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
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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 committee for the revision of the Combined Mathematics syllabus by accommodating 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 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.
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, speak 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 and 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 feedback 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.
## A Basic Course for G.C.E (Advanced Level)

### Combined Mathematics

<table>
<thead>
<tr>
<th>Competency</th>
<th>Competency Level</th>
<th>Content</th>
<th>Learning outcome</th>
<th>No. of Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Review of Basic Algebra</td>
<td>1.1 Expands algebraic expressions</td>
<td>• Expansion of $a^2 - b^2, a^3 \pm b^3$ and $(a \pm b \pm c)^2, (a \pm b \pm c)^3$</td>
<td>Applies the formula to simplify algebraic expression.</td>
<td>04</td>
</tr>
<tr>
<td></td>
<td>1.2 Factorises algebraic expressions</td>
<td>• Factorisation for $a^2 - b^2, a^3 \pm b^3$</td>
<td>Factorises algebraic expression by using the formula.</td>
<td>02</td>
</tr>
<tr>
<td></td>
<td>1.3 Simplifies algebraic fractions</td>
<td>• Addition, Subtraction, Multiplication and Division of Algebraic fractions.</td>
<td>Uses the knowledge of factorisation in the formulae involved expansion</td>
<td>04</td>
</tr>
<tr>
<td></td>
<td>1.4 Solves Equations</td>
<td>• Equations with algebraic fractions, simultaneous equations up to three unknowns, quadratic simultaneous equations with two variables.</td>
<td>Solves equations by using factorisation formulae involved expansion</td>
<td>04</td>
</tr>
<tr>
<td></td>
<td>1.5 Simplifies expressions involving indices and logarithms</td>
<td>• Rules of indices fundamental properties of logarithms</td>
<td>Simplifies expressions involves indices.</td>
<td>02</td>
</tr>
<tr>
<td></td>
<td>1.6 Describes and uses the properties of proportions</td>
<td>• Equality of two ratios is a proportion $\frac{a}{b} = \frac{c}{d} \Rightarrow a:b = c:d$ Properties of the above proportion</td>
<td>Finds values of algebraic expression using proportions.</td>
<td>02</td>
</tr>
<tr>
<td>Competency</td>
<td>Competency Level</td>
<td>Contents</td>
<td>Learning outcomes</td>
<td>No. of Periods</td>
</tr>
<tr>
<td>------------</td>
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</tr>
<tr>
<td>2. <strong>Geometry Analyses</strong></td>
<td>2.1 Identifies theorems involving rectangles in circle and uses is Geometry problems.</td>
<td>• Pythagoras theorem acute angled theorem obtuse angled theorem, apollonius theorem.</td>
<td>• Describes the theorem when two chords intersect and the theorem involved alternate segments. • Uses the above theorems to solve problems.</td>
<td>04</td>
</tr>
<tr>
<td></td>
<td>2.2 Applies pythagoras theorem and its extensions in problems.</td>
<td>• Pythagoras theorem acute angled theorem obtuse angled theorem, apollonius theorem.</td>
<td>• Uses the theorems to prove statements. • Uses the theorem to find length and angles.</td>
<td>04</td>
</tr>
<tr>
<td></td>
<td>2.3 Applies bisector theorem in geometry problems.</td>
<td>• Internal and external Angles of a triangle bisects the opposite side proportionally,</td>
<td>• Uses the theorem involved find length in triangle.</td>
<td>02</td>
</tr>
<tr>
<td></td>
<td>2.4 Applies theorems on similartriangles in geometry.</td>
<td>• The areas of similar triangles are proportional to the square of the corresponding sides.</td>
<td>• Describes the theorem and uses it to solve problems.</td>
<td>03</td>
</tr>
<tr>
<td></td>
<td>2.5 Identifies the centres of a triangles</td>
<td>• Circum centre, Incentre, Orthocentre, Centroidal medians, attitudes.</td>
<td>• Defines the 4 centres of a triangles and uses it in problems.</td>
<td>02</td>
</tr>
</tbody>
</table>
### 6.0 PROPOSED TERM WISE BREAKDOWN OF THE SYLLABUS

**Grade 12**

<table>
<thead>
<tr>
<th>Competency Levels</th>
<th>Subject Topics</th>
<th>Number of Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Term</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined Mathematics I</td>
<td>Real numbers</td>
<td>02</td>
</tr>
<tr>
<td>1.1, 1.2</td>
<td>Functions</td>
<td>04</td>
</tr>
<tr>
<td>2.1, 2.2</td>
<td>Angular measurements</td>
<td></td>
</tr>
<tr>
<td>8.1, 8.2</td>
<td>Rectangular cartesian system, Straight line</td>
<td>03</td>
</tr>
<tr>
<td>9.1, 9.2, 9.3, 9.4</td>
<td>Circular functions</td>
<td>12</td>
</tr>
<tr>
<td>11.1</td>
<td>sine rule, cosine rule</td>
<td>01</td>
</tr>
<tr>
<td>4.1, 4.2, 4.3</td>
<td>Polynomials</td>
<td>07</td>
</tr>
<tr>
<td>10.1, 10.2, 10.3, 10.4</td>
<td>Trigonometric identities</td>
<td>14</td>
</tr>
<tr>
<td>5.1</td>
<td>Rational functions</td>
<td>06</td>
</tr>
<tr>
<td>6.1</td>
<td>Index laws and logarithmic laws</td>
<td>01</td>
</tr>
<tr>
<td>7.1, 7.2, 7.3</td>
<td>Basic properties of inequalities and solutions of inequalities</td>
<td>14</td>
</tr>
<tr>
<td>9.5</td>
<td>Solving trigonometric equations</td>
<td>04</td>
</tr>
<tr>
<td>Combined Mathematics II</td>
<td>Vectors</td>
<td>14</td>
</tr>
<tr>
<td>1.1, 1.2, 1.3, 1.4</td>
<td>Systems of coplanar forces acting at a point</td>
<td>10</td>
</tr>
<tr>
<td>2.1, 2.2, 2.3</td>
<td></td>
<td></td>
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<tr>
<td><strong>Second Term</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined Mathematics I</td>
<td>Quadratic functions and quadratic equations</td>
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</tr>
<tr>
<td>3.1, 3.2</td>
<td>Inverse trigonometric functions</td>
<td>08</td>
</tr>
<tr>
<td>12.1, 12.2, 12.3</td>
<td>sine rule, cosine rule</td>
<td>06</td>
</tr>
<tr>
<td>Competency Levels</td>
<td>Subject Topics</td>
<td>Number of Periods</td>
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<tr>
<td>-------------------</td>
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<td>------------------</td>
</tr>
<tr>
<td><strong>Combined Mathematics II</strong></td>
<td>System of coplanar forces acting on a rigid body</td>
<td>23</td>
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<tr>
<td>2.4, 2.5, 2.6, 2.7</td>
<td>Motion in a straight line</td>
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<tr>
<td>3.1, 3.2, 3.3</td>
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### Third Term

<table>
<thead>
<tr>
<th>Combined Mathematics I</th>
<th>Subject Topics</th>
<th>Number of Periods</th>
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</thead>
<tbody>
<tr>
<td>15.1, 15.2, 15.3, 15.4</td>
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<table>
<thead>
<tr>
<th>Combined Mathematics II</th>
<th>Subject Topics</th>
<th>Number of Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.4</td>
<td>Projectiles</td>
<td>08</td>
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<tr>
<td>2.8</td>
<td>Equilibrium of three coplanar forces</td>
<td>08</td>
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<td>2.9</td>
<td>Friction</td>
<td>10</td>
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<td>3.5</td>
<td>Newton’s laws of motion</td>
<td>10</td>
</tr>
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<td>3.6, 3.7</td>
<td>Work, power, energy,</td>
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</tr>
<tr>
<td>3.8, 3.9</td>
<td>Impulse and collision</td>
<td>15</td>
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### Grade 13

