

MATHEMATICS EDUCATION IN Ngee ANN TECHNICAL COLLEGE

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1. Introduction

Ngee Ann Technical College (NATC) is one of the institutions of higher learning offering courses in engineering and business studies at diploma level to meet the growing needs of industry and commerce in the Republic. The College conducts five full-time courses, namely, Mechanical Engineering (ME), Electrical & Electronics Engineering (EEE), Shipbuilding & Repair Technology (SRT), Building Maintenance & Management (BMM) leading to Technician Diplomas and Diploma in Business Studies (BS).

All courses are of three years duration for GCE 'O' level holders and two years for GCE 'A' level holders. Mathematics courses are offered for the students in the first year or first and second years in the Technician Diploma courses. The Mathematics and Science Unit is responsible for the teaching of all the mathematics courses.

2. Mathematics Curriculum

The mathematics curriculum designed for various Technician Diploma courses is based mainly on the knowledge of Elementary Mathematics of the GCE 'O' level examination and other mathematics subjects required in the various disciplines. The objectives are : (i) to provide a systematic training of mathematics knowledge, which is required as a tool for the study of the respective technical subjects in the Technician Diploma courses ; (ii) to equip students with the mathematics knowledge that is useful to them in connection with their future working life. There are four types of mathematics courses offered at NATC for various departments.

- a) The following mathematics courses are given in the first and second years of the three-year Technician Diploma courses in Mechanical Engineering and Shipbuilding & Repair Technology :

1st Year : Engineering Mathematics I

2nd Year : Engineering Mathematics II & Computer Programming

The syllabi of the above courses are in appendices 1 & 2. A summary of the course structure is as follows :-

Engineering Mathematics I

Duration : 1 year (1st Year Course)

Time Allocation : 3 hours/week lectures
1 hour /week tutorials

Engineering Mathematics II & Computer Programming

Duration : 1 Year (2nd Year Course)

Time Allocation : 3½ hours/week lectures
1 hour /week tutorials
½ hour/week practical

The practical periods are provided for the Computer Programming practice. Due to a recent review of the curriculum in the Technician Diploma courses in ME & SRT, mathematics courses are also being reviewed in order to gear to the needs of the latest revision of the course structure of the above two diploma courses.

b) The following mathematics courses are given in the first and second years of the three-year Technician Diploma course in Electrical & Electronics Engineering :

1st Year : Engineering Mathematics I

2nd Year : Engineering Mathematics II & Computer Programming

The syllabi of the above courses are in appendices 1 & 3. A summary of the course structure is as follows:

Engineering Mathematics I

Duration : 1 Year (1st Year Course)

Time Allocation : 3 hours/week lectures
1 hour /week tutorials

Engineering Mathematics II & Computer Programming

Duration : 1 Year (2nd Year Course)

Time Allocation : 3½ hours/week lectures
1 hour/week tutorials
½ hour/week practical

The practical periods are provided for the Computer Programming practice in the Computer Centre. The first year Engineering Mathematics I course is the same as that for the other two engineering departments (ME & SRT).

c) There is a one-year mathematics course for students pursuing the First Year course of the Technician Diploma in Building Maintenance & Management. The time allocated for the course is 2 hours/week of lectures and 1 hour/week of tutorials. The syllabus of the course is given in appendix 4. The aim of this course for BMM students is to provide students with a working knowledge of fundamental mathematics applicable in building maintenance and management.

- d) For GCE 'A' level holders, students need to spend only two years to complete their diploma course. For ME, SRT & BMM courses, students are exempted from attending mathematics courses but they have to attend a one-year course in Computer Programming. The content of the Computer Programming course is the same as that of the Second Year course in the three-year structure. For the EEE course, students have to study one year in Engineering Mathematics & Computer Programming. The time allocated for this course is 2 hours/week lectures, ½ hour/week tutorials and ½ hour/week practical. The syllabus of this course is given in appendix 5.

3. Mathematics Background of Our Students

The students with GCE 'O' level are admitted to a three-year Technician Diploma course in ME, EEE, SRT or BMM or a three-year Diploma course in Business Studies. One of the minimum requirements to be admitted to the three-year diploma course is to have at least an 'O' level pass in Elementary Mathematics. Preference will be given to candidates who have also obtained an 'O' level pass in Additional Mathematics. The students with GCE 'A' level are admitted to a two-year Technician Diploma course in ME, EE, SRT or BMM or a two year Diploma course in Business Studies. In this case, one of the minimum requirements is a pass at 'A' level in any mathematics subject.

