



Kingdom Of Cambodia

Nation Religion King

Ministry of Education, Youth, and Sport

Mathematics Curriculum

At

Upper Secondary Level

Pedagogical Research Department

2006



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KINGDOM OF CAMBODIA
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Ministry of Education, Youth and Sports
No. 1869 MoEYS.P

PRAKAS
On
The Authorization for Publication of the
"Mathematics Curriculum for Upper Secondary Education"

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**The Senior Minister, Minister of Education, Youth and Sports**

*Pursuant to:*

- The Constitution of the Kingdom of Cambodia;
- Royal *Kram* No. NS/RK/0704/001, dated July 13, 2004, promulgating the Addendum to the Constitution, to ensure the normal functioning of the national institutes;
- Royal Decree No. NS/RD/0704/124, dated July 15, 2004, on the appointment of the Royal Government of the Kingdom of Cambodia;
- Royal *Kram* No. 02 NS/94, dated July 20, 1994, promulgating the Law on the Organization and Functioning of the Council of Ministers;
- Royal *Kram* No. NS/RK 0196-01, dated January 24, 1996, promulgating the Law on the Establishment of the Ministry of Education, Youth and Sports;
- Subdecree No. 21 S/E, dated March 23, 1998, on the Organization and Functioning of the Ministry of Education, Youth and Sports;
- Policy on curriculum development for general education for 2005-2009;
- Minutes of the meeting of the Directorate General of Education, held May 26, 2006;

**Hereby decides**

**Article 1:** To authorize the publication of the "**Mathematics Curriculum for Upper Secondary Education**", organized by the Department of Pedagogical Research, in collaboration with the Japan International Cooperation Agency (JICA), for use in general education schools;

**Article 2:** The General Directorate of Administration and Finance, General Directorate of Education, Inspectorate of Education, Department of Pedagogical Research, and Department of General Secondary Education, shall implement the *Prakas* herewith.  
(Initials)

CC:

- General Secretariat of the Senate
- General Secretariat of the National Assembly
- Office of the Council of Ministers "for information"
- JICA "for cooperation"
- All entities under the supervision of the Ministry of Education, Youth and Sports "for official purposes"
- As stipulated in Article 2
- Archives - Records, Department of Pedagogical Research

Phnom Penh, November 8, 2006  
(Signature)

**KOL PHENG, Ph.D.**

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### Curriculum Development Committee At Upper Secondary Level

#### 1. Management Committee

1. H.E. Koeu Nay Leang
2. Mr. Leang Nguonly
3. Mrs. Ton Sa Im

#### 2. Mathematics Curriculum Development Committee

- |                     |                    |
|---------------------|--------------------|
| 1. Mr. Y Seangly    | 2. Mrs. Ouk Somany |
| 3. Mr. Ban Kornheng | 4. Mr. Simr Visoth |
| 5. Mrs. An Nitha    | 5. Mr. Bou San     |
| 7. Mr. Tea Kun      |                    |

#### 3. Implementation Committee

- |                        |                   |
|------------------------|-------------------|
| 1. Mr. Leang Nguonly   | 2. Mrs. Ton Sa Im |
| 3. Mr. Eng Kimly       | 4. Dr. Neth Barom |
| 5. Mr. Chour Sovan Dan | 6. Dr. Yok Lin    |
| 7. Mr. Kret Por Ly     | 8. Dr. Heng Meng  |



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## FOREWORD

Cambodia considers education as an important sector that requires attention in strengthening the foundation and quality of education, and training human resources in a highly efficient and professional manner.

Quality improvement of education will offer people profound basic knowledge and extend new skills, which are important for absorbing new technologies, knowledge and more high-level skills. And curriculum development is the core in improving the quality and efficiency of education.

In this regard, the Ministry of Education, Youth and Sports has established the Policy for Curriculum Development 2005-2009 to respond the different demands globally, regionally as well as personally, and particularly to achieve the 2003-2015 national "Education For All" plan, strategic plan of education, education-supporting programs, etc.

The improvement of the new mathematics curriculum is aimed at helping our students to be qualified in a society that demands knowledge, responsibility, virtue, morale, and daily life skills, as well as knowledge for problem solving in all situations of people's livelihood concerning business, technological development and economy, etc.

The new curriculum is a basis for the preparation of textbooks, teaching materials and strategy and for synchronizing the development of a strong educational system with participation from teachers, parents and students.

The Ministry of Education, Youth and Sports strongly believes that the new high-school mathematics curriculum is a key document for teachers, education officers, scientists, researchers and interested persons that serves the building of human resources in Cambodia.

I would like to express my sincere gratitude to the Japan International Cooperation Agency (JICA), technical specialists for their painstaking work in setting up the new curriculum. I would also like to highly praise the indispensable work of all working groups for the curriculum development in order to promote our educational sector. Particularly, I would like to thank teachers for helping our students to get knowledge, skills and better attitudes.

Phnom Penh, Date: 27 October 2006  
Minister of Education, Youth and Sports

Dr. Kol Pheng

## PREFACE

In developing a country, human resources are a key force for making social development successful. Human resources training are the responsibility of the Ministry of Education, Youth and Sports. With this spirit, the Ministry of Education, Youth and Sports has cooperated with JICA to set up a committee for improving mathematics education at upper secondary level.

The new curriculum is based on the Policy for Curriculum Development 2005-2009. The new mathematics curriculum requires content improvement and allocation of study hours as well as options for students to select their favorite subject. Students can select fundamental or advanced mathematics in grade 11 and 12.

The new curriculum achieves a balance between the result of knowledge and the application of skills. Moreover, the new curriculum also requires cooperation from all teachers for effective implementation.

Our committee would like to express profound gratitude for assistance from JICA and active participation in the new curriculum improvement from professors and teachers in the Ministry of Education, Youth and Sports.

Our committee hopes that the new mathematics curriculum can help to provide students and teachers with a good opportunity in learning and teaching with effective implementation throughout the Kingdom of Cambodia.

Mathematics Curriculum Development Committee



## INTRODUCTION

Mathematics is a key foundation for student's learning. If students have a good knowledge of this subject, they will get knowledge and skill as an effective tool for use in their daily lives and their continuing higher education studies or vocational training, or participating in the social life.

This curriculum has been developed with cooperation between Ministry of Education, Youth and Sports and JICA in order to create a project for improving mathematic and science education for the development of curriculum and books at upper secondary education. The Ministry of Education, Youth and Sports has set up a joint project implementation committee and working group to develop the new curriculum with the aim to improve some shortages in the 1996 curriculum to adjust to the educational situation in accordance with the advancement of science and actual development of the country.

Based on the Policy for Curriculum Development 2005-2009, which was officially announced by the Ministry of Education, Youth and Sports on December 14, 2004, the upper secondary mathematics curriculum was divided into "fundamental mathematics" and "advanced mathematics" in grade 11 and 12. The fundamental mathematics is aimed at providing students with basic skills in mathematics, while advanced mathematics is aimed at developing mathematics rationale skill, learning to be creative in solving problems in daily life. Meanwhile, the grade-12 curriculum is considered as a bridge for students to study at higher education. Students can learn necessary content of the fundamental mathematics to get some knowledge to be used in their daily lives.

