$ Defines the argument of a complex number Defines the principle argument of a non zero complex number Constructs points representing $z_1 z_2$ and $\frac{z_1}{z_2}$ in the Argand diagram Constructs points representing $r(\cos\alpha + i\sin\alpha)$ where $\alpha \in R,\ \ r = 0$ Constructs points representing $\frac{\lambda z_1 + \mu z_2}{\lambda + \mu}$, where $\lambda, \mu \in R$ and $\lambda + \mu \neq 0$	04

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
		• proof of the triangle inequality $\lvert z_1 + z_2\rvert \le \lvert z_1\rvert + \lvert z_2\rvert$ • Deduction of reverse triangle inequality $\lvert\lvert z_1\rvert - \lvert z_2\rvert\rvert \le \lvert z_1 - z_2\rvert$	• Proves the triangle inequality • Deduces the reverse triangle inequality • Uses the above inequalities to solve problems	
	23.6 Uses the DeMovier's theorem.	• State and prove of the DeMovier's Theorem for positive integgral index. • Elementary applications of DeMovier's theorem	• States and prove of the DeMovier's Theorem • Solves problems involvings elementary applications of DeMovier's theorem	02
	23.7 Identifies locus / region of a variable complex number.	• Locus of ú $\lvert z - z_0\rvert = k$ and $\lvert z - z_0\rvert \le k$ ú $\text{Arg}(z - z_0) = \alpha$ and $\text{Arg}(z - z_0) \le \alpha$ where $-\pi \le \alpha \le \pi$ and z_0 is fixed ú $\lvert z - z_1\rvert = \lvert z - z_2\rvert$, where z_1 and z_2 are given distinct complex numbers	• Sketchs the locus of variable complex numbers in Argand diagram • Obtains the Cartesian equation of a locus	04

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
24. Uses permutations and combinations as mathematical models for sorting and arranging.	24.1 Defines factorial.	• Definition of $n!$, the factorial n for $n \in \mathbb{Z}^+$ or $n = 0$. - General form - Recursive relation	- Defines factorial - States the recursive relation for factorials	01
	24.2 Explains fundamental principles of counting.	• Techniques regarding the principles of counting	- Explains the fundamental principle of counting	02
	24.3 Use of permutations as a technique of solving mathematical problems.	• Permutations - Definition - The notation ${}^nP_r$ and the formulae Where $0 \le r \le n;\ \gamma \in Z^+$	- Defines ${}^nP_r$ and obtain the formulae for ${}^nP_r$. - The number of permutations of n different objects taken r at a time - Finds the number permutations of different objects taken all time at a time - Permutation of n objects not all different - Finds numer of permutations of n different objects not all different taken r at a time	06

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	24.4 Uses combinations as a technique of solving mathematical problems.	• Combinations ú Definition ú Define as ^nC_r and finds a formulae for ^nC_r ú Distinction between permutation and combnation	Defines combination Finds the number of combination of different objects taken r at a time where $r(0 \le r \le n)$ Define ^nC_r and finds a formulae for ^nC_r Finds the number of combinations of n different objects not all different taken r at a time where $r(0 \le r \le n)$ Explains the distinction between permutations and combinations	05
25. Manipulates matrices.	25.1 Describes basic properties of matrices.	• Definition and notation ú Elements, rows, columns ú Size of a matrix ú Row matrix, column matrix, square matrix, null matrix • Equality of two matrices • Meaning of λA where λ is a scalar ú Properties of scaler product ú Definition of addition ú Compatibility for addition ú Properties of addition • Multiplication of matrices ú Compatibility ú Definition of multiplication ú Properties of multiplication	Defines a matrix Defines row matries and columns matrices Defines the equality of matrices Defines the multiplication of a matrix by a scalar Writes the compatibility for addition Uses the addition of matrices to solve problems Defines subtraction using addition and scalar multiplication Writes the conditions for compatibility for multiplication Defines multiplication Uses the properties of multiplication to solve problems	02

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	25.2 Explains special cases of square matrices.	• Square matrices ú Order of a square matrix ú Identity matrix, diagonal matrix, symmetric matrix, skew symmetric matrix ú Triangular matries (upper, lower)	Identifies the order of a square matrices Defines special types of matrices	02
	25.3 Describes the transpose and the inverse of a atrix..	• Transpose of a matrix ú Definition and notation • Determinant of 2×2 matrices • Inverse of a matrix ú Only for 2×2 matrices	Finds the transpose of a matrix Finds the determinant of 2×2 matrices Finds the inverse of a 2x2 matrix	04
	25.4 Uses matrices to solve . simultaneous equations..	• Solution of a pair of linear equations with two variables ú Explains existence of unique solutions, infinitely many solutions and no solutions graphically using determinat ú Solves simultaneous equation using matrices	Examine the solution of a pair of linear equation Solves simultaneous equations using matrices Illustrates the solutions graphically	06

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
26. Interprets the Cartesian equation of a circle.	26.1 Finds the Cartesian equation of a circle.	• Describe a circle • General equation of circle • Equation of a circle having two points as the end points of an of a diameter of the circle	□ Defines circle as a locus of a variable point in a plane such that the distance from a fixed point is a constant □ Finds equation of a circle with origen as a center and given radius □ Finds equation of a circle with given center and given radius □ Interprets general equation of a circle □ Finds the equation of the circle having two given points as the end points at a diameter	03
27.Explores Geometric properties of circles.	27.1 Describes the position of a straight line relative to a circle.	• Conditions that a circle and a straight line intersects, touches or do not intersect • Equation of the tangent to a circle at a point on circle	□ Discuses the position of a straight line with respect to a circle □ Obtains the equation of the tangent at a point on a circle	02
	27.2 Finds the equations of tangents drawn to a circle from an external point.	• Equation of tangents to a circle from an external point to the circle • Length of tangents drawn from an extenal point to the circle • Equation of chord of contact	□ Obtains the equation of the tangent drawn to a circle from an external point □ Obtains the length of tangent drawn from an external point to a circle □ Obtains the equation of the chord of contact	03