In recent years, more than half of the GCE 'O' level applicants admitted to the College has also obtained a pass in Additional Mathematics in their GCE 'O' level examinations. This is no doubt an advantage for the study of mathematics in the various departments. Since not all students admitted has a pass in Additional Mathematics, students' level of knowledge and their attainment in mathematics vary and this creates some problems during the first year. However, every effort has been made to narrow the gap of their mathematics attainment in the first year course. The ideal mathematical background that these students should have is to attain a common level of mathematics before they are admitted to the College. Furthermore, more practical problems related to general applications should be included in the teaching of the secondary school mathematics especially in the application to the relevant science subjects.

4. Our Graduates

Ngee Ann Technical College graduates are employed in many technical, administrative and commercial posts, of which the following are a sample :-

- Assistant Engineer
- Assistant Foreman
- Assistant Maintenance Manager
- Draughtsman/Draughtswoman
- Electronics Technician
- Electrical Technician
- Technical Officer

Estimator
Estate Officer/Supervisor
Housing Maintenance Officer
Installation & Maintenance Supervisor
Production Engineer
Production Superintendent
Technical Sales Executive
Project Officer
Project Planner

The basic mathematics knowledge the graduates have acquired in the College is valuable for solving related problems encountered in their various technical professions.

5. Teaching Staff

There are 16 staff members in the Mathematics and Science Unit. They teach Physics, Mathematics and Computer Programming to students pursuing various Technician Diploma courses in the College. All staff members have at least a basic science degree in Mathematics or Physics. More than half of the staff members have a postgraduate degree in one of the following fields :-

Mathematics, Physics, Statistics, Operational Research,
Numerical Analysis and Control Engineering etc.

Due to the recent emphasis on computer education in the College, more staff members will be involved in the teaching of Computer Programming. In view of the great demand of computer personnel, it is very difficult to recruit staff members with considerable experience in the computer field. Every effort has been made to send staff members for further training in this field so that they will be able to acquaint themselves with the latest knowledge in computer science and its applications

6. Revision of Mathematics Courses

In order to meet the complicated higher technology industries in the 1980s, the College has started planning its next five years expansion project. The courses offered in various departments are being reviewed with the aim to cater for the need of rapid technology advancement. More optional subjects will be offered for final year students in order to meet the various needs of industries in the 80s. The syllabi of mathematics courses are also being reviewed to equip students with the necessary knowledge for the study of their respective technical subjects. Furthermore, computer programming may be taught as a separate subject instead of coupling it with mathematics as the use of computer becomes more widespread in the industry.

Syllabus of Engineering Mathematics I (For ME/EEE/SRT 1st Year Students)

1. Trigonometry

- 1.1 Revision of trigonometric functions.
- 1.2 Radian Measures.
- 1.3 Graphs of trigonometric functions and their applications.
- 1.4 Trigonometric identities and formulae
- 1.5 Solution of triangle.
- 1.6 Inverse trigonometric functions.

2. Analytic Geometry

- 2.1 Plane rectangular coordinates system.
- 2.2 Equation of a straight line.
- 2.3 Equation of conic section.
- 2.4 Polar coordinates and graph of an equation in polar form.

3. Complex Number

- 3.1 Concept of complex number.
- 3.2 Arithmetic operations of complex number.
- 3.3 Polar and exponential forms of complex number.

4. Differentiation and Integration

- 4.1 Limit and continuity of a function.
- 4.2 Derivatives of simple algebraic and trigonometric functions.
- 4.3 Derivatives of sum, product, quotient of functions, function of a function and implicit function.
- 4.4 Derivatives of the logarithmic, exponential and inverse functions.
- 4.5 Applications of differentiation to general problems.
- 4.6 Turning points, maxima and minima of a function.
- 4.7 Integration of simple functions by use of standard integrals.
- 4.8 Applications of definite integral to area, volume, mean and root mean square values.
- 4.9 The graphs, properties and derivatives of hyperbolic functions.
- 4.10 Integration by substitution and by parts.
- 4.11 Integration by partial fractions and by use of reduction formulae.
- 4.12 Simple partial differentiation of functions of two or more variables and its applications.

5. Vector

- 5.1 Definition of vectors, the resultant and resolution of vectors.
- 5.2 Rules of vector manipulation.
- 5.3 Applications of vectors.