<table>
<thead>
<tr>
<th>Competency Levels</th>
<th>Subject Topics</th>
<th>Number of Periods</th>
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</thead>
<tbody>
<tr>
<td><strong>First Term</strong></td>
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<tr>
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<td>16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9</td>
<td>Integration</td>
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<td><strong>Combined Math II</strong></td>
<td>Jointed rods</td>
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<tr>
<td>2.10</td>
<td>Frame work</td>
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<tr>
<td>2.11</td>
<td>Relative motion</td>
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<tr>
<td>3.10, 3.11, 3.12, 3.13</td>
<td>Circular rotation</td>
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<td>3.14, 3.15, 3.16</td>
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<td>16</td>
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<td><strong>Second Term</strong></td>
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<td>26.1, 27.1, 27.2, 27.3, 27.4, 27.5</td>
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<td>19.1</td>
<td>Principle of Mathematical Induction</td>
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<td>Series</td>
<td>18</td>
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<tr>
<td>Competency Levels</td>
<td>Subject Topics</td>
<td>Number of Periods</td>
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<tr>
<td><strong>Combined Mathematics II</strong></td>
<td>Probability</td>
<td>10</td>
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<td></td>
<td>Simple harmonic motion</td>
<td>18</td>
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<td>Center of mass</td>
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<td>4.1, 4.2</td>
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<td>3.17, 3.18, 3.19</td>
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<tr>
<td><strong>Third Term</strong></td>
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<tr>
<td><strong>Combined Mathematics I</strong></td>
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<tr>
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<td>Binomial expansion</td>
<td>12</td>
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<td>23.1, 23.2, 23.3, 23.4, 23.5, 23.6</td>
<td>Complex numbers</td>
<td>18</td>
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<tr>
<td>25.1, 25.2, 25.3, 25.4</td>
<td>Matrices</td>
<td>14</td>
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<tr>
<td><strong>Combined Mathematics II</strong></td>
<td>Probability</td>
<td>18</td>
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<tr>
<td>4.3, 4.4, 4.5</td>
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<tr>
<td>5.1, 5.2, 5.3, 5.4, 5.5, 5.6</td>
<td>Statistics</td>
<td>18</td>
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<tr>
<td>5.7, 5.8, 5.9.</td>
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<td>Subject</td>
<td>Number of Periods</td>
<td>Total</td>
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</tr>
<tr>
<td></td>
<td><strong>First Term</strong></td>
<td></td>
</tr>
<tr>
<td>Combined Mathematics I</td>
<td>70</td>
<td>94</td>
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<td>Combined Mathematics II</td>
<td>24</td>
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<tr>
<td></td>
<td><strong>Second Term</strong></td>
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<tr>
<td>Combined Mathematics I</td>
<td>57</td>
<td>103</td>
</tr>
<tr>
<td>Combined Mathematics II</td>
<td>46</td>
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<td><strong>Third Term</strong></td>
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<tr>
<td>Combined Mathematics I</td>
<td>45</td>
<td>112</td>
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<tr>
<td>Combined Mathematics II</td>
<td>67</td>
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<td><strong>Fourth Term</strong></td>
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<tr>
<td>Combined Mathematics I</td>
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<td>110</td>
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<td>Combined Mathematics II</td>
<td>66</td>
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<td><strong>Fifth Term</strong></td>
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<tr>
<td>Combined Mathematics I</td>
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<td>101</td>
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<td>Combined Mathematics II</td>
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### 7.0 Detailed Syllabus - COMBINED MATHEMATICS - I