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	27.3 Derives the general equation of a circle passing through the points of intersection of a given straight line and a given circle.	• The equation of a circle passing through the points of intersection of a straight line and a circle	Interprets the equation $S + \lambda U = 0$	02
	27.4 Describes the position of two circles.	• Position of two circles - Intersection of two circles - Non-intersection of two circles - Two circles touching externally - Two circles touching internally - One circle lying within the other	Discribes the condition for two circles to intersect or not-intersect Discribes the condition for two circles to touch externally or touch internally Discribes to have one circle lying within the other circle	03
	27.5 Finds the condition for two circle to intersect orthogonally.	• Condition for two circles to intersects orthogonaly	Finds the condition for two circles to intersect orthogonally	02

COMBINED MATHEMATICS - II

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
1. Manipulates Vectors.	1.1 Investigates vectors.	• Introduction of scalar quantities and scalars • Introduction of vector quantities and vectors • Magnitude and direction of a vector • Vector notation ú Algebraic, Geometric ú Null vector • Notation for magnitude (modulus) of a vector • Equality of two vectors • Triangle law of vector addition • Multiplying a vector by a scalar • Defining the difference of two vectors as a sum • Unit vectors • Parallel vectors ú Condition for two vectors to be parallel • Addition of three or more vectors • Resolution of a vector in any directions	□ Explains the differneces between scalar quantities and scalars □ Explains the differnece between vector quantity and a vectors. □ Represents a vector geometrically □ Expresses the algebraic notation of a vector □ Defines the modulus of a vector □ Defines the null vector □ Defines -$\underline{a}$, where a is a vector □ States the conditions for two vectors to be equal □ States the triangle law of addition □ Deduces the paralle logram law of addition □ Adds three or more vectors □ Multiplies a vector by a scalar □ Subtracts a vector from another □ Identifies the angle between two vectors □ Identifies parallel vectors □ States the conditions for two vectors to be paralles	03

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
			State the conditions for two vectors to be parallel Defines a "unit vector" Resolves a vector in a given directions	
	1.2 Constructs algebraic system for vectors.	• laws for vector addition and multiplication by a scaler	States the properties of addition and multiplication by a scaler	01
	1.3 Applies position vectors to solve problems.	• Position vectors • Introduction of $\underset{\sim}{i}$ and $\underset{\sim}{j}$ • Position vector relative to the 2D Cartesian Co-ordinate system • Additional two vectors • Application of the following results If $\underline{a}$ and $\underline{b}$ are non - zero and non - parallel vectors and if $\lambda \underline{a} + \mu \underline{b} = \underset{\sim}{0}$ then $\lambda = 0$ and $\mu = 0$	Defines position vectors Expresses the position vector of a point in terms of the cartesian co-ordinates of that point Adds and subtracts vectors in the form $x\underline{i} + y\underline{j}$ Proves that if $\underline{a}$, $\underline{b}$ are two non zero, non - parallel vectors and if $\lambda \underline{a} + \mu \underline{b} = \underline{0}$ then $\lambda = 0$ and $\mu = 0$ Applies the above results	06

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	1.4 Interprets scalar and vector product.	• Definition of scalar product of two vectors • Properties of scalar product ú $\underline{a}\cdot\underline{b}=\underline{b}\cdot\underline{a}$ (Commutative law) ú $\underline{a}\cdot(\underline{b}+\underline{c})=\underline{a}\cdot\underline{b}+\underline{a}\cdot\underline{c}$ (Distributive law) • Angle between two vectors • Condition for two non-zero vectors to be perpendicular • Introduction of $\underline{k}$ • Definition of vector product of two vectors • Properties of vector product ú $\underline{a}\wedge\underline{b} = -\underline{b}\wedge\underline{a}$	Defines the scalar product of two vectors States that the scalar product of two vectors is a scalar States the properties of scalar product Interprets scalar product geometrically Finds the angle between tow non zero vectors Explain condition for two non zero vectors to be perpendicular to each other Define vector product of two vectors States the properties of vector product (Application of vector product are not expected)	04
2. Uses systems of coplanar forces .	2.1 Explains forces acting on a particle.	• Concept of a particle • Concept of a force and its representation • Dimension and unit of force • Types of forces • Resultant force	Describes the concept of a particle Describes the concept of a force States that a force is a localized vector Represents a force geometrically Introduces diamention and unit of a force Introduces different types of forces in mechanics Describes the resultant of a system of coplaner forces acting at a point	02

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	2.2 Explains the action of two forces acting on a particle	• Resultant of two forces • Parallelogram law of forces • Equilibrium under two forces • Resolution of a force ú in two given directions ú in two directions perpendicular to each other	States resultant of two forces States the parallelogram law of forces Uses the parallelogram law of forces to obtain formulae to determine the resultant of two forces acting at a point Solves problems using the parallelogram law of forces Writes the condition necessary for a particle to be in equilibrium under two forces Resolves a given force into two components in two given directions Resolves a given force into two components perpendicular to each other	04
	2.3 Explains the action of a systems of coplanar forces acting on a particle.	• Coplanar forces acting on a particle • Resolving the system of coplanar forces in two directions perpendicular to each other • Resultant of the system of coplanar forces ú Method of resolution of forces ú Graphical method	Expresses Determines the resultant of three or more coplanar forces acting on a particle by resolution Determines graphically the resultant of three or more coplanar forces acting at a particle States the conditions for a system of coplanar forces acting on a particle to be in equilibrium	05

Competency	Competency Level	Contents	Learning outcomes	No. of Periods

		• Conditions for equilibrium
		  ◦ null resultant vector
		  $\underline{R} = X\underline{i} + Y\underline{j} = \underset{\sim}{0}$
		  ◦ Vector sum = $\underline{0}$ or, equivalently, $X = 0$ and $Y = 0$
		  ◦ Completion of Polygon of forces
			• Writes the condition for eqilibrium
			(i) $\underline{R} = \underline{0}$
			$\underline{R} = X\underline{i} + Y\underline{j} = \underline{0}$
			$X = 0,\ Y = 0$
			• Completes a polygon of forces.	