Advanced mathematics offers students additional capacity in creating mathematics references with creativity and skills in working out many complicated questions. The working group has added new contents in advanced mathematics for the more advanced students to get a high level of mathematics knowledge.

The working group and Japanese specialists in JICA project hope that the new curriculum will provide learners with comprehensive mathematics knowledge as a foundation for use in all situations in society.



### **1. Upper Secondary Mathematics Curriculum Development Policy Grade 10**

- Basic knowledge and skill in learning science and mathematics in grade 11 and 12;
- Providing students with skill in correct reasoning;
- Demonstrating the contents with explanation and adequate illustration;
- Adding new contents relating to daily life.

### **2. Grade 11 and 12 (Basic level)**

- Providing students with mathematics skill and basic life skill;
- Developing student's skill in using mathematics method to solve various questions;
- Participating in various activities of society.

### **3. Grade 11 and 12 (Advanced level)**

- Providing students with sufficient mathematics capacity for further study at higher education;
- Developing skill in correct reasoning, creativity and skill in working out various questions;
- Providing students with sufficient knowledge and skill in creating mathematics reference through a proper principle.

### **4. Philosophy and Concept in Developing Curriculum Content**

Mathematics curriculum includes fundamental mathematics and advanced mathematics. The fundamental mathematics provides students with basic mathematics skill for application in their daily lives and labor market. While the advanced mathematics not only provides students, who are highly interested in mathematics and science, with comprehensive mathematics theory and rule, but also sufficient mathematics skill for their further studies in higher education.

### **5. Purpose of the Mathematics Education at Upper Secondary Level**

At upper secondary level, mathematics becomes more abstract. Mathematics rule must be given through definitions, use of symbols and mathematics language to relate mathematics to scientific and technological fields in creating new concepts, innovation as well as further study in higher education. At upper secondary level, mathematics teaching is intended to:

- Strengthen and extend students' knowledge to be more comprehensive and with proper rule;
- Provide students with basic knowledge and skill for further study in higher levels;
- Develop student's proper thinking skill;
- Extend student's creativity through mathematics study;
- Allow students to apply mathematics knowledge in solving real problems;
- Allow students to relate mathematics to sciences and technologies;
- Allow students to use mathematics for the study of other subjects;
- Enable students to have management capacity, be responsible for their activities and decisions, and be self-confident.

### A. Sub-Subjects

The mathematics curriculum at upper secondary level consists of the following sub-subjects:

- Arithmetic;
- Algebra;
- Analysis;
- Trigonometry;
- Plane and solid geometry;
- Probability and statistics;
- Conics.

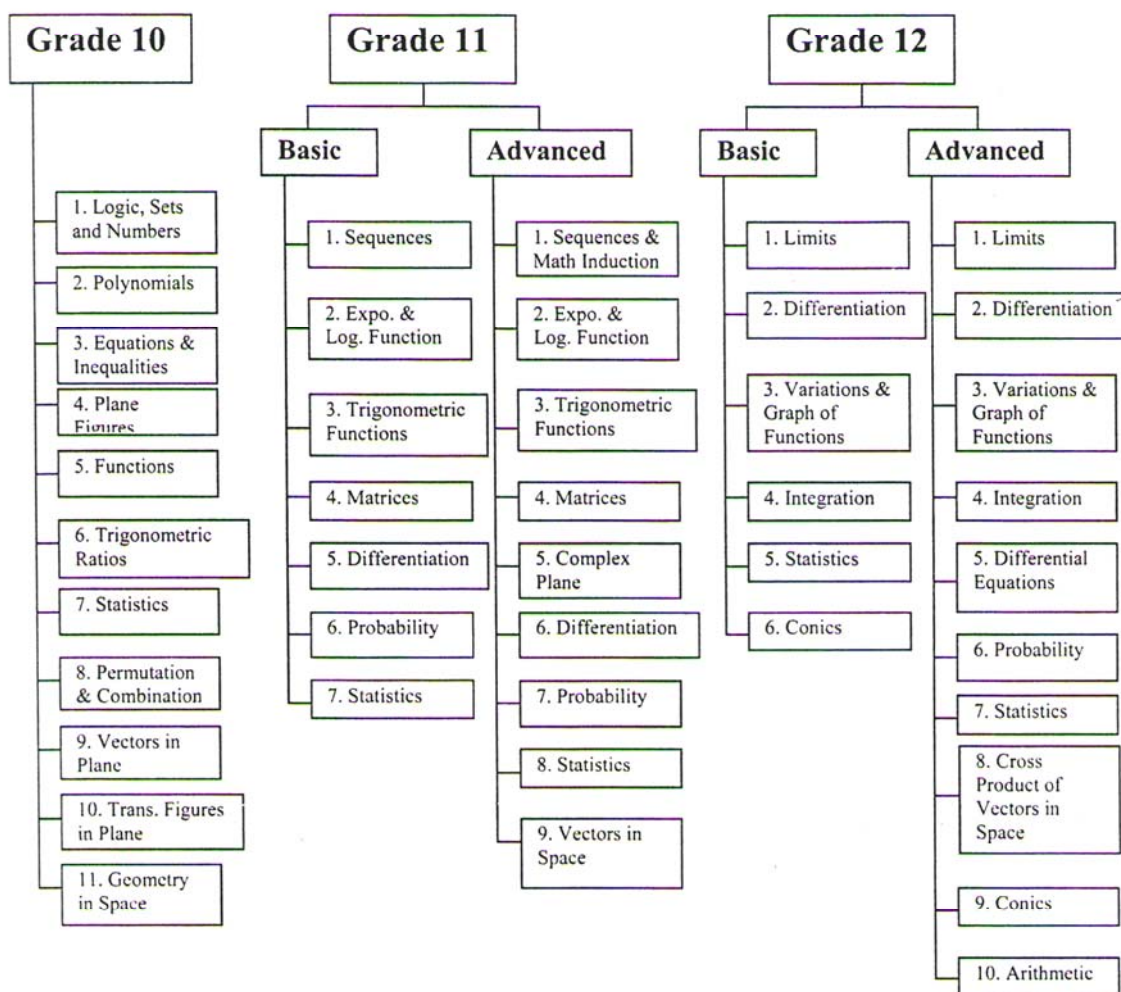
### B. Study Hours

- The number of hours per week for mathematics study at upper secondary level are as follows:

|          |                |         |
|----------|----------------|---------|
| Grade 10 |                | 6 hours |
| Grade 11 | Basic level    | 4 hours |
|          | Advanced level | 8 hours |
| Grade 12 | Basic level    | 4 hours |
|          | Advanced level | 8 hours |



## Framework of Contents in Basic and Advanced Mathematics



## Learning Outcome and Mathematics Contents in Grade 10

### 1. Learning Outcome

#### 1.1 Logic, Sets and Numbers

- Identify the truth values of statements and use connectives correctly to solve Problems of logical thinking.
- Use set language; notation and Venn diagrams to describe set and represent Relationships between sets (collect and classify the objects, according to their own Common characteristics).
- Solve multi-step problems, including word problems, involving sets,
- Convert decimal to binary system and vice versa.
- Use binary numbers in electronic areas and decimal numbers in daily life.
- Identify, compare, order, classify and carry out four operations in whole Numbers, integers, rational numbers, irrational number and real numbers
- Carry out calculation of expressions containing radicals.
- Use real numbers to solve a variety problem in daily life.