<table>
<thead>
<tr>
<th>Competency</th>
<th>Competency Level</th>
<th>Contents</th>
<th>Learning outcomes</th>
<th>No. of Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Analyses the system of real numbers</td>
<td>1.1 Classifies the set of real numbers</td>
<td>• Historical evolution of the number system</td>
<td>□ Explains the evolution of the number systems</td>
<td>01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Notations for sets of numbers</td>
<td>□ Represents a real number geometrically</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Geometrical representation of real numbers</td>
<td></td>
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<td></td>
<td></td>
<td>o Number line.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.2 Uses surds or decimals to describe real numbers</td>
<td>• Decimal representation of a real number</td>
<td>□ Classifies decimal numbers</td>
<td>01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Decimals, infinite decimals, recurring decimals, and non-recurring decimals</td>
<td>□ Rationalises the denominator of expressions with surds</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Simplification of expressions involving surds</td>
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<td>2. Analyses single variable functions</td>
<td>2.1 Review of functions</td>
<td>• Intuitive idea of a function</td>
<td>□ Explains the intuitive idea of a function</td>
<td>02</td>
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<td></td>
<td>o Constants, Variables</td>
<td>□ Recognizes constants, variables</td>
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<td>o Expressions involving relationships between two variables</td>
<td>□ Relationship between two variables</td>
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<td>o Functions of a single variable</td>
<td>□ Explains inverse functions</td>
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<td>o Functional notation</td>
<td>□ Explain Domain, Codomain</td>
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<td>o Domain, codomain and range</td>
<td>□ Explains One - one functions explains onto functions</td>
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<td>o One - one functions</td>
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<td>o Onto functions</td>
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<td>o Inverse functions</td>
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| 2.2 | Reviews types of functions | • Types of functions  
  - Constant functions, linear functions, piece-wise functions, modulus (absolute value) 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 | Introduction of 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 quadratic functions | 10 |
| | | Interprets the roots of a quadratic equation | □ Explaining the Roots of a quadratic equation  
  □ Finds the roots of a quadratic 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 quadratic equation  
  □ Finds quadratic equations whose roots are symmetric expressions of \( \alpha \) and \( \beta \) | 15 |
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| 4. Manipulates Polynomial functions | 4.1 Explores polynomials of a single variable | • Polynomials of single variable polynomials  
  ○ Terms, coefficients, degree, leading term, leading coefficient | □ Solves problems involving quadratic functions and quadratic equations  
 □ Transforms roots to other forms | 01 |
|  | 4.2 Applies algebraic operations to polynomials | • Addition, subtraction, multiplication, division and long division | □ Defines a polynomial of a single variable  
 □ Distinguishes among linear, quadratic and cubic functions  
 □ States the conditions for two polynomials to be identical | 01 |
|  | 4.3 Solves problems using Remainder theorem, Factor theorem and its converse | • Division algorithm  
 • Synthetic division  
 • 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 $\leq 4$ ) | 05 |
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| 5. Resolves rational functions into partial fractions | 5.1 Resolves rational function into partial fractions | • Rational functions  
  - Proper and improper rational functions  
  • Partial fractions of rational functions  
  - With distinct linear factors in the denominator  
  - With recurring linear factors in the denominator  
  - With quadratic factors in the denominator  
• The index laws  
• Logarithmic laws of base  
• Change of base | □ Defines rational functions  
□ Defines proper rational functions and improper rational functions  
□ Finds partial fractions of proper rational functions (upto 4 unknowns)  
□ Partial fractions of improper rational function (upto 4 unknowns) | 06 |
| 6. Manipulates index and logarithmic laws | 6.1 Uses index laws and logarithmic laws to solve problems | | □ Uses index laws  
□ Uses logarithmic laws  
□ Uses change of base to solve problems | 01 |
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</table>
| 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  
  ○ Introducing 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 algebraic expressions  
□ Solves inequalities including rational functions, algebraically and graphically | 04 |
| 7.3 Solves inequalities involving modulus (absolute value) function |                  | • Inequalities involving moduli (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 |
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| 8. Uses relations involving angular measures | 8.1 States the relationship between radians and degrees | - Angular measure  
- The angle and its sign convention  
- 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 | - Length of a circular arc, \( S = r\theta \)  
- Area of a circular sector, \( A = \frac{1}{2} r^2 \theta \) | - Find the length of an arc and area of a circular sector | 01 |
| 9. Interpretes trigonometric functions | 9.1 Describes basic trigonometric (circular) functions | - Basic trigonometric functions  
- Definition of the six basic trigonometric 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  
\[ 0, \frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3} \text{ and } \frac{\pi}{2} \] | - Finds the values of trigonometric functions at given angles  
- States the sign of basic trigonometric function in each quadrant | 01 |
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| 9.3        |                 | Derives the values of basic trigonometric functions at angles differing by odd multiples of $\frac{\pi}{2}$ and integer multiples of $\pi$ | - Describes the periodic properties of circular functions  
- Describes the trigonometric relations of $(-\theta), \frac{\pi}{2} \pm \theta, \pi \pm \theta, \frac{3\pi}{2} \pm \theta, 2\pi \pm \theta$ in terms of $\theta$  
- Finds the values of circular functions at given angles | 03 |
| 9.4        |                 | Describes the behaviour of basic trigonometric functions graphically | - Represents the circular functions graphically  
- Draws graphs of combined circular functions | 04 |
<p>| 9.5        |                 | Finds general solutions | - Solves trigonometric equations | 04 |</p>
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| 10.Manipulates trigonometric identities | 10.1             | Uses Pythagorean identities  
- Trigonometric identities | ☐ Explains an identity  
☐ Explains the difference between identities and equations  
☐ Obtains Pythagorean Identities  
☐ Solves problems involving Pythagorean Identities | 04             |
|                                  | 10.2             | Solves trigonometric problems using sum and difference formulae  
- 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  
- 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 $a, b, c \in \mathbb{R}$ | ☐ Solves problems using double, triple and half angles  
☐ Derives trigonometric formula for double, triple and half angles  
☐ Solves equations of the form $a \cos \theta + b \sin \theta = c$ only finding solutions is expected) | 03             |
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| 11. Applies sine rule and cosine rule to solve trigonometric problems | 11.1 States and proves sine rule and cosine rule | • Sine rule and cosine rule | □ Introduces usual notations for a triangle  
□ States and prove sine rule for any triangle  
□ States and prove cosine rule for any triangle | 01 |
| | 11.2 Applies sine rule and cosine rule | • Problems involving sine rule and cosine rule | □ Solves problems involving sine rule and cosine rule | 06 |
| 12. Solves problems involving inverse trigonometric functions | 12.1 Describes inverse trigonometric functions | • Inverse trigonometric functions  
• Principal values | □ Defines inverse trigonometric functions  
□ States the domain and the range of inverse trigonometric functions | 02 |
<p>| | 12.2 Represents inverse functions graphically | • Sketching graphs of inverse trigonometric functions ( \sin^{-1}, \cos^{-1}, \tan^{-1} ) | □ Draws the graph of an inverse trigonometric functions | 02 |
| | 12.3 Solves problems involving inverse trigonometric functions | • Problems involving inverse trigonometric functions | □ Solves simple problems involving inverse trigonometric functions | 04 |</p>
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| 13. Determines the limit of a function         | 13.1            | • Intuitive idea of $\lim_{x \to a} f(x) = l$, where $a, l \in \mathbb{R}$ | □ Explains the meaning of limit  
□ Distinguishes the cases where the limit of a function does not exist | 02            |
|                                                | 13.2            | • Basic theorems on limits and their applications                       | □ Expresses the theorems on limits.                                               | 03            |
|                                                | 13.3            | • 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            | • Sandwich theorem (without Proof)  
• Proof of $\lim_{x \to 0} \left( \frac{\sin x}{x} \right) = 1$ and its applications | □ Stares the sandwich theorem  
□ Proves $\lim_{x \to 0} \frac{\sin x}{x} = 1$  
□ Solves the problems using the above result | 03            |
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| 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 |
<p>| 13.8       | Interprets continuity at a point | • Intuitive idea of continuity | □ Explains continuity at a point by using examples | 02 |</p>
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<td>14.1 Describes the idea of derivative of a function</td>
<td>• Derivative as the slope of tangent line</td>
<td>□ Explains slope and tangent at a point</td>
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<td></td>
<td>• Derivative as a limit</td>
<td>□ Defines the derivative as a limit</td>
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<td>• Derivative as a rate of change</td>
<td>□ Explains rate of change</td>
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<td>14.2 Determines the derivatives from the first principles</td>
<td>• Derivatives from the first principles</td>
<td>□ Finds derivatives from the first principles</td>
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<td>o $x^n$, where $n$ is a rational number</td>
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<td>o Basic trigonometric functions</td>
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<td></td>
<td>o Functions formed by elementary algebraic operations of the above</td>
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<td>14.3 States and uses the theorems on differentiation</td>
<td>• Theorems on differentiation</td>
<td>□ States basic rules of derivative</td>
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<td></td>
<td>o Constant multiple rule</td>
<td>□ Solves problems using basic rules of derivatives</td>
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<td></td>
<td></td>
<td>o Sum rule</td>
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<td>o Product rule</td>
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<td>o Quotient rule</td>
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<td>o Chain rule</td>
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<td>14.4 Differentiates inverse trigonometric functions</td>
<td>• Derivatives of inverse trigonometric functions</td>
<td>□ Finds the derivatives of inverse trigonometric functions</td>
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<td>□ Solves problems using the derivatives of inverse trigonometric functions</td>
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| 14.5       | Describes natural exponential function and find its derivative | • The properties of natural exponential function  
  o \[ \frac{d}{dx}(e^x) = e^x \]  
  o 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  
 The graph of \(y = e^x\) | 02 |
| 14.6       | Describes natural logarithmic function | • Properties of natural logarithmic function  
  o Definition of natural logarithmic function, \(\ln x\) or \(\log_e x (x > 0)\), as the inverse function of \(e^x\), its domain and range  
  o \[ \frac{d}{dx}(\ln x) = \frac{1}{x}, \text{ for } x > 0 \]  
  o 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 \(\ln x\)  
 □ The graph of \(y = \ln x\)  
 □ 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 \(\ln x\)  
 □ Deduces the derivative of \(a^x\)  
 □ Solves problems using the derivatives of \(\ln x\) and \(a^x\) | 03 |
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| 14.7       | Differentiates implicit functions and parametric functions | • Intuitive idea of implicit functions and parametric functions  
• Differentiation involving implicit functions and parametric equation including parametric forms at parabola  
\[ y^2 = 4 ax \] and ellipse  
\[ \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \]  
and hyperabola | □ Defines implicit 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 |
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| 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 to inflection  
• First derivative test and second derivative test | □ Defines stationary points of a given function  
□ Describes local (relative) maximum and a 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 points of a given function is a local maximum or a local minimum | 05 |