	2.4 Explains equilibrium of a particle under the action of three forces.	• Triangle law of forces • Coverse of triangle law of forces • Lami's theorem • Problems involving Lami's theorem	• Explains equilibrium of a particle under the action of three coplaner forces • States the conditions for equilibrium of a particle under the action of three forces • States the law of triangle of forces, for equilibrium of three coplanar forces • States the converse of the law of triangle of forces • States Lami's theorem for equilibrium of three coplanar forces acting at a point • Proves Lami's Theorem. • Solves problems involving equilibrium of three coplanar forces acting on a particle	05

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	2.5 Explains the Resultant of coplanar forces acting on a rigid body.	• Concept of a rigid body ΰ Forces acting on a rigid body ΰ Principle of transmission of forces ΰ Explaining the translational and rotational effect of a force ΰ Defining the moment of a force about a point ΰ Dimension and unit of moment ΰ Physical meaning of moment ΰ Magnitude and sense of moment of a force about a point ΰ Geometric interpretation of moment • General principle about moment of forces ΰ Algebraic sum of the moments of the component forces about a point on the plane of a system of coplanar forces is equvalent to moment of the resultant force about that point	Describes a rigid body States the principle of transmission of forces Explains the translation and rotation of a force Defines the moment of a force about a point States the dimensions and units of moments Explains the physical meaning of moment Finds the magnitude of the moment about a point and its sense Represents the magnitude of the moment of a force about a point geometrically Determines the algebraic sum of the moments of the forces about a point in the plane of a coplanar system of forces Uses the general principle of moment of a system of forces	04

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	2.6 Explains the effect of two parallel coplanar forces acting on a rigid body.	• Resultant of two forces ú When the two forces are not parallel ú When the two forces are parallel and like ú When two forces of unequal magnitude are parallel and unlike • Equilibrium under two forces • Introduction of a couple • Moment of a couple ú Magnitude and sense of the moment of a couple ú The moment of a couple is independent of the point about which the moment is taken • Equivalence of two coplanar couples • Equilibrium under two couples • Composition of coplanar couples	Finds the resultant of two non - parallel forces acting on a rigid body Finds the resultant of two paralle forces States the conditions for the equilibrium of two forces acting on a rigid body Describes a couple Describes the sense of a couple Calculates magnitude and moment of a couple States that the moment of a couple is independent of the point about which the moment of the forces is taken States the conditions for two coplanar couples to be equivalent States the conditions for two coplanar couples to balance each other Combines coplanar couples	06

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	2.7 Analyses a system of coplanar forces acting on a rigid body.	• A force ($\underline{F}$) acting at a point is equivalent to a single force $\underline{F}$ acting at any given point together with a couple • Reducing a system of coplanar forces to a single force $\underline{R}$ acting at a given point together with a couple of moment $\underline{G}$ • Magnitude, direction and line of action of the resultant • Conditions for the reduction of system of coplanar forces to ú a single force: $\underline{R} \neq \underline{0}$ $(X \neq 0$ or $Y \neq 0)$ ú a couple : $\underline{R} = \underline{0}$ $(X = 0$ and $Y = 0)$ and $\underline{G} \neq \underline{0}$ ú equilibrium $\underline{R} = \underline{0}$ (X= 0 and Y=0) and $\underline{G} = \underline{0}$ ú Single force at other point : $\underline{R} \neq \underline{0}$, $\underline{G} \neq \underline{0}$ • Problems involving equlibrium of rigid bodies under the action of coplanar forces	• Reduces a couple and a single force acting in its plane into a single force • Shows that a single force acting at a point is equivalent to the combination of an equal single force acting at another point together with a couple • Reduces a system of coplanar forces to a single force acting at O together with couple of moment $\underline{G}$ • Finds magnitude, direction and line of action of a system of coplaner forces • Reduces a system of coplanar forces to a single force acting at given point in that plane • States the condition to reduce a system a of coplaner forces to a couple • States the condition for a system of coplaner forces to reduce a single force ú Expresses conditions for equilibrium of a rigid bodyundertheactionofcoplaner forces • Solves problems involving rigid bodies under the action of coplaner forces.	08

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	2.8 Explains the Equillibrium of three coplanar forces acting on a rigid body.	• Conditions for the equilibrium of three coplanar forces acting on a rigid body • Use of ú Triangle Law of forces and its converse ú Lami's theorem ú Cotangent rule ú Geometrical properties ú Resolving in two directions perpendicular to each other	States conditions for the equilibrium of three coplanar forces acting on a rigid body Finds unknown forces when a rigid body is in equillibrium by using ú Triangle Law of forces and its converse ú Lami's theorem, ú Cotangent rule ú Geometrical properties ú Resolving in two directions perpendicular to each other	08
	2.9 Investigates the effect of friction .	• Introduction of smooth and rough surfaces • Frictional force and its nature • Advantages and disadvantages of friction • Limiting frictional force • Laws of friction • Coefficient of friction • Angle of friction • Problems involving friction	Describes smooth surfaces and rough surfaces Describes the nature of frictional force Explains the advantages and disadvantages of friction Writes the definition of limiting frictional force States the laws of friction defines the angle of friction and the co-efficient of friction. Solves problems involving friction	10
	2.10 Applies the properties of systems of coplanar forces to investigate equilibrium involving smooth joints.	• Types of simple joints • Distinguish a movable joint and a rigid joint • Forces acting at a smooth joint • Applications involving jointed rods	States the type of simple joints Describes the movable joints and rigid joints Marks forces acting on a smooth joints Solves problems involving joined rods	10