#### 1.2 Polynomials (Integral Expressions)

- Carry out four operations with polynomial to expand and factorize polynomial.
- Find greatest common divisor and least common multiple of polynomial to calculate the fractional expressions.
- Solve word problems by using these techniques.

#### 1.3 Equations and Inequalities

- Carry out four operations of complex numbers
- Find the formula of the solutions to a quadratic equation and apply it to physical problems, such as the motion of an object under the force of gravity, electricity, etc.
- Apply relations between solutions and coefficients to solve some problems.
- Solve simultaneous linear equations in 3 unknowns and simultaneous linear equation and quadratic equation.
- Apply the factor theorem to factorize polynomials and to solve equation of higher degree.
- Solve linear inequalities and quadratic inequalities, simultaneous inequalities.
- Prove inequalities by using basic properties, direct proof and contra positive proof.
- Solve multi-step problems, including word problems, involving linear equation, linear inequality, quadratic inequalities, simultaneous equations and simultaneous inequalities and provide justification for each step

#### 1.4 Plane figures

- Use coordinates to find distance between two points and internal and external dividing point
- Express straight line circles by equations
- Find the distance between a point and a straight line
- Find the equation of a locus of the points under some conditions
- Sketch regions represented by inequalities and simultaneous inequalities
- Solve the linear programming problems (Ex: Find minimum cost and maximum profit).



### 1.5 Function

- Identify the notion of function and its graph
- Find domain and range of a function
- Find inverse function of a given function
- Sketch graph of quadratic functions and simple fractional function and simple irrational function
- Find the extremum values quadratic functions
- Solve the quadratic equations and quadratic inequalities by using the graph of quadratic functions
- Solve problems in daily life involving quadratic functions.

### 1.6 Trigonometric Ratios

- Find the trigonometric ratios of acute angle and apply them to find height and length
- Prove relation among geometric ratios
- Find trigonometric ratios of obtuse angle in terms of coordinate system
- Prove Sine theorem and Cosine theorem and apply them to solve problems
- Find the area of triangle with two sides and the angle between them given and a triangle with three sides given

### 1.7 Statistic

- Collect, classify and tabulate statistical data
- Construct bar chart, dot diagram, histogram and frequency polygons.
- Find mean, median and mode of distribution of data in the particular situations.

### 1.8 Permutation and Combination

- Use fundamental counting principle to solve problems relevant to daily life
- Identify the concept of factorial, permutation and combination and find the value of permutation and combination by using factorials.

### 1.9 Vectors in Plane

- Recognize the meaning of a vector and carry out the operations of vectors
- Define the inner product and use components to calculate inner product of vectors
- Identify the position vectors of points and find the position vectors of the internal and external dividing point of a line segment
- Represent the straight line by using direction vector ( $\vec{p} = \vec{a} + t\vec{d}$ ) and by using normal vector  $(\vec{p} - \vec{a}) \cdot \vec{n} = 0$ .
- Find the vector equation of a circle
- (Prove some theorems in geometry by using position vector)
- Apply vectors to identify force vectors, composite force and velocity vectors

### 1.10 Transformations figures in plane

- Define an image of a plane figure by translation, reflection, rotation and enlargement and interpret in the coordinate system.
- Construct plane figure which has same shape with a given figure.

### 1.11 Geometry in Space

- Represent three dimension figures on a plane
- Determine the position between two figures in space
- Reconstruct an object from the three views.

## 2. Objective

- To enable students to understand Logic, Sets, Numbers, Polynomials, Equation, Inequalities, Function, Trigonometric Ratios, Plane Figures, Transformations of Plan Figures, Geometry in the Space, Counting, and Statistics.
- To gain fundamental knowledge and skills from the above-lesson
- To utilize knowledge and skill for solving problem in daily living
- To observe and use mathematical thinking

## 3. Detailed Contents (6x38= 228 hours)

### 3.1 Logic, Sets and Numbers (28 hours)

#### a. Logic

- Statement or proposition
- Negation,  $\wedge$  Conjunction,  $\vee$  Disjunction,  $\Rightarrow$  Conditional,  $\Leftrightarrow$  Biconditional
- Truth table
- Types of proof:
  - + Direct proof
  - + Indirect proof
    - Contrapositive proof
    - Proof by contradiction
  - + Biconditional
  - + Counter example

#### b. Sets

- Notion of sets
- Elements of set
- Subset
- Intersection and union of sets
- Complementary sets
- Sets with non-numerical elements

#### c. Numbers

- Numeration system
  - + Decimal System
  - + Binary system
- Whole Numbers
- Integers
- Rational numbers and irrational numbers
- Real numbers:
  - + The numbers line and real numbers
    - Comparison of real numbers
    - Absolute value of real numbers
    - Classification of real numbers
      - \* Rational numbers
        - Integers ( $>0$  ;  $=0$ ;  $<0$ )



- Non-integer rational numbers
- \* Irrational numbers
- + Calculating expressions containing radicals
  - The product and quotient of square roots
  - Rationalizing the denominator
  - Simplifying double radicals.

### 3.2 Polynomials (Integral Expressions) (21hours)

#### a. Notion of Polynomials

- Monomials
- Polynomials

#### b. Operations of Polynomials

- Addition, subtraction
- Multiplication
- Expansion formulas

$$(a \pm b)^2 = a^2 \pm 2ab + b^2$$

$$(a + b)(a - b) = a^2 - b^2$$

$$(x + a)(x + b) = x^2 + (a + b)x + ab$$

$$(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$$

$$(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3$$

$$(a - b)(a^2 + ab + b^2) = a^3 - b^3$$

$$(a + b)(a^2 - ab + b^2) = a^3 + b^3$$

#### c. Factorizing

- Extracting the common factors
- Factorization formulas

$$a^2 \pm 2ab + b^2 = (a \pm b)^2$$

$$a^2 - b^2 = (a + b)(a - b)$$

$$acx^2 + (ac + bd)x + bd = (ax + b)(cx + d)$$

$$a^3 + 3a^2b + 3ab^2 + b^3 = (a + b)^3$$

$$a^3 - 3a^2b + 3ab^2 - b^3 = (a - b)^3$$

$$a^3 - b^3 = (a - b)(a^2 + ab + b^2)$$

$$a^3 + b^3 = (a + b)(a^2 - ab + b^2)$$

#### d. Division of Polynomials

- Division of Polynomials
  - +  $A = B \times Q$ ;  $A = B \times Q + R$ , degree(R) < deg (B)
  - + Synthetic division
- Greatest common divisor and least common Multiple of Integral Expression.
- Calculations Involving Fractional Expression

### 3.3 Equations and Inequalities (30 hours)

#### a. Quadratic Equations

- Complex Numbers

- + Imaginary unit and Imaginary numbers
- + Principal square root of negative numbers
- + Standard form of an imaginary number
- + Equivalence of 2 complex numbers
- + Operations
- Quadratic equations
  - + Introduction (definition)
  - + Solving  $ax^2 = b$
  - + Solving  $(x+n)^2 = m$
  - + The quadratic formula  $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
  - + Relation between solution and coefficient

**b. Simultaneous Equations and Higher Degree Equations**

- Simultaneous linear equation in 3 variables
- Simultaneous linear equation and quadratic equations.
- Simple higher degree equations

**c. Factor theorem**

- Remainder theorem: If  $R$  is the remainder of  $f(x)$  divided by  $x - \alpha$  then  $R = f(\alpha)$ .
- Factor theorem: If  $f(\alpha) = 0$  then  $f(x) = (x - \alpha)q(x)$  as an integral expression.
- Solving equation of higher degree by using the factor theorem.