<p>| | 15.2 Investigates the concavity | • Concavity and points of inflection | □ Uses second derivative 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 |</p>
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<td><strong>16. Find indefinite and definite Integrales of functions</strong></td>
<td>16.1 Deduces indefinite Integral using anti-derivatives</td>
<td>• Integration as the reverse process of differentiation (anti-derivatives of a function)</td>
<td>□ Finds indefinite integrals using the results of derivative</td>
<td>03</td>
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<td>16.2 Uses theorems on integration</td>
<td>• Theorems of integration</td>
<td>□ Uses theorem on integration</td>
<td>02</td>
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<td>16.3 Review the basic properties of a definite integral using the fundamental theorem of calculus</td>
<td>• Fundamental Theorem of Calculus • Intuitive idea of the definite integral • Definite integral and its properties • Evaluation of definite integrals</td>
<td>□ Uses the fundamental theorem of calculus to solve problems □ Solves definite integral problems □ Uses the properties of definite integral</td>
<td>02</td>
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<tr>
<td></td>
<td>16.4 Integrates rational functions using appropriate methods</td>
<td>• Indefinite integrals of functions of the form $\frac{f''(x)}{f'(x)}$ where $f'(x)$ is the derivative of $f(x)$ with respect to $x$</td>
<td>□ Uses the formula</td>
<td>05</td>
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<td></td>
<td>16.5 Integrates trigonometric expressions using trigonometric identities</td>
<td>• Use of partial fractions • Use of trigonometric identities</td>
<td>□ Uses of partial fractions for integration □ Uses trigonometric identities for integration</td>
<td>03</td>
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<td>16.6</td>
<td>Uses the method of substitution for integration</td>
<td>• Integration by substitution</td>
<td>Uses suitable substitutions to find integrals</td>
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<td>16.7</td>
<td>Solve problems using integration by parts</td>
<td>• Integration by parts</td>
<td>Uses integration by parts to solve problems</td>
<td>03</td>
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| 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 |
<p>| 16.9       | Determines the volume of revolution | • Use of the formulae ( \int_a^b \pi (f(x))^2 , dx ) to find the volume of revolution | Uses integration formula to find the volume of revolution | 02 |</p>
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<td>17. Uses the rectangular system of Cartesian axes and geometrical results</td>
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<td>· Rectangular Cartesian coordinates</td>
<td>□ Explains the Cartesian coordinate system</td>
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<td>· Rectangular Cartesian system</td>
<td>□ Defines the abscissa and the ordinate</td>
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<td>· Distance between two points</td>
<td>□ Introduces the four quadrants in the cartesian coordinate plane</td>
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<td>Finds the length of a line segment joining two points</td>
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<td>17.2</td>
<td>· Coordinates of the point that divides a line segment joining two given points in a given ratio</td>
<td>□ Finds Co-ordinates of the point dividing the straight line segment joining two given points internally in a given ratio</td>
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<td></td>
<td></td>
<td>· internally</td>
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<tr>
<td>18. Interprets the straight line in terms of Cartesian co-ordinates</td>
<td>18.1 Derives the equation of a straight line</td>
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</table>
| 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  
○ Principle of Mathematical Induction  
○ 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  
• \[ \sum_{r=1}^{n}(U_r + V_r) = \sum_{r=1}^{n}U_r + \sum_{r=1}^{n}V_r \]  
• \[ \sum_{r=1}^{n}kU_r = k\sum_{r=1}^{n}U_r; \text{where } k \text{ is a constant} \] | □ Describes finite sum  
□ Uses the properties of “\[ \sum \]” notation | 03 |
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<tr>
<td>20.2</td>
<td>Finds sums of elementary series</td>
<td>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</td>
<td>□ 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</td>
<td>05</td>
</tr>
</tbody>
</table>
| 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 determine convergence and divergence | • Sequences 
• Partial sums 
• Concept of convergence and divergence 
• Sum to infinity 
• Sequences | □ Interprets sequences 
□ Finds partial sum of an infinite series 
□ Explains the concepts of convergence and divergence using partial sums 
□ Finds the sum of a convergent series | 03 |
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</table>
| 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  
  o Binomial coefficients, general term  
  o Proof of the theorem using mathematical Induction |                |
|                                              | 22.2             | Applies binomial theorem                                               | • Relationships among the binomial coefficients  
  • Specific terms                                                                 | 06             |
|                                              |                  |                                                                        | □ States binomial theorem for positive integral indices  
  □ Writes general term and binomial coefficient  
  □ Proves the theorem using Mathematical Induction  
  □ Writes the relationship among the binomial coefficients  
  □ Finds the specific terms of binomial expansion | 02             |
| 23. Interprets the system of complex numbers | 23.1             | Uses the Complex number system                                         | • Imaginary unit  
  • Introduction of $i$, 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 at a complex number  
  □ Uses the equality of two complex numbers | 02             |
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<tr>
<td>23.2</td>
<td>introduces algebraic operations on complex numbers</td>
<td>• Algebraic operations on complex numbers $z_1 + z_2$, $z_1 - z_2$, $z_1 \cdot z_2$, $\frac{z_1}{z_2}$ ($z_2 \neq 0$)</td>
<td>□ Defines algebraic operations on complex numbers □ Uses algebraic operations between two complex numbers and verifies that they are also complex numbers □ Basic operations of algebraic operations</td>
<td>02</td>
</tr>
</tbody>
</table>
| 23.3       | Proves basic properties of complex conjugate | • Definition of $\overline{z}$ • Proofs of the following results:  
  - $\overline{z_1 + z_2} = \overline{z_1} + \overline{z_2}$  
  - $\overline{z_1 - z_2} = \overline{z_1} - \overline{z_2}$  
  - $\overline{z_1 \cdot z_2} = \overline{z_1} \cdot \overline{z_2}$  
  - $\overline{\left( \frac{z_1}{z_2} \right)} = \left( \frac{\overline{z_1}}{\overline{z_2}} \right)$ | □ Defines $\overline{z}$ □ Obtains basic properties of complex conjugate □ Proves the properties | 02 |
| 23.4       | Define the modulus of a complex number | • Definition of $|z|$, modulus of a complex number $z$ • Proves the following results:  
  - $|z_1 \cdot z_2| = |z_1| \cdot |z_2|$  
  - $\left| \frac{z_1}{z_2} \right| = \frac{|z_1|}{|z_2|}$ if $z_2 \neq 0$  
  - $z \cdot \overline{z} = |z|^2$  
  - $|z_1 + z_2|^2 = |z_1|^2 + 2 \text{Re}(z_1 \cdot z_2) + |z_2|^2$ applications of the above results | □ Defines the modulus $|z|$ of a complex number $z$ □ Proves basic properties of modulus □ Applies the basic properties | 04 |
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| 23.5       |                  | • The Argand diagram  
• Representing \( z = x + iy \) by the point \((x, y)\)  
• Geometrical representations of \( z_1 + z_2, \ z_1 - z_2, \ z, \ \lambda z \) where \( \lambda \in \mathbb{C} \)  
• Polar form of a non zero complex number  
• Definition of \( \text{arg}(z) \)  
• Defining \( \text{Arg} z \), principal value of the argument \( z \) is the value of \( \theta \) satisfying \(-\pi < \theta \leq \pi\)  
• Geometrical representation of  
  ∙ \( z_1 \cdot z_2, \ \frac{z_1}{z_2} \neq 0 \)  
  ∙ \( r(\cos \alpha + i \sin \alpha) \), where \( \alpha \in \mathbb{R} \), \( r > 0 \)  
  ∙ \( \frac{\lambda z_1 + \mu z_2}{\lambda + \mu} \), where \( \lambda, \mu \in \mathbb{C} \) and \( \lambda + \mu \neq 0 \)  |  
|  |                  | □ Represents the complex number on Argand diagram  
□ Constructs points representing \( z_1 + z_2, \ z, \ \lambda z \) where \( \lambda \in \mathbb{C} \)  
□ Expresses a non zero complex number in polar form  
□ Defines the argument of a complex number  
□ Defines the principle argument of a non zero complex number  
□ Constructs points representing \( z_1 \cdot z_2 \) and \( \frac{z_1}{z_2} \) in the Argand diagram  
□ Constructs points representing \( r(\cos \alpha + i \sin \alpha) \) where \( \alpha \in \mathbb{R} \), \( r > 0 \)  
□ Constructs points representing \( \frac{\lambda z_1 + \mu z_2}{\lambda + \mu} \), where \( \lambda, \mu \in \mathbb{R} \) and \( \lambda + \mu \neq 0 \) | 04  |
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<td></td>
<td></td>
<td>• proof of the triangle inequality $</td>
<td>z_1 + z_2</td>
<td>\leq</td>
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<tr>
<td></td>
<td></td>
<td>• Deduction of reverse triangle inequality $</td>
<td></td>
<td>z_1</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>□ Uses the above inequalities to solve problems</td>
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<tr>
<td>23.6</td>
<td>Uses the DeMovier’s theorem</td>
<td>Stat and prove of the DeMovier’s Theorem Elementary applications of DeMovier’s theorem</td>
<td>□ States and prove of the DeMovier’s Theorem</td>
<td>02</td>
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<tr>
<td>23.7</td>
<td>Identifies locus / region of a variable complex number</td>
<td>Locus of $</td>
<td>z - z_0</td>
<td>= k$ and $</td>
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<td>• $\text{Arg}(z - z_0) = \alpha$ and $\text{Arg}(z - z_0) \leq \alpha$ where $-\pi \leq \alpha \leq \pi$ and $z_0$ is fixed</td>
<td>□ Obtains the Cartesian equation of a locus</td>
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<td></td>
<td></td>
<td>• $</td>
<td>z - z_1</td>
<td>=</td>
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| 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 $P_r^n$, and the formulae When $0 \leq r \leq n; \gamma \in \mathbb{Z}^+$ | - 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  
  - Explains the cyclic permutations  
  - Finds number of permutations of $n$ different objects not all different taken $r$ at a time | 06             |
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| 24.4       | Uses combinations as a technique of solving mathematical problems | **Combinations**  
  o Definition  
  o Define as \( ^nC_r \) and finds a formulae for \( ^nC_r \)  
  o Distinction between permutation and combination | □ Defines combination  
 □ Define as \( ^nC_r \) and finds a formulae for \( ^nC_r \)  
 □ Finds the number of combinations of \( n \) different objects taken \( r \) at a time where \( 0 \leq r \leq n \)  
 □ Explains the distinction between permutations and combinations | 05 |
| **25. Manipulates matrices** | 25.1 Describes basic properties of matrices | **Definition and notation**  
  o Elements, rows, columns  
  o Size of a matrix  
  o Row matrix, column matrix, square matrix, null matrix  
 **Equality of two matrices**  
 **Meaning of \( \lambda A \) where \( \lambda \) is a scalar**  
  o Properties of scaler product  
  o Definition of addition  
  o Properties of addition | □ Defines a matrix  
 □ Defines the equality of matrices  
 □ Defines the multiplication of a matrix by a scalar  
 □ Explains special types of matrices  
 □ Uses the addition of matrices  
 □ Writes the condition for compatibility | 02 |
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|            |                  | • Subtractions of matrices  
○ Compatibility  
○ Definition of multiplication  
○ Properties of multiplication | □ Defines subtraction using addition and scaler multiplication  
□ Writes the conditions for compatibility  
□ States and uses the properties of multiplication to solve problems |               |
| 25.2       | Explains special cases of square matrices | • Square matrices  
○ Order of a square matrix  
○ Identity matrix, diagonal matrix, symmetric matrix, skew symmetric matrix  
○ Triangular matrices (upper, lower) | □ Identifies the order of a square matrices  
□ Classifies the different types of matrices | 02 |
| 25.3       | Describes the transpose and the inverse of a matrix | • Transpose of a matrix  
○ Definition and notation  
• Inverse of a matrix  
○ Only for $2 \times 2$ matrices | □ Finds the transpose of a matrix  
□ Finds the inverse of a $2\times2$ matrix | 03 |
| 25.4       | Uses matrices to solve simultaneous equations | • Solution of a pair of linear equations with two variables  
○ Solutions graphically  
○ The existence of a unique solutions, infinitely many solutions and no solutions graphically | □ Solves simultaneous equations using matrices  
□ Illustrates the solutions graphically | 04 |
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<tr>
<td>26. Interprets the Cartesian equation of a circle</td>
<td>26.1 Finds the Cartesian equation of a circle</td>
<td>• Equation of a circle with origin as the centre and a given radius</td>
<td>□ Defines circle as a locus of a variable point such that the distance from a fixed point is a constant</td>
<td>03</td>
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<td>• Equation of a circle with a given centre and radius</td>
<td>□ Obtains the equation of a circle</td>
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<td>• Conditions that a circle and a straight line intersects, touches or do not intersect</td>
<td>□ Obtains the general equation of a circle</td>