Competency	Competency Level	Contents	Learning outcomes	No. of Periods

	2.11 Determines the stresses in the rods of a framework with smoothly jointed light rods.	• Frameworks with light rods
		• Conditions for the equilibrium at each joint at the framework
		  ◦ Bow's notation and stress diagram
		  ◦ Calculation of stresses
			• Describes a frame work with light rods
			• States the condition for the equilibrum at each joint in the frame work
			• Uses Bow's notation
			• Solves problem involing a frame work with light rod
				10

	2.12 Applies various techniques to determine the centre of mass of symmetrical uniform bodies.	• Definition of centre of mass
		• Centre of mass of a plane body symmetrical about a line
		  ◦ Uniform thin rod
		  ◦ Uniform rectangular lamina
		  ◦ Uniform circular ring
		  ◦ Uniform circular disc
		• Centre of mass of a body symmetrical about a plane
		  ◦ Uniform hollow or solid cylinder
		  ◦ Uniform hollow or solid sphere
		• Center of mass of
		  ◦ Uniform tringular lamina
		  ◦ Uniform lamina in the shape of a parallalogram
			• Defines the centre of mass of a system of particles in a plane
			• Defines the centre of mass of a lamina
			• Finds the centre of mass of uniform bodies symmetrical about a line
			• Finds the centre of mass of bodies symmetrical about a plane
			• Finds centre of mass of Lamminas of different shapes
			• Finds center of mass of a uniform triangular lamina using thin rectangular stripes
			• Finds center of mass of a uniform lamina in the shape of a parallalogram using thin rectangular stripes
				04

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	2.13 Finds the centre of mass of simple geometrical bodies using integration.	• Centre of mass of uniform continuous symmetrical bodies ú Circular arc, circular sector • The centre of mass of uniform symmetrical bodies ú Hollow right circular cone ú Solid right circular cone ú Hollow hemisphere ú Solid hemisphere ú Segment of a hollowsphere ú Segment of a solid sphere	Finds the centre of mass of uniform bodies symmetric about a line using integration Finds the centre of mass of uniform bodies symmetrical about a plane using integration	06
	2.14 Finds the centre of mass of composite bodies and remaining bodies.	• Centre of mass of composite bodies • Centre of mass of remaining bodies	Finds the centre of massof composite bodies Finds the centre of mass of remaining bodies	04
	2.15 Explains centre of gravity.	• Introduction of centre of gravity • Coincidence of the centre of gravity and centre of mass	Explains center of gravity of a body States the centre of mass and centre of gravity are same under gravitational field.	02
	2.16 Determines the stability of bodies in equilibrium.	• Stability of equilibrium of bodies resting on a plane	Explains the stabillity of bodies in equilibrium using centre of gravity	02
	2.17 Determines the angle of inclination of suspended bodies.	• problems involving suspended bodies	Solves problem involving suspended bodies	02

Competency	Competency Level	Contents	Learning outcomes	No. of Periods

3. Applyes the Newtonian model to describe the instantaneous motion in a plane.	3.1 Uses graphs to solve problems involving motion in a straight line.	• Distance and speed and their dimensions and units
		• Average speed, instantaneous speed, uniform speed
		• Position coordinates
		• Displacement and velocity and their dimensions and units
		• Average velocity, instantaneous velocity, uniform velocity
		• Displacement - time graphs
		  ◦ Average velocity between two positions
		  ◦ Instantaneous velocity at a point
		• Average acceleration, its dimensions and units
		• Instantaneous acceleration, uniform acceleration and retardation
		• Velocity-time graphs
		• Gradient of the velocity time graph is equal to the instantaneous acceleration at that instant
			• Defines "distance, speed"
			• States diamention and units of distance and speed
			• Defines average speed
			• Defines instantaneous speed
			• Defines uniform speed
			• States dimensions and standard units of speed
			• States that distance and speed are scalar quantities
			• Defines position coordinates of a particle undergoing rectilinear motion
			• Defines Displacement
			• States the dimension and units of displacement
			• Defines average velocity
			• Defines instantaneous velocity
			• Defines uniform velocity
			• States dimension and units of velocity
			• Draws displacement - time graph
			• Draws velocity - time graph	

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
		• The area signed between the time axis and the velocity time graph is equal to the displacement described during that time interval	□ Finds the average velocity between two positions using the displacement time graph □ Determines the instantaneous velocity using the displacement time graph □ Defines accelaration □ States the dimension and unit of acceleration □ Defines average acceleration □ Defines instantaneous acceleration □ Defines uniform acceleration □ Defines retardation □ Draws the velocity time graph □ Finds average accelaration using the velocity time graph □ Finds the acceleration at a given instant using velocity - time graph □ Finds displacement using velocity time graph □ Draws velocity time graphs for different types of motion □ Solves problems using displacement time and velocity-time graphs	08

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	3.2 Uses kinematic equations to solve problems involving motion in a straight line with constant acceleration.	• Derivation of constant acceleration formulae ◦ Using definitions ◦ Using velocity - time graphs • Vertical motion under constant acceleration due to gravity ◦ Use of graphs and kinematic equations	- Derives kinematic equations for a particle moving with uniform acceleration - Derives kinematic equations using velocity - time graphs - Uses kinematic equations for vertical motion under gravity - Uses kinematics equations to solve problems - Uses velocity - time and displacement - time graphs to solve problems	08
	3.3 Investigates relative motion between bodies moving in a a straight line with constant accelerations.	• Frame of reference for one dimensional motion • Relative motion in a straight line • Principle of relative displacement, relative velocity and relative acceleration • Use of kinematic equations and graphs when relative acceleration is constant	- Describes the concept of frame of reference for two dimensional motion - Describes the motion of one body relative to another when two bodies are moving in a straight line - States the principle of relative displacement for two bodies moving along a straight line - States the principle of relative velocity for two bodies moving along a straight line	06