**d. Inequalities**

- Introduction
- Properties of inequality
- Solving linear inequalities
  - + Sign of binomial
  - + Solving linear inequalities
- Applications of linear inequalities
- Simultaneous linear inequalities
  - + Solving simultaneous inequalities
  - + Applications of simultaneous inequalities
- Quadratic inequalities
  - + Definition
  - + Sign of trinomial
  - + Solving quadratic inequalities
    - In case  $\Delta > 0$
    - In case  $\Delta = 0$
    - In case  $\Delta < 0$
- Applications of quadratic inequalities
  - + Proving inequalities  $a^2 + b^2 \geq 2ab$ 
    - For  $a > 0; b > 0$ :  $a > b \Leftrightarrow a^2 > b^2$
    - For  $a > 0; b > 0$ :  $\sqrt{a} + \sqrt{b} > \sqrt{a+b}$  &  $\sqrt{a} - \sqrt{b} < \sqrt{a-b}$
  - + Arithmetic mean and geometric mean (Cauchy inequality) :

$$\frac{a+b}{2} \geq \sqrt{ab}, \text{ where } a \geq 0; b \geq 0.$$



- + Using direct and contra positive proof.

### 3.4 Plane figures (19 hours)

#### a. Coordinates of Points

- Coordinates of points on a straight line
  - + Coordinates of points on a straight line
  - + Distance between 2 points
  - + Internal and External Dividing point
- Coordinates of points in the plane
  - + Coordinate plane
  - + Distance between 2 points
  - + Internal and external dividing point

#### b. Straight Lines

- Equation of straight lines
  - + Various form of equations of straight lines
 
$$y - y_1 = m(x - x_1)$$

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$
- Parallel and perpendicular straight lines
  - + Parallel and perpendicular straight lines
  - + Distance between a point and a straight line
  - + Using coordinates to prove properties of figures
- Equation of a Locus
  - + Basic locus (locus of the points at a constant distance from a fixed line, locus of the points at a constant distance from a fixed point, locus of the points equidistant from two fixed points, etc.)
  - + Equation of locus (equation of locus of the points equidistant from two fixed points, etc.)

#### c. Circles

- Equation of circles :  $(x - a)^2 + (y - b)^2 = R^2$
- Circles and straight lines
  - + Common point of circle and straight lines
  - + Tangents of circles

#### d. Regions Represented by Inequalities

- Regions represented by inequalities
 
$$(ax + by + c \geq 0 \text{ or } \leq 0; (x - a)^2 + (y - b)^2 \geq R^2 \text{ or } \leq R^2)$$
- Regions represented by simultaneous inequalities

### 3.5 Function (25hours)

#### a. Functions and Graphs

- Concept of Function (by inductive way)
- Domain, range, increasing and decreasing of a function
- Concept of applications
- Graph of functions
- Inverse functions

### b. Quadratic Functions and their Graphs

- Graph of  $y = ax^2$
- Translation of graph of functions  $y = ax^2$
- Graph of  $y = a(x - p)^2 + q$
- Graph of  $y = ax^2 + bx + c$  ( $a \neq 0$ )
- Minimum and Maximum values of quadratic functions
- Equations and Inequalities and the graph of functions
  - + The graph of quadratic function and quadratic equation.
  - + The graph of quadratic function and quadratic inequalities.

### c. Simple Fractional Functions and Irrational Functions

#### ➤ Fractional Function and Graphs

- + Graph of  $y = \frac{a}{x}$
- + Graph of  $y = \frac{a}{x - p} + q$
- + Graph of  $y = \frac{ax + b}{cx + d}$

#### ➤ Irrational Functions and Graphs

- + Graph of  $y = \sqrt{ax}$
- + Graph of  $y = \sqrt{ax + b}$

## 3.6 Trigonometric Ratios (15hours)

### a. Trigonometric ratios

- Sine ; cosine ; tangent and cotangent
- Relations among trigonometric ratios
- Extending trigonometric ratios
- Trigonometric ratio of  $(180^\circ - \alpha)$

### b. Applications of Trigonometric Ratios

- The sine theorem
- The cosine theorem
- Area of a triangle
  - + Given 2 sides and angle between these 2 sides
  - + Given 3 sides (Heron's formula)

## 3.7 Statistics (10hours)

### a. Frequency Distribution and Charts

### b. Measures of Position

- Mean, median, mode

## 3.8 Permutation and Combination (15hours)

### a. Counting

- Sum laws
- Product laws



**b. Permutation**

- Concept of permutation
- Circular permutation
- Repeated permutation.

**c. Combination**

- Concept of combination
- Binomial theorem (proved by a pattern)

**3.9 Vectors in Plane (25hours)**

**a. Vectors and their Operations**

- The meaning of a vector
- Addition and subtraction of vectors
- Multiplying a vector by a real number
- Component of a vector
- Scalar product of vectors

**b. Applications of vectors**

- Position of a vector
  - + Position vector of a point
  - + Internal and external dividing points of a line segment
  - + Coordinates and position vectors
- Straight lines and vectors
  - + Straight lines, direction vectors and parametric representation of straight lines
  - + Straight lines and normal vectors
- Circles and Vectors
  - + Vector equation of a circle
  - + Equation of a circle
- Force, Velocity and Vectors
  - + Force vectors and composite force
  - + Velocity vectors

**3.10 Transformations of Plane Figures (20hours)**

**a. Translation**

- Translation of a point and translation of plane figures
- Interpreting translation in a coordinate system

**b. Reflection**

- Reflection of a point, reflection of a plane figure
- Interpreting reflection in a coordinate system

**c. Rotation**

- Rotation of a point, rotation of plane figures
- Interpreting rotation in a coordinate system

**d. Enlargement**

- Enlargement of a point
- Enlargement of a plane figures
- Interpreting enlargement in a coordinate system.