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<td>• Equation of the tangent to a circle at a point on circle</td>
<td>□ Finds the equation of the circle having two given points as the end points at a diameter</td>
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<tr>
<td>27. Explores Geometric properties of circles</td>
<td>27.1 Describes the position of a straight line relative to a circle</td>
<td>• Conditions that a circle and a straight line intersects, touches or do not intersect</td>
<td>□ Discusses the position of a straight line with respect to a circle</td>
<td>02</td>
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<td></td>
<td>• Equation of the tangent to a circle at a point on circle</td>
<td>□ Obtains the equation of the tangent at a point on a circle</td>
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<td>27.2 Finds the equations of tangents drawn to a circle from an external point.</td>
<td>• Equation tangent drawn to a circle from an external point</td>
<td>□ Obtains the equation of the tangent drawn to a circle from an external point</td>
<td>03</td>
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<td>• length of tangent drawn from an external point to a circle</td>
<td>□ Obtains the length of tangent drawn from an external point to a circle</td>
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<td>• Equation of chord of contact</td>
<td>□ Obtains the equation of the chord of contact</td>
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<td>27.3</td>
<td>Derives the general equation of a circle passing through point of intersection of a given straight line and a circle</td>
<td>• The equation of a circle passing through the points of intersection of a straight line and a circle</td>
<td>□ Interprets the equation $S + \lambda U = 0$</td>
<td>02</td>
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</table>
| 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 | □ Describes the condition for two circles to intersect or Not-intersect  
  □ Describes the condition for two circles to Touch externally or Touch internally  
  □ Describes To have one circle lying within the other circle | 03 |
<p>| 27.5       | Finds the condition for two circle to intersect orthogonally | • Condition for two circles to enter set orthogonally | □ Finds the condition for two circles to intersect orthogonally | 02 |</p>
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</table>
| 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  
  - Algebraic, Geometric  
  - 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  
  - Condition for two vectors to be parallel  
- Addition of three or more vectors  
- Resolution of a vector in any directions | - Explains the differences between scalar quantities and scalars  
- Explains the difference between vector quantity and vectors.  
- Represents a vector geometrically  
- Expresses the algebraic notation of a vector  
- Defines the modulus of a vector  
- Defines the null vector  
- Defines \(-a\), where \(a\) is a vector  
- States the conditions for two vectors to be equal  
- States the triangle law of addition  
- Deduces the parallelogram 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 parallel | 03 |
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<tr>
<td>1.2</td>
<td>Constructs algebraic system for vectors</td>
<td>• laws for vector addition and multiplication by a scaler</td>
<td>State the conditions for two vectors to be parallel</td>
<td>01</td>
</tr>
<tr>
<td>1.3</td>
<td>Applies position vectors to solve problems</td>
<td>• Position vectors</td>
<td>Defines position vectors</td>
<td>06</td>
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<td></td>
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<td>• Introduction of ( \hat{i} ) and ( \hat{j} )</td>
<td>Expresses the position vector of a point in terms of the cartesian co-ordinates of that point</td>
<td></td>
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<tr>
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<td></td>
<td>• Position vector relative to the 2D Cartesian Co-ordinate system</td>
<td>Adds and subtracts vectors in the form ( x\hat{i} + y\hat{j} )</td>
<td></td>
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<td>• Application of the following results</td>
<td>Proves that if ( \overrightarrow{a} ), ( \overrightarrow{b} ) are two non zero, non-parallel vectors and if ( \lambda\overrightarrow{a} + \mu\overrightarrow{b} = \overrightarrow{0} ) then ( \lambda = 0 ) and ( \mu = 0 )</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• If ( \overrightarrow{a} ) and ( \overrightarrow{b} ) are non-zero and non-parallel vectors and if ( \lambda\overrightarrow{a} + \mu\overrightarrow{b} = \overrightarrow{0} ) then ( \lambda = 0 ) and ( \mu = 0 )</td>
<td>Applications of the above results</td>
<td></td>
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| 1.4        | Interprets scalar and vector product | • Definition of scalar product of two vectors  
• Properties of scalar product  
  ∘ \( a \cdot b = b \cdot a \) (Commutative law)  
  ∘ \( a \cdot (b + c) = a \cdot b + a \cdot c \) (Distributive law)  
• Condition for two non-zero vectors to be perpendicular  
• Introduction of \( \mathbf{k} \)  
• Definition of vector product of two vectors  
Properties of vector product  
  ∘ \( \mathbf{a} \times \mathbf{b} = -\mathbf{b} \times \mathbf{a} \) | □ 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  
□ Solves simple geometric problems involving scalar product  
□ Define vector product of two vectors  
□ States the properties of vector product  
□ (Application of vector product are not expected) | 04 |
| 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 different types of forces in mechanics  
□ Describes the resultant of a system of coplanar forces acting at a point | 02 |
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| 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  
  o in two given directions  
  o in two directions perpendicular to each other | □ States the parallelogram law of forces to find the resultant of two forces acting at a point  
□ Uses the parallelogram law 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. | • Define 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  
  o method of resolution of forces  
  o graphical method | □ Determines the resultant of three or more coplanar forces acting at a point 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 | 04 |
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</table>
|            |                 | • Conditions for equilibrium  
  o null resultant vector  
    \( R = X\hat{i} + Y\hat{j} = 0 \)  
  o Vector sum = 0 or, equivalently,  
    \( X = 0 \) and \( Y = 0 \)  
  o Completion of Polygon of forces | \( R = 0 \)  
  \( R = X\hat{i} + Y\hat{j} = 0 \)  
  \( X = 0 \) and \( Y = 0 \)  
  Completes a polygon of forces. | 05 |
| 2.4        |                 | • Explains equilibrium of a particle under the action of three forces.  
  • Triangle Law  
  • Lami’s Theorem  
  • Problems involving Lami’s theorem | Explains what is meant by equilibrium.  
  States the conditions for equilibrium of a particle under the action of three forces  
  States the theorem of triangle of forces, for equilibrium of three coplanar forces  
  States the converse of the theorem 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 |
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</table>
| 2.5        | Explains the Resultant of coplanar forces acting on a rigid body | • Concept of a rigid body  
○ Principle of transmission of forces  
○ Explaining the translational and rotational effect of a force  
○ Forces acting on a rigid body  
○ Defining the moment of a force about a point  
○ Dimension and units of moment  
○ Physical meaning of moment  
○ Magnitude and sense of moment of a force about a point  
○ Geometric interpretation of moment  
• General principle about moment of forces  
○ Algebraic sum of the moments of the component forces about a point on the plane of a system of coplanar forces is equivalent 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  
□ Explains the physical meaning of moment  
□ Finds the magnitude of the moment about a point and its sense  
□ States the dimensions and units of moments  
□ 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  
□ Uses the resultant of two parallel forces acting on a rigid body | 04 |
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<td>2.6</td>
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<td>Explains the effect of two parallel coplanar forces acting on a rigid body</td>
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<td></td>
<td>Resultant of two forces</td>
<td>□ Uses the resultant of two non-parallel forces acting on a rigid body</td>
<td>06</td>
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<tr>
<td></td>
<td></td>
<td>□ When the two forces are not parallel</td>
<td>□ States the conditions for the equilibrium of two forces acting on a rigid body</td>
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<td>□ When the two forces are parallel and like</td>
<td>□ Describes a couple</td>
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<tr>
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<td></td>
<td>□ When two forces of unequal magnitude are parallel and unlike</td>
<td>□ Calculates the moment of a couple</td>
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<td></td>
<td>Equilibrium under two forces</td>
<td>□ States that the moment of a couple is independent of the point about which the moment of the forces is taken</td>
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<td></td>
<td>Introduction of a couple</td>
<td>□ States the conditions for two coplanar couples to be equivalent</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Moment of a couple</td>
<td>□ States the conditions for two coplanar couples to balance each other</td>
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<tr>
<td></td>
<td></td>
<td>□ Magnitude and sense of the moment of a couple</td>
<td>□ Combines coplanar couples</td>
<td></td>
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</table>
| 2.7        | Analyses a system of coplanar forces acting on a rigid body | - A force ($F$) acting at a point is equivalent to a force $F$ acting at any given point together with a couple  
- Reducing a system of coplanar forces to a single force $R$ acting at a given point together with a couple of moment $G$  
- Magnitude, direction and line of action of the resultant  
- Conditions for the reduction of system of coplanar forces to  
  - a single force: $R \neq 0$ ( $X \neq 0$ or $Y \neq 0$ )  
  - a couple: $R = 0$ ( $X = 0$ and $Y = 0$ ) and $G \neq 0$  
  - equilibrium: $R = 0$ ( $X = 0$ and $Y = 0$ ) and $G = 0$  
  - Single force at other point: $R \neq 0$, $G \neq 0$  
- Problems involving equilibrium 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 force acting at a point is equivalent to the combination of an equal force acting at another point together with a couple  
- Reduces a system of coplanar forces to a single force acting at an arbitrary point $O$ and a couple of moment $G$  
- Reduces any coplanar system of forces to a single force and a couple acting at any point in that plane  
(i) Reduces of a system of coplanar forces to a single force $(X \neq 0$ or $Y \neq 0)$  
(ii) Reduces of a system of forces to a couple when $X = 0$, $Y = 0$ and $G \neq 0$  
(iii) Expresses conditions for equilibrium  
- Finds the magnitude, direction and the line of action of the resultant of a coplanar system of forces | 08 |
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<tr>
<td>2.8</td>
<td>Explains the Equilibrium of three coplanar forces acting on a rigid body</td>
<td>• All forces must be either concurrent or all parallel  • Use of  o Triangle Law of forces and its converse  o Lami’s theorem  o Cotangent rule  o Geometrical properties  o Resolving in two perpendicular directions</td>
<td>States conditions for the equilibrium of three coplanar forces acting on a rigid body  Finds unknown forces when a rigid body is in equilibrium</td>
<td>08</td>
</tr>
<tr>
<td>2.9</td>
<td>Investigates the effect of friction</td>
<td>• 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</td>
<td>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 coefficient of friction  Solves problems involving friction</td>
<td>10</td>
</tr>
<tr>
<td>2.10</td>
<td>Applies the properties of systems of coplanar forces to investigate equilibrium involving smooth joints</td>
<td>• Types of simple joints  • Distinguish a movable joint and a rigid joint  • Forces acting at a smooth joint  • Applications involving jointed rods</td>
<td>States the type of simple joints  Describes the movable joints and rigid joints  Marks the forces acting on a smooth joint  Solves the problems involving joined rods</td>
<td>10</td>
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| 2.11       | Determines the stresses in the rods of a framework with smoothly jointed 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 framework with light rods  
• States the condition for the equilibrium at each joint in the framework  
• Uses Bow’s notation  
• Solves problems involving a framework with light rods | 08 |
| 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  
• Use of thin rectangular stripes to find the centre of mass of a plane lamina and use of it in finding the centre of mass of the following lamina  
  ○ Uniform triangular lamina  
  Uniform lamina in the shape of a parallelogram | • 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 a Lammina of different shapes | 04 |
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<tr>
<td>2.13</td>
<td>Finds the centre of mass of simple geometrical bodies using integration</td>
<td>- Centre of mass of uniform continuous symmetric bodies &lt;br&gt;  - Circular arc, circular sector &lt;br&gt;  - The centre of mass of uniform symmetric bodies &lt;br&gt;  - Hollow right circular cone &lt;br&gt;  - Solid right circular cone &lt;br&gt;  - Hollow hemisphere &lt;br&gt;  - Solid hemisphere &lt;br&gt;  - Segment of a hollowsphere &lt;br&gt;  - Segment of a solid sphere</td>
<td>- Finds the centre of mass of symmetrical bodies using integration</td>