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
			States the principle of relative acceleration for two bodies moving along a straight line Uses kinematic equations and graphs related to motion for two bodies moving along the same straight line with constant relative acceleration	
	3.4 Explains the motion of a particle on a plane.	• Position vector relative to the origin of a moving particle • Velocity and acceleration when the position vector is given as a function of time	Finds relation between the cartesian coordinates and the polar coordinates of a particle moving on a plane Finds the velocity and acceleratain when the position vector is givin as a function of time	06
	3.5 Determines the relative motion of two particles moving on a plane.	• Frame of reference • Displacement, velocity and acceleration relative to a frame of reference • Introduce relative motion of two particles moving on a plane • Principles of relative displacement, relative velocity,and relative acceleration. • Path of a particle relative to another particle • Velocity of a particle relative to another particle	Defines the frame of referance Obtains the displacement and velocity and acceleration relative to frame of reference Explains the principles of relative displacement,relative velocity, and relative acceleration Finds the path and velocity of a particle relative to another particle	06

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	3.6 Uses principles of relative motion to solve real word problems.	• Shortest distance between two particles and the time taken to reach the shortest distance • The time taken and position when two bodies collide • Time taken to describe a given path • Use of vectors	Uses the principles of relative motion to solves the problems Finds the shortest distance between two particles Finds the requirements for collision of two bodies Uses vectors to solve problums involving relative velocity	10

	3.7 Explains the motion of a projectile in a vertical plane.	• Given the initial position and the initial velocity of a projected particle the horizontal and vertical components of velocity and displacement, after a time t
		• Equation of the path of a projectile
		• Maximum height
		• Time of flight
		• Horizontal range
		  - Two angles of projection which give the same horizontal range
		  - Maximum Horizontal range
			Introduces projectile
			Describes the terms "velocity of projection" and "angle of projection"
			States that the motion of a projectile can be considered as two motions, separately, in the horizontal and vertical directions
			Applies the kinematic equations to interprets the motion of a projectile
			Calculates the components of velocity of a projectile after a given time t
			Finds the components of displacement of a projectile in a given time t
				08

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
			- Calculates the maximum height of a projectile - Calculates the time taken to reach the maximum height of a projectile - Calculates the horizontal range of a projectile and its maximum - Proves that in general there are two angles of projection for the same horizontal range for a given velocity of projection - Finds the maximum horizontal range for a given speed - For a given speed of projection finds the angle of projection giving the maximum horizontal range - Derives Cartesian equations of the path of a projectile - Finds the time of flight - Finds the angles of projection to pass through a given point	

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	3.8 Applies Newton's laws to explain motion relative to an inertial frame.	• Newton's first law of motion • concept of mass and linear momentum • Inertial frame of reference • Newton's second law of motion • Absolute units and gravitational units of force • Distinguish between weight and mass • Newton's third law of motion • Application of newton's l aws (under constant foce only) • Bodies in contact and particales connected by light inextensible string • System of pullys (maximum 4 pullys) • Wedges	□ States Newton's first law of motion □ Defines "force" □ Defines "mass" □ Defines linear momentum of a particle □ States that linear momentum is a vector quantity □ States the dimensions and unit of linear momentum □ Describes an inertial frame of reference □ States Newton's second law of motion □ Defines Newton as the absolute unit of force □ Derives the equation $\underline{F} = m\underline{a}$ from second law of motion □ Explains the vector nature of the equation $\underline{F} = m\underline{a}$ □ States the gravitational units of force □ Explains the difference between mass and weight of a body □ Describes "action" and "reaction" □ States Newton's third law of motion □ Solves problems using $\underline{F} = m\underline{a}$ □ Bodies in contact and particles connected by light inextensible strings □ Solves problems involving pullys, □ Solves problems involvingwedges	15

Competency	Competency Level	Contents	Learning outcomes	No. of Periods

	3.9 Interprets mechanical energy.	• Definition of work
		  • work done by constant force
		  • Dimension and units of work
		• Introduce energy,its dimensions and units
		• Kinetic energy as a type of mechanical energy
		  • Definition of kinetic energy of a particle
		  • work energy equation for kinetic energy
		• Disssipative and conservative forces
		• Potential energy as a type of mechanical energy
		
		• Definition of potential energy
		  • Definition of gravitational potential energy
		  • work energy equation for potential energy
			• Explains the concept of work
			• Defines work done under a constant force
			• States dimension and units of work
			• Explains Energy
			• States dimension and units of energy
			• Explains the mechanical energy
			• Defines Kinetic Energy
			• Defines Potential Energy
			• Explains the Gravitational Potential Energy
			• Explains the Elastic Potential Energy
			• Explains conservative forces and dissipative force
			• Writes work - energy equations
			• Explains conservation of mechanical Energy and applies it to solve problems
				02

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
		• Definition of elastic potential energy • Expression for the elastic potential energy • The work done by a conservative force is independent of the path described • Principle of conservation of mechanical energy and its applications		
	3.10 Solves problems involving power.	• Definition of power its dimensions and units • Tractive force(F) (constant case only) • Definition and application of Power= tractive force x velocity (P=F.V)	Defines Power States its units and dimensions Explains the tractive force Derives the formula for power Uses tractive force to solve problums when impluse is constant	08
	3.11 Interprets the effect of an impulsive action.	• Impulse as a vector its dimension and units • $\underline{I} = \Delta(m\underline{v})$ Formula • Change in kinetic energy due to an impulsive action	Explains the Impulsive action States the units and Dimension of Impulse Uses $\underline{I} = \Delta(m\underline{v})$ to solve problems Finds the change in Kinetic energy due to impulse	05