**3.11 Geometry in the Space (20hours)**

**a. Representing Figures on the Plane**

**b. Basic Laws (Lines, planes, defining a plane and intersection of planes).**

**c. Position between Lines and Planes**

- Positions of two lines in space
- Positions between two planes

**d. Lines and Parallel Planes in Space**

- Parallel properties space and lines parallel to a plane
- Solve problems by using contra positive proof and proof by contradiction

**e. Orthogonality in Space**

- Formula for surface area and volume of some solids such as right parallelepiped, right prism, cylinder, sphere, regular pyramid and cone.
- Orthogonal lines
- A line perpendicular to a plane
- Perpendicular bisector plane
- Orthogonal planes
- Orthogonal projection



## Learning Outcome and Basic Mathematics Content in Grade 11

### 1. Learning Outcome

#### 1.1 Sequences

- Identify arithmetic and geometric sequences;
- Find their general terms and sum of their  $n$  primary terms
- Solve some daily life problems.

#### 1.2 Exponential and Logarithmic Functions

- Identify the concept of  $n^{\text{th}}$  roots and use the laws of exponents to calculate the expressions with fractional exponents
- Define exponential and logarithmic functions, sketch graphs
- use their properties to solve exponential and logarithmic equations and inequalities
- Apply exponential and logarithmic functions to solve the problems in daily life

#### 1.3 Trigonometric Function

- Define trigonometric functions of general angles, sketch graph
- Use the properties of associated angles to find the value of trigonometric functions
- Demonstrate addition, double angles and transformation formulae, and use them to solve trigonometric problems
- Solve the basic trigonometric equations and trigonometric inequalities
- Use trigonometric in a variety of applications and word problems.

#### 1.4. Matrices

- Identify the concept of matrices and carry out operations with matrices
- Find the inverse matrices and determinants of  $2 \times 2$
- Solve simultaneous linear equations with two variables
- Solve some daily life problems.

#### 1.5 Differentiation

- Identify the concept of limit and carry out the operations with limits
- Identify the concept of the differentiation and find derivative of polynomials and rational functions

#### 1.6 Probability

- Identify the sample spaces, total event, null event, sum event, product event, mutually exclusive events and complementary events
- Solve variety of appropriate problems in daily life.

#### 1.7 Statistics

- Find range, quartile, deciles, percentile, variance and standard deviation of a distribution of data in the particular situations,
- Interpreting them by graphs.

### 2. Objective

- To enable students to understand Exponential and Logarithmic Functions, Trigonometric Function, Matrices, Differentiation, Probability, and Statistics

- To give direction to the students who want to study science at the higher education or vocational training and apply mathematics to the daily life and practical work

### 3. Detailed Contents (4x38 = 152 hours)

#### 3.1 Sequences (20 hours)

- Concept of sequences**
  - + Definition
  - + Generation of sequence
  - + Increase and decrease of sequence
- Arithmetic sequences**
  - + General term of an arithmetic sequence
  - + Finite sum of an arithmetic sequence
- Geometric Sequences**
  - + General term of a geometric sequence
  - + Finite sum of a geometric sequence

#### 3.2 Exponential and Logarithmic Functions (26 hours)

- Exponential Functions**
  - The  $n^{\text{th}}$  roots and extension
  - Exponential laws
  - Exponential functions (Properties, graphs, equations and inequalities)
  - Applications
- Logarithmic Functions**
  - Properties of logarithm
  - Logarithmic functions (Properties, graphs, equations and inequalities)
  - Common logarithm
  - Applications

#### 3.3 Trigonometric Functions (30 hours)

- Trigonometric Functions**
  - General angles (General formula, Radian measure)
  - Trigonometric functions
  - Properties of trigonometric functions
    - +  $\sin(\alpha + 2k\pi) = \sin \alpha$  ;  $(k \in \mathbb{Z})$
    - +  $\cos(\alpha + 2k\pi) = \cos \alpha$  ;  $(k \in \mathbb{Z})$
    - +  $\tan(\alpha + k\pi) = \tan \alpha$  ;  $(k \in \mathbb{Z})$
    - +  $\cot(\alpha + k\pi) = \cot \alpha$  ;  $(k \in \mathbb{Z})$
    - + Associated angles
  - The graphs of trigonometric functions
- Addition theorems**
  - Addition theorems
  - Applications of the addition theorems
  - Double angle theorems
  - Transformation formulae
- Trigonometric Equations and Trigonometric Inequalities**
  - $\sin x = a$  ;  $\cos x = b$  ;  $\tan x = t$  ;  $\cot x = r$



- $\sin U(x) = \sin V(x)$  ;  $\cos U(x) = \cos V(x)$  ;  $\tan U(x) = \tan V(x)$  ;  $\cot U(x) = \cot V(x)$
- $\sin x \leq a$  ;  $\cos x \leq b$  ;  $\tan x \leq t$  ;  $\cot x \leq t$

### 3.4 Matrices (12 hours)

#### a. Matrices

- Concept of matrices
- Operations on matrices
- Inverse matrices and determinants of  $2 \times 2$  matrices

#### b. Simultaneous Linear Equations

- Simultaneous linear equations with two variables

### 3.5 Differentiation (Polynomials and Rational Functions) (34 hours)

#### a. Derivatives

- Limits
- Derivatives

#### b. Applications of Differentiation

- Tangent lines
- Increasing and Decreasing of a function
- Local maximum, local minimum and inflexion point of a function

#### c. Variation and graphs of functions

- Polynomial functions  $y = ax^3 + bx^2 + cx + d$  and  $y = ax^4 + bx^2 + c$
- Simple rational functions
  - + Horizontal and vertical asymptotes
  - + Variation and graph of  $y = \frac{ax+b}{cx+d}$

### 3.6 Probability (14 hours)

#### a. The Meaning of Probability

#### b. Sample Spaces

- Probability of an event
- Total Event
- Null Event
- Sum Event and Product Event
- Mutually Exclusive Events
- Complementary Event

### 3.7 Statistics (16 hours)

#### a. Range

#### b. Quartile, Deciles, and Percentile

#### c. Variance

#### d. Standard Deviation

#### e. Normal distribution



## Learning Outcome and Advanced Mathematics Content in Grade 11

### 1. Learning Outcome

#### 1.1 Sequences and Mathematical Induction

- Identify arithmetic and geometric sequences
- find their general terms and sum of their  $n$  primary terms
- Use the difference, sum and recurrence relation of sequence to find its general term
- Prove of various properties by using the method of mathematical induction.
- Use the binomial theorem and Pascal Triangle to expand  $(1+x)^n$ , where  $n$  is a positive integer
- Solve some daily life problems.

#### 1.2 Exponential and Logarithmic Functions

- Identify the concept of  $n^{\text{th}}$  roots and use the laws of exponents to calculate the expressions with fractional exponents
- Define exponential and logarithmic functions, sketch graphs
- use their properties to solve exponential and logarithmic equations and inequalities
- Apply exponential and logarithmic functions to solve the problems in daily life and solve more difficulty exercises in the enriching topics.

#### 1.3 Trigonometric Function

- Define trigonometric functions of general angles, sketch graph
- use the properties of associated angles to find the value of trigonometric functions
- Demonstrate addition, double angles and transformation formulae, and use them to solve trigonometric problems
- Solve trigonometric equations and trigonometric inequalities

#### 1.4 Matrices

- Identify the concept of matrices and carry out operations with matrices
- Find the inverse matrices and determinants of  $2 \times 2$  and  $3 \times 3$  matrices and solve simultaneous linear equations
- Identify the meaning of linear transformation by using matrices
- find composite linear transformations
- Solve some daily life problems.