<td>06</td>
</tr>
<tr>
<td>2.14</td>
<td>Finds the centre of mass (centre of gravity) of composite bodies and remaining bodies</td>
<td>- Centre of mass of composite bodies &lt;br&gt; - Centre of mass of remaining bodies</td>
<td>- Finds the centre of mass of composite bodies &lt;br&gt; - Finds the centre of mass of remaining bodies</td>
<td>04</td>
</tr>
<tr>
<td>2.15</td>
<td>Explains centre of gravity</td>
<td>- Introduction of centre of gravity &lt;br&gt; - Coincidence of the centre of gravity and centre of mass</td>
<td>- States the centre of mass and centre of gravity are same under gravitational field.</td>
<td></td>
</tr>
<tr>
<td>2.16</td>
<td>Determines the stability of bodies in equilibrium</td>
<td>- Stability of equilibrium of bodies resting on a plane</td>
<td>- Explains the stability of bodies in equilibrium using centre of gravity</td>
<td>02</td>
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<tr>
<td>2.17</td>
<td>Determines the angle of inclination of suspended bodies</td>
<td>- problems involving suspended bodies</td>
<td>- Solves problem involving suspended bodies</td>
<td>02</td>
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</table>
| 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”  
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  
Expresses the dimension and standard units of displacement  
Defines average velocity  
Defines instantaneous velocity  
Defines uniform velocity  
Defines instantaneous velocity  
Expresses dimension and units of velocity  
Draws the displacement time graphs |
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|            |                  | • 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 acceleration  
☑ Expresses the dimension and unit of acceleration  
☑ Defines average acceleration  
☑ Defines instantaneous acceleration  
☑ Defines uniform acceleration  
☑ Defines retardation  
☑ Draws the velocity time graph  
☑ Finds average acceleration 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 |
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</table>
| 3.2        | Uses kinematic equations to solve problems involving motion in a straight line with constant acceleration | • Derivation of constant acceleration formulae  
  o Using definitions  
  o Using velocity - time graphs  
  \[
  v = u + at, 
  s = ut + \frac{1}{2}at^2, 
  v^2 = u^2 + 2as
  \]  
  • Vertical motion under constant acceleration due to gravity  
  o 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        | Investigate relative motion between bodies moving in 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 |
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<td></td>
<td>□ States the principle of relative acceleration for two bodies moving along a straight line</td>
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<td></td>
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<td></td>
<td>□ Uses kinematic equations and graphs related to motion for two bodies moving along the same straight line with constant relative acceleration</td>
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</table>
| 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 point moving on a plane  
□ Finds the velocity and acceleration when the position vector is given 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 reference  
□ 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 relative to another particle | 06             |
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| 3.6        | Uses principles of relative motion to solve real world problems | • Uses the principles of relative motion to solve the problems  
• Finds the shortest distance between two particles  
• Finds the requirements for collision of two bodies  
• 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 interpret motion of a projectile  
• Calculates the components of velocity of a projectile after a given time  
• Finds the components of displacement of a projectile in a given time | | 10 |
| 3.7        | Explains the motion of a projectile in a vertical plane | • 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  
  (i) velocity  
  (ii) 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 | | 08 |
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<td>Calculates the maximum height of a projectile</td>
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<td></td>
<td>Calculates the time taken to reach the maximum height of a projectile</td>
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<td></td>
<td>Calculates the horizontal range of a projectile and its maximum</td>
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<td></td>
<td>States that in general there are two angles of projection for the same horizontal range for a given velocity of projection</td>
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<td></td>
<td>Finds the maximum horizontal range for a given speed</td>
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<td></td>
<td>For a given speed of projection finds the angle of projection giving the maximum horizontal range</td>
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<td></td>
<td>Derives Cartesian equations of the path of a projectile</td>
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<td>Finds the time of flight</td>
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<td></td>
<td>Finds the angles of projection to pass through a given point</td>
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| 3.8 Applies Newton’s laws to explain motion relative to an inertial frame | • Newton’s first law of motion  
• concept of mass linear momentum and 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 laws (under constant force only)  
• Bodies in contact and particles connected by light inextensible string | • 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 $F = ma$ from second law of motion  
• Explains the vector nature of the equation $F = ma$  
• 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 $F = ma$  
• Bodies in contact and particles connected by light inextensible string  
• System of pulleys, wedges (maximum 4 pulleys) | 15 |
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<td>3.9</td>
<td>Interprets mechanical energy</td>
<td>- Definition of work done by constant force&lt;br&gt;- Dimension and units of work&lt;br&gt;- Introduce energy, its dimensions and units&lt;br&gt;- Kinetic energy as a type of mechanical energy&lt;br&gt;- Definition of kinetic energy of a particle&lt;br&gt;- Work energy equation for kinetic energy&lt;br&gt;- Dissipative and conservative forces&lt;br&gt;- Potential energy as a type of mechanical energy&lt;br&gt;- Definition of potential energy&lt;br&gt;- Definition of gravitational potential energy&lt;br&gt;- Work energy equation for potential energy&lt;br&gt;- Definition of elastic potential energy&lt;br&gt;- Expression for the elastic potential energy&lt;br&gt;- The work done by a conservative force is independent of the path described&lt;br&gt;- Principle of conservation of mechanical energy and its applications</td>
<td>- Explains the concept of work&lt;br&gt;- Defines work done under a constant force&lt;br&gt;- States dimension and units of work&lt;br&gt;- Explains Energy&lt;br&gt;- Explains the mechanical energy&lt;br&gt;- Defines Kinetic Energy&lt;br&gt;- Defines Potential Energy&lt;br&gt;- Explains the Gravitational Potential Energy&lt;br&gt;- Explains the Elastic Potential Energy&lt;br&gt;- Explains conservative forces and dissipative force&lt;br&gt;- Writes work - energy equations&lt;br&gt;- Explains conservation of mechanical Energy and applies to solve problems&lt;br&gt;- States dimension and units of energy</td>
<td>08</td>
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<tr>
<td>3.10Solves problems involving power</td>
<td>• Definition of power its dimensions and units&lt;br&gt;• Tractive force (F) constant case only&lt;br&gt;• Definition and application of Power = tractive force ( \times ) velocity (( P=F \cdot V ))</td>
<td>□ Defines Power&lt;br&gt;□ States its units and dimensions&lt;br&gt;□ Explains the tractive force&lt;br&gt;□ Derives the formula for power&lt;br&gt;□ Uses tractive force when impulse is constant</td>
<td>08</td>
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<tr>
<td>3.11Interprets the effect of an impulsive action</td>
<td>• Impulse as a vector its dimension and units&lt;br&gt;• ( I = \Delta (m \cdot v) ) Formula&lt;br&gt;• Loss of kinetic energy due to an impulsive action</td>
<td>□ Explains the Impulsive action&lt;br&gt;□ States the units and Dimension of Impulse&lt;br&gt;□ Uses ( I = \Delta m \cdot v ) to solve problems&lt;br&gt;□ Finds the change in Kinetic energy due to impulse</td>
<td>05</td>
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<tr>
<td>3.12Uses Newton's law of restitution to direct elastic impact</td>
<td>• Newton’s law of restitution&lt;br&gt;• Coefficient of restitution ( (e), \ 0 &lt; e \leq 1 )&lt;br&gt;• Perfect elasticity ( (e = 1) )&lt;br&gt;• Loss of energy when ( e &lt; 1 )&lt;br&gt;• Direct impact of two smooth elastic spheres&lt;br&gt;• Impact of a smooth elastic sphere moving perpendicular to a plane</td>
<td>□ Explains direct impact&lt;br&gt;□ States Newton's law of restitution&lt;br&gt;□ Defines coefficient of restitution&lt;br&gt;□ Explains the direct impact of a sphere on a fixed plane&lt;br&gt;□ Calculates change in kinetic energy&lt;br&gt;□ Solves problems involving direct impacts</td>
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<tr>
<td>3.13 Solves problems using the conservation of linear momentum</td>
<td>• Principle of conservation of linear momentum</td>
<td>□ Solves problem using the principle of linear momentum</td>
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<td>3.14 Investigates velocity and acceleration for motion in circuler</td>
<td>• Angular velocity $\dot{\theta}$ and angular acceleration $\ddot{\theta}$ of a particle moving on a circle &lt;br&gt; • Velocity and acceleration of a particle moving on a circle</td>
<td>□ Defines the angular velocity and acceleration of a particle moving in a circle &lt;br&gt; □ Find the velocity and the acceleration of a particle moving on a circle</td>
<td>06</td>
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<tr>
<td>3.15 Investigates motion in a horizontal circle</td>
<td>• Motion of a particle attached to an end of a light in extensible string whose other end is fixed on a smooth horizontal plane &lt;br&gt; • Conical pendulum</td>
<td>□ Finds the magnitude and direction of the force on a particle moving in a horizontal circle with uniform speed &lt;br&gt; • solves the problems involving motion in a horizontal circle &lt;br&gt; • solves the problems involving conical pendulum.</td>
<td>04</td>
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<tr>
<td>3.16 Investigates the relevant principles for motion on a vertical circle</td>
<td>• Applications of law of conservation of energy &lt;br&gt; • uses the law $\vec{F} = ma$ &lt;br&gt; • Motion of a particle &lt;br&gt; o on the surface of a smooth sphere &lt;br&gt; o inside the hollow smooth sphere &lt;br&gt; o suspende from an inextensible, light string attached to a fixed point &lt;br&gt; o threaded in a fixed smooth circular vertical wire &lt;br&gt; o In a vertical tube</td>
<td>□ Explains vertical motion &lt;br&gt; □ Explains the motion of a ring threaded on a fixed smooth vertical wire/particle moving in a fixed smooth circular,vertical tube &lt;br&gt; • Finds the condition for the motion of a particle suspended from an inelastic light string attached to a fixed point in a vertical circle. &lt;br&gt; • Discusses the motion of a particle on the outersurface of a fixed smooth sphere in a vertical plane &lt;br&gt; • Solves problems including circular motion.</td>
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| 3.17       | Analyses simple harmonic motion | - Definition of simple harmonic motion  
- Characteristic 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 motion (SHM)  
- Obtain the differential equation of simple harmonic motion and verifies its general solutions  
- Obtains the velocity as a function of displacement  
- Defines amplitude and period of SHM  
- Describes SHM associated with uniform circular motion and finds time | 04 |
| 3.18       | Describes the nature of a simple harmonic motion on a horizontal line | - Using Hooke’s law  
  o Tension in a elastic string  
  o Tension or thrust in a spring  
- Simple harmonic motion of a particle under the action of elastic forces | - Finds the tension in an elastic string  
- Tension or thrust in a spring using Hookes Law  
- Describes the nature of simple Harmonic motion 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 |
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| 4. Applies mathematical models to analyse random events | 4.1 Interprets events of a random experiment | • Intuitive idea of probability  
• Definition of a random experiment  
• Definition of sample space and sample points  
  o Finite sample space  
  o Infinite sample space  
• Events  
  o Definition  
  o Simple event, composite events, null event, complementary events,  
  o Union of two events, intersection of two events  
  o Mutually exclusive events  
  o Exhaustive events  
  o Equally probable events  
  o Event space | □ Explains random experiment  
□ Defines sample space and sample point  
□ Defines an event  
□ Explains an event space  
□ Explains simple events and compound events  
□ Classifies the events finds union and intersection of events | 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 the axiomatic definition  
□ Proves the theorems on probability using axiomatic definition and solves problems using the above theorems. | 06 |
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|            |                 | Theorems on probability with proofs
• Let $A$ and $B$ be any two events in a given sample space
  (i) $P(A') = 1 - P(A)$ where $A'$ is the complement of $A$
  (ii) Addition rule
    • $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
    • If $A \subseteq B$, then $P(A) = P(B)$
| ✓ States |
| ✓ Frequency approximation to probability and its limitation. |
| ✓ Importance of axiomatic definition. |