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	3.12 Uses Newton's law of restitution to direct elastic impact.	• Newton's law of restitution • Coefficient of restitution $(e),\ 0<e\leq 1$ • Perfect elasticity $(e=1)$ • Loss of energy when $e<1$ • Direct impact of two smooth elastic spheres • Impact of a smooth elastic sphere moving perpendicular to vertical plane	Explains direct impact States Newton's law of restitution Defines coefficient of restitution Explains the direct impact of a sphere on a fixed plane Calculates change in kinetic energy Solves problems involving direct impacts	10
	3.13 Solves problems using the conservation of linear momentum.	• Principle of conservation of linear momentum	Defines linear momentum Solves problem using the priciple of linear momentum	04
	3.14 Investigatesvelocity and acceleration for motion in circuler.	• Angular velocity $\dot{\theta}$ and angular acceleration $\ddot{\theta}$ of a particle moving on a circle • Velocity and acceleration of a particle moving on a circle	Defines the angular velocity and accelaration of a particale moving in a circle Find the velocity and the acceleration of a particle moving in a circle	06

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	3.15 Investigates motion in a horizontal circle.	• Motion of a particle attached to an end of a light in extensible string whose other end is fixed, on a smooth horizontal plane • Conical pendulum	• Finds the magnitude and direction of the force on a particle moving in a horizontal circle with uniform speed • solves the problems involving motion in a horizontal circle • solves the problems involving conical pendulam.	04
	3.16 Investigates the relevent principles for motion on a vertical circle.	• Applications of law of conservation of energy • Uses the law $\underline{F} = m\underline{a}$ • Motion of a particle ú on the surface of a smooth sphere ú inside the hollow smooth sphere ú suspended from an inextensible, light string attached to a fixed point ú motion of a ring threaded in a fixed smooth circular vertical wire ú motion of a particle in a vertical tube	• Explains vertical motion • Discusses the motion of a particle on the outersurface of a fixed smooth sphere in a vertical plane • Discusses the motion of a particle on the inner surface of a fixed smooth sphere in a vertical plane • Finds the condition for the motion of a particle suspended from an inelastic light string attached to a fixed point,in vertical circle. • Explains the motion of a ring threeded on a fixed smooth circular wire in a verticale plane • Explains the motion of a particle in a vertical tube • Solves problems including circular motion.	10

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	3.17 Analyses simple harmonic motion.	• Definition of simple harmonic motion • Characterstic equation of simple harmonic motion,and its solutions • Velocity as a function of displacement • The amplitude and period • Displacement as a function of time • Interpretation of simple harmonic motion by uniform circular motion, and finding time	Defines simple harmonic mortion (SHM) Obtain the differential equation of simple harmonic motion and verifies its general solutions Derives the velocity as a function of displacement Defines amplitude and period of SHM Describes displacement as a function of time Interprets SHM associated with uniform circular motion Finds time using circular motion associated with SHM	04
	3.18 Describes the nature of a simple harmonic motion on a horizontal line.	• Using Hooke's law ú Tension in a elastic string ú Tension or thrust in a spring • Simple harmonic motion of a particle under the action of elastic forces on a horizontal line	Finds the tension in an elastic string using Hook's law Finds tension or thust in a spring using Hooke's Law Describes the nature of simple harmonic motion of a particle on a horizontal line	06
	3.19 Describes the nature of a simple harmonic motion on a vertical line.	• Simple harmonic motion of a particle on a vertical line under the action of elastic forces and its own weight • Combination of simple harmonic motion and free motion under gravity	Explains the simple harmonic motion on a vertical line Solves problem with combination of simple harmonic motion and motion under gravity.	06

Competency	Competency Level	Contents	Learning outcomes	No. of Periods

4. Applies mathematical models to analyse events on random experiment.	4.1 Interprets events of a random experiment.	• Intuitive idea of probability
		• Definition of a random experiment
		• Definition of sample space and sample points
		  ◦ Finite sample space
		  ◦ Infinite sample space
		• Events
		  ◦ Definition
		  ◦ Simple event, compound events, null event & complementary events,
		  ◦ Union of two events, intersection of two events
		  ◦ Mutually exclusive events
		  ◦ Exhaustive events
		  ◦ Equally probable events
		  ◦ Event space
			• Explains random experiment
			• Defines sample space and sample point
			• Defines an event
			• Explains simple events, compound events, nul events and complementary events
			• Classifies the union of enents and intersection of events
			• Explants mutually exclusive events and Exhaustive events
			• Explains equally probable events
			• Explains event space
				04

	4.2 Applies probability models to solve problems on random events.	• Classical definition of probability and its limitations • Frequency approximation to probability, and its limitations • Axiomatic definition of probability, and its importance	• States classical definition of probability and its limitations • States frequency approximation of probability and its limitations • States the axiomatic definition • Importance of axiomatic detinition. • Proves the theorems on probability using axiomatic definition • Solves problems using the above theorems	06

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
		• Theorems on probability with proofs ú Let A and B be any two events in a given sample space ú $P(A')=1-P(A)$ where A' is the complementry event of A ú Addition rule $P(A\cup B)=P(A)+P(B)-P(A\cap B)$ ú If $A\subseteq B$, then $P(A)\leq P(B)$		
	4.3 Applies the concept of conditional probability to determine the probability of a event on random experiment under given conditions.	• Definiton of conditional probability • Theorems with proofs let A, B, B_1, B_2 be any four events is a given sample space with $P(A)>0$. then (i) $P(\varnothing \mid A)=0$ (ii) $P(B' \mid A)=1-P(B \mid A)$, (iii) $P(B_1 \mid A)=P(B_1\cap B_2 \mid A)+P(B_1\cap B_2' \mid A)$ (iv) $P[(B_1\cup B_2) \mid A]=P(B_1 \mid A)+P(B_2 \mid A)-$ $P(B_1\cap B_2 \mid A))$ • Multiplication rule • If A_1, A_2 are any two events in a given sample space with $P(A_1)>0$ then $P(A_1\cap A_2)=P(A_1)\cdot P(A_2 \mid A_1)$	Defines conditional probability States and proves the theorems on conditional probability states multiplication rule	08