#### 1.5 Complex Plane

- Plot complex numbers on the complex plane and represent complex numbers in polar form
- Carry out operations with complex numbers given in polar form
- Prove and use De Moivre's theorem to solve problems.
- Find the distance between two points, the coordinate of an internal and external dividing point and the loci under given conditions on the complex plane

#### 1.6 Differentiation

- Identify the concept of limit and carry out the operations with limits
- Identify the concept of the differentiation and find derivative of polynomials and

rational functions

- Find the tangent line equation to the graph of a function given
- Apply derivative to find the variation and sketch the graph of a function
- Apply derivative to solve parametric equations, inequalities and daily life problems

### 1.7 Probability

- Identify the sample spaces, total event, null event, sum event, product event, mutually exclusive events and complementary events
- Identify the conditional probability,
- Define dependent and independent events and
- Solve probability problems relevant to daily life.

### 1.8 Statistics

- Find range, quartile, deciles, percentile, variance and standard deviation of a distribution of data in the particular situations, and interpreting them by graphs

### 1.9 Vectors in space

- Identify the meaning of vector in space and carry out operations with vectors
- Find the scalar product of two vectors in space and use the properties of scalar products to solve geometric problems in space.
- Identify the meaning of position vectors and use it to find the internal and external dividing points and solve variety of appropriate problems.

## 2. Objective

- To enable students to understand Sequences and Mathematical Induction, Exponential and Logarithmic Functions, Trigonometric Function, Matrices, Complex Plane, Differentiation, Vectors in space, Probability, and Statistics
- To help student who want to study Mathematics, Chemistry and Technology at the higher education because these subjects need skill of advanced mathematics

## 3. Detailed Contents (8×38 = 304 hours)

### 3.1 Sequences and Mathematical Induction (40 hours)

- Concept of sequences
  - Definition
  - Generation of sequence
  - Increase and decrease of sequence
- Arithmetic sequences
  - General term of an arithmetic sequence
  - Finite sum of an arithmetic sequence
- Geometric Sequences
  - General term of a geometric sequence
  - Finite sum of a geometric sequence
- A variety of sequences
  - Use of symbol  $\sum$
  - Sequence of difference
  - Finite sum of a variety of sequences
- Recurrence relations

- Recurrence relation between 2 terms
  - Recurrence relation between 3 terms
- f. Mathematical Induction
- Concept of mathematical induction
  - Use of mathematical induction
  - Binomial theorem

### 3.2 Exponential and Logarithmic Functions (32 hours)

#### a. Exponential Functions

- The  $n^{\text{th}}$  roots and extension
- Exponential laws
- Exponential functions (Properties, graphs, equations and inequalities)
- Applications

#### b. Logarithmic Functions

- Properties of logarithm
- Logarithmic functions (Properties, graphs, equations and inequalities)
- Common logarithm
- Applications

#### c. Enriching Topics

### 3.3 Trigonometric Functions (40 hours)

#### a. Trigonometric Functions

- General angles (General formula, Radian measure)
- Trigonometric functions
- Properties of trigonometric functions
  - +  $\sin(\alpha + 2k\pi) = \sin \alpha$  ;  $(k \in Z)$
  - +  $\cos(\alpha + 2k\pi) = \cos \alpha$  ;  $(k \in Z)$
  - +  $\tan(\alpha + k\pi) = \tan \alpha$  ;  $(k \in Z)$
  - +  $\cot(\alpha + k\pi) = \cot \alpha$  ;  $(k \in Z)$
  - + Associated angles
- The graphs of trigonometric functions

#### b. Addition theorems

- Addition theorems
- Applications of the addition theorems
- Double angle theorems
- Transformation formulae

#### c. Trigonometric Equations and Trigonometric Inequalities

- $\sin x = a$  ;  $\cos x = b$  ;  $\tan x = t$  ;  $\cot x = r$
- $\sin U(x) = \sin V(x)$  ;  $\cos U(x) = \cos V(x)$  ;  $\tan U(x) = \tan V(x)$  ;  $\cot U(x) = \cot V(x)$
- $a \cos x + b \sin x = c$
- $a \sin^2 x + b \sin x \cos x + c \cos^2 x + d = 0$
- $\sin x \leq a$  ;  $\cos x \leq b$  ;  $\tan x \leq t$  ;  $\cot x \leq t$
- $a \cos x + b \sin x \leq c$

### 3.4 Matrices (32 hours)



#### a. Matrices

- Concept of matrices
- Operations on matrices
- Inverse matrices and determinants of  $2 \times 2$  matrices
- Inverse matrices and determinants of  $3 \times 3$  matrices

#### b. Simultaneous Linear Equations

- Simultaneous linear equations with two variables
- Simultaneous linear equations with three variables

#### c. Linear Transformations

- Reflection
- Rotation
- Enlargement
- Composite linear transformations

### 3.5 Complex Plane (38 hours)

#### a. Complex Plane

- Representation on the complex plane
  - + Absolute values of complex numbers
  - + Geometric meaning of addition, subtraction and scalar multiple
  - + Translation
- Polar form of complex numbers
  - + Absolute values and arguments of complex numbers
  - + Geometric meaning and of multiplication and division of complex numbers.
  - + Rotation around the origin on the complex plane.

#### b. De Moivre's Theorem

- De Moivre's theorem
  - + Use of the theorem for calculating the power of complex numbers
  - + Solutions of an equation  $z^n = k$  and geometric representation of its  $n$  roots

#### c. Complex Numbers and Geometric Figures

- Coordinate geometry on the complex plane
  - + Distance between two points
  - + Internal and external division
  - + Loci on the complex plane
- Triangle on the complex plane
  - + Ratio of sides and measure of angles.

### 3.6 Differentiation (Polynomials and Rational Functions) (46 hours)

#### a. Derivatives

- Limits
- Derivatives

#### b. Applications of Differentiation

- Tangent lines
- Increasing and decreasing of a function
- Local maximum, local minimum and inflexion point of a function

#### c. Variation and Graphs of Functions

- Polynomial functions  $y = ax^3 + bx^2 + cx + d$  and  $y = ax^4 + bx^2 + c$
- Simple rational functions

- + Horizontal and vertical asymptotes
- + Variation and graph of  $y = \frac{ax+b}{cx+d}$

**d. Applications of Differentiation to Equations and Inequalities.**

**3.7 Probability (24 hours)**

**a. The Meaning of Probability**

**b. Sample Spaces**

- Probability of an event
- Total Event
- Null Event
- Sum Event and Product Event
- Mutually Exclusive Events
- Complementary Event

**c. Conditional Probability**

**d. Dependent and Independent Events**

**3.8 Statistics (Measures of Dispersions) (16 hours)**

**a. Range**

**b. Quartile, Deciles and Percentile**

**c. Variance**

**d. Standard Deviation**

**e. Normal distribution**

**3.9 Vectors in space (36 hours)**

**a. Vectors in space and Operations involving them**

- The meaning of Vector in Space
- Operations involving vectors
- Component of Vector
- The scalar product and component representation
- Distance of 2 points
- Equation of a sphere

**b. Equations of straight lines and planes in space**

- Position vectors
- Equation of straight line
- Equation of plane
- The distance between a point and a plane.