| 4.3 Applies the concept of conditional probability to determine the probability of a random event under given condition. |
| Definition 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) $P(\emptyset | A) = 0$
  (ii) $P(B' | A) = 1 - P(B | A)$,
  (iii) $P(B_i | A) = P(B_i \cap B_i | A) + P(B_i \cap B_i | A)$
  (iv) $P[(B_i \cup B_i) | A] = P(B_i | A) + P(B_i | A) -$
    $P(B_i \cap B_i | A)$
• Multiplication rule
• If $A_1, A_2$ are any two events in a given sample space with $P(A_i) > 0$
  then $P(A_i \cap A_i) = P(A_i) \cdot P(A_i | A_i)$ |
| ✓ Defines conditional probability |
| ✓ States and proves the theorems on conditional probability |
| ✓ states multiplication rule |

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<tr>
<td>4.4 Uses the probability model to determine the independence of two or three events</td>
<td>Independence of two events</td>
<td>Uses independent two or three events to not solve problems</td>
<td>04</td>
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<tr>
<td>4.5 Applies Bayes theorem</td>
<td>Independence of three events</td>
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<td>Pairwise Independence</td>
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<td>Mutually Independence</td>
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<td>Partition of a sample space</td>
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<td></td>
<td>Theorem on total probability, with proof</td>
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<td></td>
<td>Baye’s Theorem</td>
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</table>
| 5. Applies scientific tools to develop decision making skills | 5.1 Introduces the nature of statistics | Definition of 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 | ☐ Finds the central tendency measurements  
  ☐ Describes the mean, median and mode as measures of central tendency | 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 | 04 |
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</table>
| 5.4        | Describes measure of dispersion | - Introduction to Measures of dispersion and their importance  
- Types of dispersion measurements  
  - Range  
  - Inter Quartile range and Semi inter - quartile range  
  - mean deviation  
  - variance and standard deviation  
  - ungrouped data  
  - ungrouped data with frequency distributions  
  - grouped data with frequency distributions  
  - pooled mean  
  - pooled variance  
  - Z - score | - Uses suitable measure dispersion to make decisions on frequency distribution  
- States the measures of dispersion and their importance  
- Explain pooled mean, variance at Z-score | 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 |
8.0 TEACHING LEARNING STRATEGIES