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
	4.4 Uses the probability model to determine the independence of two or three events.	• Independence of two events • Independence of three events • Pairwise Independence • Mutually Independence	Defines independent of two events Defines independent of three events Defines pairwise independent Defines mutually independent Uses independent of two or three events to solve problems	04
	4.5 Applies Baye's theorem To solve problems.	• Partition of a sample space • Theorem on total probability, with proof • Baye's Theorem	Defines a partition of a sample space States and prove on theorem of total probability States Baye's theorem Solves problems using above theorems	06

Competency	Competency Level	Contents	Learning outcomes	No. of Periods
5. Applies statistical tools to develop decision making skills	5.1 Introduces to nature of statistics	• Introduction to statistics • Descriptive statistics	Explains what is statistics Explains the nature of statistics	01
	5.2 Describes measures of central tendency	• Arithmetic mean, mode and median • Ungrouped data • Data with frequency distributions • Grouped data with frequency distributions • Weighted arithmetic mean	Describes the mean,median and mode as measures of central tendency Finds the central tendency measurments Finds weighted mean	03
	5.3 Interprets a frequency distribution using measures of relative positions	• Median, Quartiles and Percentiles for ungrouped and grouped data with frequency distributions BOX Plots	Finds the relative position of frequency distribution Uses Box plot to represent data	04

Competency	Competency Level	Contents	Learning outcomes	No. of Periods

	5.4 Describes measure of dispersion.	• Introduction to measures of dispersion and their importancy
		• Types of dispersion measurements
		  ◦ Range
		  ◦ inter quartile range and semi inter - quartile range
		  ◦ mean deviation
		  ◦ variance and standard deviation for
		    ◦ ungrouped data
		    ◦ ungrouped data with frequency distributions
		    ◦ group data with frequency distrubutions
		• pooled mean
		• pooled variance
		• Z - score
			• Uses suitable measures of dispersion to make decisions on frequency distributions
			• States the measures of dispersion and their importancy
			• Explains pooled mean and pooled variance
			• Obtains formulas for pooled mean and pooled variance
			• Describes Z-score
			• Applies measures of dispersion to solve problems
				08

	5.5 Determines the shape of a distribution by using measures of skewness.	• Introduction to Measures of skewness • Karl Pearson's measures of skewness	• Defines the measure of skewness • Determines the shapes of the distribution using measures of skewness	02

9.0 TEACHING LEARNING STRATEGIES

To facilitate the students to achieve the anticipated outcome of this course, a variety of teaching stategies must be employed. If students are to improve their mathematical communication, for example, they must have the opportunity to discuss interpretations, solution, explanations etc. with other students as well as their teacher. They should be encouraged to communicate not only in writing but orally, and to use diagrams as well as numerial, symbolic and word statements in their explanations.

Students learn in a multitude of ways. Students can be mainly visual, auditory or kinesthetic learners, or employ a variety of senses when learning. The range of learning styles in influenced by many factors, each of which needs to be considered in determining the most appropriate teaching strategies. Research suggests that the cltural and social background has a significant impact on the way students learn mathematics. These differences need to be recognised and a variety of teaching strategies to be employed so that all students have equal access to the development of mathematical knowledge and skills.

Learning can occur within a large group where the class is taught as a whole and also within a small gruop where students interact with other members of the group, or at an individual level where a student interacts with the teacher or another student, or works independently. All arrangements have their place in the mathematics classroom.

10.0 SCHOOL POLICY AND PROGRAMMES

To make learning of Mathematics meaningful and relevant to the students classroom work ought not to be based purely on the development of knowledge and skills but also should encompass areas like communication, connection, reasoning and problem solving. The latter four aims, ensure the enhancement of the thinking and behavioural process of childern.

For this purpose apart from normal classroom teaching the following co-curricular activities will provide the opportunity for participation of every child in the learning process.

- Student's study circles
- Mathematical Societies
- Mathematical camps
- Contests (national and international)
- Use of the library
- The classroom wall Bulletin
- Mathematical laboratory
- Activity room
- Collectin historical data regarding mathematics
- Use of multimedia
- Projects

It is the responsibility of the mathematics teacher to organise the above activities according to the facilities available. When organising these activities the teacher and the students can obtain the assistance of relevant outside persons and institution.

In order to organise such activites on a regular basis it is essential that each school develops a policy of its own in respect of Mathematics. This would form a part of the overall school policy to be developed by each school. In developin the policy, in respect of Mathematics, the school should take cognisance of the physical environment of the school and neighbourhood, the needs and concerns of the students and the community associated with the school and the services of resource personnel and institutions to which the school has access.

11.0 ASSESSMENT AND EVALUATION

It is intended to implement this syllabus in schools with the School Based Assessment (SBA) process. Teachers will prepare creative teaching - learning instruments on the basic of school terms.

The First Examination under this syllabus will be held in 2019.

MATHEMATICAL SYMBOLS AND NOTATIONS

The following Mathematical notation will be used.