## Learning Outcome and Basic Mathematics Content in Grade 12

### 1. Learning Outcome

#### 1.1 Limits

- Find limits of irrational functions, trigonometric functions, exponential and logarithmic functions.
- Identify the concept of continuity of a function, continuity of composite functions and use Intermediate value theorem to prove existence of roots of an equation in a given interval.

#### 1.2 Differentiation

- Find derivative (first and second order) of composite functions, inverse functions, trigonometric functions, exponential and logarithmic functions.
- Apply derivative to find variation of functions, convexity and concavity of graphs and to solve daily life problems (Ex: Physics, Chemistry, Economics, etc.)

#### 1.3 Variations and Graphs of Various functions

- Find variations and sketch graphs of simple rational and functions  $y = e^x$  and  $y = \ln x$
- Apply  $y = e^x$  and  $y = \ln x$  to solve problems involving exponential growth and decay.

#### 1.4 Integration

- Identify the concept of antiderivative, indefinite integrals and definite integrals.
- Find indefinite integrals and definite integrals by basic formulae, by substitution and by parts methods
- Apply definite integrals to find the area of plane figures
- Apply the definition of the integral to model problem in physics, economics, and so forth, obtaining results in terms of integrals.

#### 1.5 Statistics

- Identify the concept of statistics of two variables and represent it by graphs
- Find equation of linear regression and correlation coefficient and use them to interpret relations between these variables
- Discover the relationships between two separate quantities and derive the conclusion.

#### 1.6 Conics (Quadratic Relations)

- Identify the concept of quadratic relations, parabola, ellipse and hyperbola
- Find standard form and general form of the equation of parabola, ellipse and hyperbola
- Sketch parabola, ellipse and hyperbola and apply the conics concept to daily life

### 2. Objective

- To enable students to understand Sequences Limits, Differentiation, Variations and Graphs of Various functions, Integration, Statistics, and Conics



- To help student who want to study science at the higher education and apply these skills to the daily life and work place

### **3. Detailed Contents (4×38 = 152 hours)**

#### **3.1 Limits (26 hours)**

##### **a. Limits of Functions**

- Limits of irrational functions
- Limits of trigonometric functions
- Limits of exponential functions
- Limits of logarithmic functions

##### **b. Continuity of functions**

- Concept of continuity
- Properties
- Continuity of composite functions
- Intermediate value theorem

#### **3.2 Differentiation (24 hours)**

##### **a. Derivative of composite functions and Inverse functions**

##### **b. Derivative of Trigonometric functions**

##### **c. Derivative of Exponential functions Logarithmic functions**

##### **d. Derivative of second order**

##### **e. Applications of Differentiation**

- Variation of functions
- Application to extremum value
- Convexity and concavity of graphs
- Velocity and acceleration

#### **3.3 Variations and Graphs of Various functions (26 hours)**

##### **a. Variations and graphs of rational functions**

- Slant asymptotes
- $y = \frac{ax^2 + bx + c}{a'x + b'}$
- $y = \frac{ax^2 + bx + c}{a'x^2 + b'x + c'}$

##### **b. Variation and Graph of Exponential Functions**

- Applications

##### **c. Variation and Graph of Logarithmic Functions**

- Applications

#### **3.4 Integration (24 hours)**

##### **a. Antiderivative and Indefinite Integrals**

- Antiderivative
- Indefinite integrals
  - + Integration by substitution

+ Integration by parts

**b. Definite Integrals**

- Definite integrals
- Functions expressed by definite integrals

**3.5 Statistics (26 hours)**

- a. Concept of Statistic of 2 variables
- b. Representation of statistic of 2 variables
- c. Equation of Linear Regression
- d. Correlation Coefficient

**3.6 Conics (Quadratics Relation) (26hours)**

**a. Introduction to Quadratic Relations**

**b. Parabola**

- Definition of parabola
- Standard form of the equation of a parabola
- General form of the equation of a parabola

**c. Ellipse**

- Definition of ellipse
- Standard form of the equation of an ellipse
- General form of the equation of an ellipse

**d. Hyperbola**

- Definition of hyperbola
- Standard form of the equation of a hyperbola
- General form of the equation of a hyperbola
- Asymptotic lines of a hyperbola

## Learning Outcome and Advanced Mathematics Content in Grade 12

### 1. Learning Outcome

#### 1.1 Limits

- Find the Limits of infinite sequences, infinite geometric sequences and infinite geometric series and apply to infinite repeated decimals.
- Find limits of irrational functions, trigonometric functions, exponential and logarithmic functions.
- Identify the concept of continuity of a function, continuity of composite functions and use Intermediate value theorem to prove existence of roots of an equation in a given interval.

#### 1.2 Differentiation

- Find derivative (first, second and higher order) of composite functions, inverse functions, trigonometric functions, exponential and logarithmic functions.
- Apply derivative to prove mean value theorem and inequalities, to find variation of functions, convexity and concavity of graphs and to solve daily life problems
- Use differentiation to solve optimization (maximum-minimum problems) in a variety of pure and applied contexts.

#### 1.3 Variations and Graphs of Various functions

- Find variations and sketch graphs of simple rational, simple irrational, combined trigonometric functions, functions  $y = e^x$  and  $y = \ln x$
- Apply  $y = e^x$  and  $y = \ln x$  to solve problems involving exponential growth and decay.

#### 1.4 Integration

- Identify the concept of antiderivative, indefinite integrals and definite integrals.
- Find indefinite integrals and definite integrals by basic formulae, by substitution and by parts methods
- Find the functions expressed by definite integrals.
- Apply definite integrals to find the area of plane figures, volume of solids, the length of paths, velocity, acceleration, work, etc.
- Apply definite integral to find the area of plane figures
- Apply definition of integral in problem, physics, economics etc that its result is function of integral
- Identify primitive notion, indefinite integrals, and definite integrals

#### 1.5 Differential Equations

- Find general solution and a particular solution satisfying given initial conditions of first-order and second-order homogeneous differential equations
- Formulate differential equations as models and interpret the solutions.
- Use differential equations and their applications to a wide variety of situations, including growth, decay problems and solve some physical problems (Ex: free fall, elastic pendulum, etc.)



### 1.6 Probability

- Identify the random variables and find their probability distributions
- Prove the binomial distribution and use it to find the probability of repeated trials,
- Find the expected (or mean) value, variance and standard deviation of binomial distribution.
- Find the probability in the normal distribution.
- Use the normal distributions to solve for events in problems in which the distribution belongs to those families.

### 1.7 Statistics

- Identify the concept of statistics of two variables and represent it by graphs
- Find equation of linear regression and correlation coefficient and use them to interpret relations between these variables
- Discover the relationship between two separate quantities and derive the conclusion (Ex: Correlation between mathematics and physics scores of 20 students who have taken exam in grade 12).

### 1.8 Cross product of vectors in space

- Identify the concept of cross product of two vectors in space and find its components.
- Interpret cross product of two vectors geometrically and use it to solve geometric problems in space.