6. Series

- 6.1 Arithmetical and geometrical progression. Binominal expression.
- 6.2 Maclaurin and Taylor series.

Syllabus of Engineering Mathematics II & Computer Programming

(For ME/SRT 2nd Year Students)

1. Algebra

- 1.1 Relationship between roots and coefficients of an equation.
- 1.2 The solution of an algebraic equation by graphical method.
- 1.3 Second and third order determinants.
- 1.4 Solution of simultaneous linear equations by determinants.
- 1.5 The consistency and linear dependence of a set of simultaneous linear equations.

2. Differential Equations

- 2.1 General and particular solutions of various types of first order differential equations.
- 2.2 Applications of first order differential equations in engineering problems.
- 2.3 Second order linear differential equations with constant coefficients.
- 2.4 Particular integral and general solution of a second order linear differential equation.
- 2.5 Applications of second order differential equations to problems involving motion of bodies in a straight line, damped oscillations and forced oscillations.

3. BASIC Computer Programming

- 3.1 Introduction to the functions of the main elements of a digital computer and its peripherals.
- 3.2 Sets of BASIC characters, variable names and elementary operators.
- 3.3 Structure of simple BASIC statements : LET, REM, PRINT, READ, DATA, END, RUN etc.
- 3.4 Transfer of control : GO TO, IF THEN.
- 3.5 Looping: FOR NEXT, nesting of loops.
- 3.6 Subscripts and arrays.
- 3.7 Character string manipulations.
- 3.8 Library functions and subroutines.
- 3.9 Printout format.
- 3.10 Common error - messages.
- 3.11 Matrix manipulation.
- 3.12 Simple BASIC commands for file processing.
- 3.13 Concept of file and file structure
- 3.14. Application of computer programming in solving engineering problems, non-standard integrals by Simpson or Trapezoidal Rule, simultaneous differential equations by Gaussian Elimination method. and fitting of curves.

4. Integral Calculus and Applications

- 4.1 Lengths of curves; areas volumes and surface areas of solids.
- 4.2 Centres of gravity and centroids of areas and volumes.
- 4.3 Second moments of areas and the mass moments of inertia of bodies.
- 4.4 Area/mass moments of inertia of composite areas/masses about given axis using Parallel-axis Theorem.
- 4.5 Radius and centre of curvature of a given curve.
- 4.6 Simple double integrals in cartesian and polar coordinates.

5. Introduction to Partial Differential Equations and Fourier Series

- 5.1 Simple partial differential equations which can be solved by direct integration.
- 5.2 Formulae for simple Fourier Series and their applications.

6. Numerical Analysis

- 6.1 Calculations of irregular area and volume by numerical method.
- 6.2 Numerical solution of algebraic and transcendental equations by simple iterative method and Newton Raphson's method.
- 6.3 Numerical solution of first order differential equation by Euler's or modified Euler's method.

7. Probability and Statistics.

- 7.1 Permutation and combination.
- 7.2 Simple concept of probability and laws of probability.
- 7.3 Conditional probability.
- 7.4 Frequency and cumulative frequency distribution.
- 7.5 Measure of central tendency.
- 7.6 Measure of dispersion.
- 7.7 Normal, Binomial and Poisson distributions and their applications.

Appendix 3

Syllabus of Engineering Mathematics II & Computer Programming (For EEE 2nd Year Students)

1. Differential Equations

- 1.1 Various types of first order differential equations and their applications in electrical engineering.
- 1.2 Second order linear differential equations with constant coefficients.
- 1.3 Second order differential equations with variable coefficients reducible to first order.
- 1.4 Simultaneous differential equations and their applications in electrical engineering.

2. Laplace Transformations

- 2.1 Define Laplace transformations and obtain Laplace transformations of certain functions from definition or its properties.
- 2.2 Obtain Laplace transforms of derivatives and integrals.
- 2.3 Solve differential equations by inverse Laplace transforms.
- 2.4 Laplace transform of unit step functions and their applications to simple circuit transients.

3. BASIC Computer Programming

- 3.1 Introduction to the functions of the main elements of a digital computer and its peripherals.
- 3.2 Sets of BASIC characters, variable names and elementary operators.
- 3.3 Structure of simple BASIC statements : LET, REM, PRINT, READ, DATA, END, RUN etc.
- 3.4 Transfer of control : GO TO, IF THEN.
- 3.5 Looping : FOR NEXT, nesting of loops.