To facilitate the students to achieve the anticipated outcome of this course, a variety of teaching strategies 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 numeral, 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 is influenced by many factors, each of which needs to be considered in determining the most appropriate teaching strategies. Research suggests that the cultural 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 group 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.
9.0 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 children.

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
- Collecting 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 activities 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 developing 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.
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...
- $n(A)$ the number of elements in set $A$
- $\emptyset$ empty set
- $\xi$ 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 $\{0, \pm 1, \pm 2, \pm 3, \ldots\}$
- $\mathbb{P}$ 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
- $\not\subseteq$ not a subset
- $\not\subset$ not a proper subset

- $\cup$ union
- $\cap$ intersection
- $[a, b]$ the closed interval $\{x \in \mathbb{R} : a \leq x \leq b\}$
- $(a, b]$ the interval $\{x \in \mathbb{R} : a < x \leq b\}$
- $[a, b)$ the interval $\{x \in \mathbb{R} : a \leq x < b\}$
- $(a, b)$ the open interval $\{x \in \mathbb{R} : a < x < b\}$

2. Miscellaneous Symbols

- $=$ equal
- $\neq$ not equal
- $\equiv$ identical or congruent
- $\approx$ approximately equal
- $\propto$ proportional
- $<$ less than
- $\leq$ less than or equal
- $>$ greater than
- $\geq$ greater than or equal
- $\infty$ infinity
- $\Rightarrow$ if then
- $\iff$ if and only if (iff)
3. Operations

\[ a + b \quad \text{a plus b} \]
\[ a - b \quad \text{a minus b} \]
\[ a \times b, \quad a \cdot b \quad \text{a multiplied by b} \]
\[ a \div b, \quad \frac{a}{b} \quad \text{a divided by b} \]
\[ a : b \quad \text{the ratio between a and b} \]
\[ \sum_{i=1}^{n} a_i \quad a_1 + a_2 + \ldots + a_n \]
\[ \sqrt{a} \quad \text{the positive square root of the positive real number a} \]
\[ |a| \quad \text{the modulus of the real number a} \]
\[ n! \quad n \text{ factorial where } n \in \mathbb{N}^+ \cup \{0\} \]
\[ ^nP_r = \frac{n!}{(n-r)!} \quad 0 \leq r \leq n \quad n \in \mathbb{N}^+, \quad r \in \mathbb{N}^+ \cup \{0\} \]
\[ ^nC_r = \frac{n!}{r!(n-r)!} \quad 0 \leq r \leq n \quad n \in \mathbb{N}^+, \quad r \in \mathbb{N}^+ \cup \{0\} \]

4. Functions

\[ f(x) \quad \text{the function of x} \]
\[ f: A \to B \quad f \text{ is a function where each element of set A has an unique image in set B} \]
\[ f: x \to y \quad \text{the function f maps the element } x \text{ to the element y} \]
\[ f^{-1} \quad \text{the inverse of the function f} \]
\[ g \circ f(x) \quad \text{the composite function of g of f} \]
\[ \lim_{x \to a} f(x) \quad \text{the limit of } f(x) \text{ as } x \text{ tends to } a \]
\[ \Delta x \quad \text{an increment of } x \]
\[ \frac{dy}{dx} \quad \text{the derivative of } y \text{ with respect to } x \]
\[ \frac{d^n y}{dx^n} \quad \text{the } n^{\text{th}} \text{ derivative of } y \text{ with respect to } x \]
\[ f^{(1)}(x), \quad f^{(2)}(x), \ldots, \quad f^{(n)}(x) \]
\[ \int y \, dx \quad \text{indefinite integral of } y \text{ with respect to } x \]
\[ \int_{a}^{b} y \, dx \quad \text{definite integral of } y \text{ w.r.t } x \text{ in the interval } a \leq x \leq b \]
\[ \dot{x}, \quad \ddot{x}, \quad \ldots \quad \text{the first, second,} \ldots \text{ derivative of } x \text{ with respect to time} \]
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. Circular Functions

- $\sin$, $\cos$, $\tan$ \{ the circular functions
- $\cosec$, $\sec$, $\cot$ \{ the inverse circular functions
- $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$ \{ the inverse circular functions
- $\cosec^{-1}$, $\sec^{-1}$, $\cot^{-1}$ \{ the inverse circular functions

7. Complex Numbers

- $i$: the square root of $-1$
- $z$: a complex number, $z = x + iy$
- $\Re(\ )$: the real part of $z$, $\Re(x + iy) = x$
- $\Im(\ )$: the imaginary part of $z$, $\Im(x + iy) = y$
- $|z|$: the modulus of $z$
- $\arg(\ )$: The argument of $z$
- $\text{Arg}(\ )$: the principle argument of $z$
- $\overline{z}$: 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

- $\overrightarrow{a}$ or $a$: the vector $a$
- $\overrightarrow{AB}$: the vector represented in magnitude and direction by the directed line segment $AB$
- $i$, $j$, $k$: unit vectors in the positive direction of the cartesian axes
- $|a|$: the magnitude of vector $a$
- $|\overrightarrow{AB}|$: the magnitude of vector $\overrightarrow{AB}$
- $\overrightarrow{a} \cdot \overrightarrow{b}$: the scalar product of vectors $\overrightarrow{a}$ and $\overrightarrow{b}$
- $\overrightarrow{a} \times \overrightarrow{b}$: the vector product of vectors $\overrightarrow{a}$ and $\overrightarrow{b}$
10. Probability and Statistics

A, B, C etc. events
A ∪ B union of the events A and B
A ∩ B intersection of the events A and B
P(A) probability of the event A
A' complement of the event A
P(A ∩ B) probability of the event A given that event B occurs
X, Y, R, ... random variables
x, y, r, etc. values of the random variables X, Y, R etc.

\[ x_1, x_2, \ldots \] observations
\[ f_1, f_2, \ldots \] frequencies with which the observations \[ x_1, x_2, \ldots \] occur
\[ \bar{x} \] Mean
\[ \sigma^2 \] Variance
\[ \sigma / S / SD \] Standard deviation