### 1.9 Conics (Quadratic Relations)

- Identify the concept of quadratic relations, parabola, ellipse and hyperbola
- Find standard form and general form of the equation of parabola, ellipse and hyperbola
- Sketch parabola, ellipse and hyperbola and apply the conics concept to daily life
- Identify the parameters and polar coordinates and use their formulae to find parametric equation and polar equation of curves, especially for conics (Enriching topics: tangent lines, area, etc.)

### 1.10 Arithmetics

- Find Multiples and Divisors of an integer
- Use Properties of relation “divide” to prove some arithmetic problems
- Find the remainder in euclidean division of two integers
- Identify the notion of prime numbers and infinity of prime numbers
- Decompose a number into prime factors
- Find greatest common divisors of two whole numbers by using Euclidean Algorithm
- Find greatest common divisors and least common multiple of two whole numbers
- Use greatest common divisors and least common multiple of whole numbers to calculate the fractional expressions
- Use Gauss theorem to prove some arithmetic problems
- Solve equations  $ax+by=d$  or  $ax-by=d$ , where  $GCD(a,b)=d$



## 2. Objective

- To enable students to understand Limit of Sequences, Limit of Function, Differentiation, Variations and Graphs of Various functions, Integration, Differential Equations, Probability, Statistics, Cross product of vectors in space, Conics, and Arithmetics
- To provide student who want to study Mathematics at the higher education with advanced mathematics knowledge especially in the sector of technology and economics

## 3. Detailed Contents (8x38 = 304 hours)

### 3.1 Limits (36 hours)

#### a. Limits of Sequences

- Infinite sequences
- Infinite geometric sequences and infinite geometric series
- Properties of limits of sequences
- Infinitely repeated decimals

#### b. Limits of Functions

- Limits of irrational functions
- Limits of trigonometric functions
- Limits of exponential functions
- Limits of logarithmic functions

#### c. Continuity of functions

- Concept of continuity
- Properties
- Continuity of composite functions
- Intermediate value theorem

### 3.2 Differentiation (30 hours)

#### a. Derivative of Composite Functions and Inverse Functions

#### b. Derivative of Trigonometric Functions

#### c. Derivative of Exponential Functions and Logarithmic Functions

#### d. Derivative of Second Order and higher order

#### e. Applications of Differentiation

- Mean value theorem
- Variation of functions
- Application to extreme value
- Application to inequalities
- Approximate values
- Convexity and concavity of graphs
- Velocity and acceleration

### 3.3 Variations and Graphs of Various functions (38 hours)

#### a. Variations and graphs of rational functions

- Slant asymptotes
- $y = \frac{ax^2 + bx + c}{a'x + b'}$

$$y = \frac{ax^2 + bx + c}{a'x^2 + b'x + c'}$$

- Applications

#### **b. Variations and Graphs of Irrational Functions**

- $y = \sqrt{ax + b}$
- $y = \sqrt{ax^2 + bx + c}$
- Applications

#### **c. Variations and Graphs of Combined Trigonometric Functions**

- Applications

#### **d. Variation and Graph of Exponential Functions**

- Applications

#### **e. Variation and Graph of Logarithmic Functions**

- Applications

### **3.4 Integration (42 hours)**

#### **a. Antiderivative and Indefinite Integrals**

- Antiderivative
- Indefinite integrals
  - + Integration by substitution
  - + Integration by parts

#### **b. Definite Integrals**

- Definite integrals
- Functions expressed by definite integrals

#### **c. Applications of Definite Integrals**

- Quadrature by partitions and definite integral
- Area of plane figures
- Volume of solids
- Length of paths

### **3.5 Differential Equations (28 hours)**

#### **a. First Order Differential Equations ( $\frac{dy}{dx} = f(x)$ ; $\frac{dy}{dx} = f(y)$ )**

- Forming and solving equations
- Independent and dependent variables
- Switching variables in differential equation

#### **b. Second order Differential Equations**

- Second order homogeneous differential equations

#### **c. Applications**

### **3.6 Probability (30 hours)**

#### **a. Random Variables and Probability Distribution**

#### **b. Binomial Distribution**

- Probability of repeated trial

#### **c. Expected Value**



- Mean of a binomial distribution
- d. Variance and Standard Deviation**
  - Variance and standard deviation of a binomial distribution
- e. Normal Distribution**

### 3.7 Statistics (26 hours)

- a. Concept of Statistic of 2 Variables**
- b. Representation of Statistic of 2 Variables**
- c. Equation of Linear Regression**
- d. Correlation Coefficient**

### 3.8. Cross Product of Vectors in Space (26 hours)

- a. Definition (Using Components)**
- b. Properties**

$$\vec{a} \times \vec{a} = \vec{0}$$

$$(\vec{a} + \vec{b}) \times \vec{c} = \vec{a} \times \vec{c} + \vec{b} \times \vec{c}$$

$$\vec{a} \times \vec{b} = -\vec{b} \times \vec{a}$$

$$(\vec{a} \times \vec{b}) \cdot \vec{a} = 0$$

$$(\vec{a} \times \vec{b}) \cdot \vec{b} = 0$$

- c. Geometric Interpretation of the Cross Product of 2 Vectors**
- d. Applications**

### 3.9 Conics (Quadratics Relation) (28 hours)

- a. Introduction to Quadratic Relations**

#### **b. Parabola**

- Definition of parabola
- Standard form of the equation of a parabola
- General form of the equation of a parabola

#### **c. Ellipse**

- Definition of ellipse
- Standard form of the equation of an ellipse
- General form of the equation of an ellipse

#### **d. Hyperbola**

- Definition of hyperbola
- Standard form of the equation of a hyperbola
- General form of the equation of a hyperbola
- Asymptotic lines of a hyperbola

#### **e. Parameters and Polar Coordinates**

- Parametric equations of curves
- Polar equations of curves
- Parametric and polar equations of conics

#### **f. Enriching Topics**

- Tangent lines
- Area

### **3.10 Arithmetic (20 hours)**

#### **a. Divisibility and Euclidean Division**

- Divisibility in integers ( $\mathbf{Z}$ )
  - + Multiples and divisors of an integer
  - + Set of multiples of an integer
- Properties of relation “divide”
  - + Euclidean division
  - + Theorem
  - + Definition of Euclidean division

#### **b. Prime Numbers**

- Infinity of prime numbers
  - + Notion of prime numbers
  - + Arrest Condition
  - + Existence of an infinity of prime numbers
- Decomposition of a number into prime factors
  - + Existence and uniqueness of the decomposition
  - + Divisibility condition

#### **c. Common Divisors and Multiples**

- Greatest common divisor (GCD)
  - + Common divisors of two whole numbers
  - + Finding the common divisors by successive divisors method
  - + Properties of GCD
  - + Relatively prime numbers
  - + Notion of irreducible fraction
- Gauss theorem and Bezout theorem
  - + Gauss theorem
  - + Bezout theorem
- Least Common Multiple (LCM)
  - + Common multiple of two whole numbers
  - + Finding the common multiples of two whole numbers
  - + Properties of LCM





Japan International Cooperation Agency

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