1. Set Notations

$\in$	an element
$\notin$	not an element
$\{x_1, x_2, \ldots\}$	the set with elements $x_1, x_2, \ldots$
$\{x / \ldots\}$ or $\{x : \ldots\}$	the set of all x such that...
$n(\mathrm{A})$	the number of elements in set A
$\varnothing$	empty set
ξ	universal set
A'	the complement of the set A
$\mathbb{N}$	the set of natural numbers, $\{1, 2, 3, \ldots\}$
$\mathbb{Z}$	the set of integers $\{0, \pm1, \pm2, \pm3, \ldots\}$
$\mathbb{Z}^+$	the set of positive integers $\{1, 2, 3, \ldots\}$
$\mathbb{Q}$	the set of rational numbers
$\mathbb{R}$	the set of real numbers
$\mathbb{C}$	the set of complex numbers
$\subseteq$	a subset
$\subset$	a proper subset
M	not subset
$\not\subset$	not a proper subset
$\cup$	union
$\cap$	intersection
$[a, b]$	the colsed interval $\{x \in R : a \leq x \leq b\}$
$(a, b]$	the interval $\{x \in R : a < x \leq b\}$
$[a, b)$	the interval $\{x \in R : a \leq x < b\}$
(a, b)	the open interval $\{x \in R : a < x < b\}$

2. Miscellaneous Symbols

$=$	equal
$\neq$	not equal
$\equiv$	identical or congruent
⊔	approximately equal
$\propto$	proportional
$<$	less than
Ÿ	less than or equal
$>$	greater than
¦	greater than or equal
∞	infinity
$\Rightarrow$	if then
$\Leftrightarrow$	if and only if (iff)

3. Operations

$a+b$	a plus b
$a-b$	a minus b
$a \times b$, $a \cdot b$	a multipllied by b
$a \div b$, $\frac{a}{b}$	a divided by b
$a:b$	the ratio between a and b
$\sum_{i=1}^{n} a_i$	$a_1 + a_2 + \ldots + a_n$
$\sqrt{a}$	the positive square root of the positive real number a
$\lvert a \rvert$	the modulus of the real number a
$n!$	n factorial where $n \in \mathbb{Z}^+ \cup \{0\}$
$^nP_r = \frac{n!}{(n-r)!}$ $0 \le r \le n$	$n \in \mathbb{Z}^+$, $r \in \mathbb{Z}^+ \cup \{0\}$
$^nC_r = \frac{n!}{r!(n-r)!}$, $0 \le r \le n$	$n \in \mathbb{Z}^+$, $r \in \mathbb{Z}^+ \cup \{0\}$

4. Functions

$f(x)$	the functin of x
$\mathrm{f}:\mathrm{A} \rightarrow \mathrm{B}$	f is a function where each element of set A has an unique Image in set B
$f: x \rightarrow y$	the function f maps the element x to the element y
f^{-1}	the inverse of the function f
$g \circ f(x)$	the composite function of g of f
$\lim_{x \to a} f(x)$	the limit of $f(x)$ as x tends to a
δx	an increment of x
$\frac{dy}{dx}$	the derivative of y with respect to x
$\frac{d^n y}{dx^n}$	the n^{th} derivative of y with respect to x
$f^{(1)}(x), f^{(2)}(x), \ldots, f^{(n)}(x)$	the first, second , ..., n^{th} derivatives of $f(x)$ with respect to x
$\int y\,dx$	indefinite integral of y with respect to x
$\int_a^b y\,dx$	definite integral of y w.r.t x in the interval $a \le x \le b$
$\dot{x}, \ddot{x}, \ldots$	the first, second,... derivative of x with respect to time

5. Exponential and Logarithmic Functions

e^x	exponential function of x
$\log_a x$	logarithm of x to the base a
$\ln x$	natural logarithm of x
$\lg_x$	logarithm of x to base 10

6. Cricular Functions

$\left.\begin{array}{l}\sin,\ \cos,\ \tan\\ \operatorname{cosec},\ \sec,\ \cot\end{array}\right\}$	the circular functions
$\left.\begin{array}{l}\sin^{-1},\ \cos^{-1},\ \tan^{-1}\\ \operatorname{cosec}^{-1},\ \sec^{-1},\ \cot^{-1}\end{array}\right\}$	the inverse circular functions

7. Complex Numbers

i	the square root of - 1
z	a complex number, $z = x + i\,y$ $= r(\cos\theta + i\sin\theta)$
Re(z)	the real part of z, $Re(x+i\,y) = x$
Im(z)	the imaginary part of z, $\operatorname{Im}(x+i\,y) = y$
$\lvert z \rvert$	the modulus of z
$\arg(z)$	The argument of z
Arg (z)	the principle argument of z
$\bar{z}$	the complex conjugate of z

8. Matrices

M	a matrix M
M^T	the transpose of the matrix M
M^{-1}	the inverse of the matrix M
det M	the determinant of the matrix M

9. Vectors

$\underline{a}$ or $\boldsymbol{a}$	the vector a
$\overrightarrow{AB}$	the vactor represented in magnitude and direction by the directed line segment AB
$\underline{i}$, $\underline{j}$, $\underline{k}$	unit vectors in the positive direction of the cartesian axes
$\lvert\mathbf{a}\rvert$	the magnitude of vector a
$\lvert\overrightarrow{AB}\rvert$	the magnitude of vector AB
$\mathbf{a} \cdot \mathbf{b}$	the scalar product of vectors a and b
$\mathbf{a} \times \mathbf{b}$	the vetor product of vrctors a and b

10. Probability and Statistics

A, B, C ect..	events
$A \cup B$	union of the events A and B
$A \cap B$	intersection of the events A and B
P(A)	probability of the event A
$A^{/}$	complement of the event A
$P(A \times B)$	probability of the event A given that event B occurs
X, Y, R, ...	random variables
x, y, r, ... ect.	values of the random variables X, Y, R etc.
x_1, x_2, ...	observations
f_1, f_2, ...	frequencies with which the observations x_1, x_2, ... occur
$\overline{x}$	Mean
σ^2	Variance
σ / S / SD	Standard deviation