- 3.6 Subscripts and arrays.
- 3.7 Character string manipulations.
- 3.8 Library functions and subroutines.
- 3.9 Printout format.
- 3.10 Common error - messages.
- 3.11 Matrix manipulation.
- 3.12 Simple BASIC commands for file processing.
- 3.13 Concept of file and file structure.
- 3.14 Application of computer programming in solving engineering problems, non-standard integrals by Simpson or Trapezoid Rule, simultaneous differential equations by Gaussian Elimination methods, and fitting of curves.

4. Numerical Analysis

- 4.1 The approximate solutions of polynomial equations and equations involving transcendental functions.
- 4.2 Difference operators and their inter-relationships and applications.
- 4.3 Numerical integration.

5. Determinants and Matrices

- 5.1 Evaluation and application of determinants.
- 5.2 Evaluation and application of matrices.
- 5.3 Applications of determinants and matrices to solve simultaneous linear equations.
- 5.4 Applications of determinants and matrices to solve simple electrical circuits.

6. Fourier Series

- 6.1 Fourier coefficients.
- 6.2 Fourier Series of odd and even functions.
- 6.3 Harmonics analysis of tabulated functions.

7. Statistics and Elementary Quality Control

- 7.1 Process of numerical information from sets of observations.
- 7.2 Permutations and combinations.
- 7.3 Concepts and rules of probability and its applications.
- 7.4 Normal, Binomial and Poisson distributions and their applications.
- 7.5 Quality control chart and its usage.

Appendix 4

Syllabus of Mathematics (For BMM 1st Year Students)

1. Trigonometry

- 1.1 Basic trigonometry identities and compound angle formulae.
- 1.2 General solution of plane triangle with applications to solution of surveying problems.
- 1.3 Three dimensional problems; heights and distance of inaccessible objects.
- 1.4 The dihedral angle, true lengths and areas from drawing of plan and elevation.

2. Mensuration

- 2.1 Plane areas of common geometrical figures, surface area and volume of solids.
- 2.2 Circular measure.
- 2.3 Mensuration of circle, ellipse and parabola.
- 2.4 Trapezoidal, mid-ordinate and Simpson's Rules for area.
- 2.5 Simpson's Rule applied to determination of excavation etc, prismatic formula.
- 2.6 Theorem of Pappus or Guldinus and its applications.

3. Calculus

- 3.1 Differentiation of simple algebraic, trigonometric, exponential and logarithmic functions.
- 3.2 Chain rule, successive differentiation, and its applications to kinematics.
- 3.3 Problems involving maxima and minima and their applications.
- 3.4 Integration of simple algebraic and trigonometric functions.
- 3.5 Integration by means of simple substitution.
- 3.6 Definite integral and its applications to area under a curve, deflection of beams, volume of a solid of revolution.

4. Algebra and Financial Mathematics.

- 4.1 Construction of scales and monograms.
- 4.2 Arithmetical progression and simple interest.
- 4.3 Geometrical progression and compound interest.
- 4.4 Applications of compound interest calculation to annuities, mortgage repayments and depreciation.

5. Statistics

- 5.1 Statistical treatment and measurement of data: histograms and frequency distributions.
- 5.2 Measure of average: means, median and mode.
- 5.3 Standard deviation and coefficient of variation.
- 5.4 Normal distribution.
- 5.5 Trend lines and moving averages.
- 5.6 Regression; correlation and significance.

Appendix 5

Syllabus of Engineering Mathematics & Computer Programming

(For EEE 1st Year Students of "A" level intake)

1. Laplace Transformations

- 1.1 Define Laplace transformations and obtain Laplace transformations of certain functions from definition or its properties.
- 1.2 Obtain Laplace transforms of derivatives and integrals.
- 1.3 Solve differential equations by inverse Laplace transforms.
- 1.4 Laplace transform of unit step functions and their applications to simple circuit transients.

2. Numerical Analysis

- 2.1 The approximate solutions of polynomial equations and equations involving transcendental functions.

- 2.2 Difference operators and their inter-relationships and applications.
- 2.3 Numerical integration.

3. Fourier Series

- 3.1 Fourier coefficients.
- 3.2 Fourier Series of odd and even functions.
- 3.3 Harmonics and analysis of tabulated functions.

4. BASIC Computer Programming

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- 4.11 Matrix manipulation.
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