EMT1201 Engineering Mathematics II

Period per Week			Contact Hour per Semester	Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
45	00	30	60	100	60	40	4

Rationale

Against the foundation of the Calculus and Algebra covered in EMT1101, this course develops the fundamental aspects of Mathematical Analysis critical to Engineering. The major themes include; Ordinary Differential Equations, Real Analysis, Complex Variable Analysis, and Numerical Analysis.

Objectives

- To introduce students to the concept of Single Predictor-Response mathematical modelling in areas such as electrical circuit problems and vibratory and oscillatory mechanical systems
- To expose students to analytical solutions of classical ordinary differential equations in mathematical physics.
- To expose students to the fundamentals of Real Analysis.
- To introduce students the foundations of Scientific Computing and Numerical Analysis.

Course Content

1. Ordinary Differential Equations

- Definition of Differential Equations
- Definition and Classification of Ordinary Differential Equations
- Formulation of Ordinary Differential Equations - electrical circuit problems and vibratory and oscillatory mechanical systems
- Solution Techniques for First Order ODE's
  - Method of Separation of Variables
  - Methods for Exact Equations

- Equation Reducible to Exact Form (The Integrating Factor)
- Applications to electrical circuit problems and vibratory and oscillatory mechanical systems

- Solution Techniques for Higher Order ODE's
  - The General n^{th} Order ODE
  - Existence and Uniqueness of Solution of Linear Equations
  - Second Order Homogeneous ODE's with Constant Coefficients (auxiliary equation and method of variation of parameters)
  - Second Order Non-Homogeneous ODE's with Constant Coefficients (The Complimentary and Particular Solution, Method of Undetermined Coefficients)
  - Special Cases (Equations Reducible to 1^{st} Order or 2^{nd} Order with Constant Coefficients)
  - Applications to electrical circuit problems and vibratory and oscillatory mechanical systems
- Solutions of Systems of Linear First Order ODE's

2. Real Analysis

- Sequences - Definitions and Examples. Convergence of Sequences, Sequences of Real and Complex Numbers. Some Limit Theorems of Sequences.
- Series – Definition, Series as a Summation of Terms of a Sequence, Necessary Condition for Convergence, Sufficient Conditions for Convergence (Cauchy's n^{th} Root Test, D'Alembert Ratio Test, Comparison Test), Convergence of Series with Negative Terms, and Absolute Converge
- Power Series – Definitions, Maclaurin's and Taylor's Series and Approximations, Arithmetic Operations on Power Series (Sum, Products, Shifting of Summation Indices, and Differentiation), Convergence (Radius, Interval and Tests)
- Differentiability, Rolle's Theorem, The Mean Value Theorem, Cauchy's Mean Value Theorem, Proof of L'Hospital's
- Proof of the Fundamental Theorem of Calculus
- Riemann Integral-Definition and Characteristics
- Fourier Series – Motivation, Definition, Existence, Fourier Series of General Functions (of period 2π or arbitrary), Fourier Series of Odd and Even Functions, Half-Range Fourier Series Expansions, Determination of Fourier Series without Integration. Dirichlet's Theorem (Limit theorems). Application of Fourier Series to Electric Circuits.

3. Scientific Computing and Numerical Analysis using MATLAB and Spreadsheets

- Definition and Rationale for Scientific Computing
- Error Analysis
- Numerical Solutions of Polynomial Algebraic Equations, Interpolation Formulae
- Numerical Differentiation and Integration, Trapezoidal and Simpson's Rules of Integration
- Numerical Solutions of Ordinary Differential Equations: Euler method, Modified Euler method and Runge-Kutta

4. Complex Variable Analysis

- Complex Variable Analysis

- Functions of a Complex Variable
- Mapping and Conformal Mapping
- Line Integrals
- Cauchy-Goursat Theorem
- Taylor and Laurent Series
- Residue Theory
- Complex Analysis Applied to Potential Theory
- Z-Transforms

Learning Outcomes

On completion of this course the student will:

- Be able to formulate Ordinary Differential models associated with Electric Circuits
- Obtain analytical and numerical solutions of Ordinary Differential Equations;
- Have acquired the analytical ability critical to engineering problem solving

Recommended and Reference Books

[1] Martin M. Lipschutz, *Theory and Problems of Differential Geometry*, McGraw-Hill, 1969

[2] C. Ray Wylie and Louis C. Barrett, Advanced *Engineering Mathematics*, 6th ed., McGraw Hill, New York, 1995.

[3] Erwin Kreyszig, Advanced *Engineering Mathematics,* 8th ed., John Wiley and Sons.

[4] Murray R Spiegel, *Theory and Problems of Vector Analysis,* SI (Metric) ed., McGraw Hill

[5] Murray R. Spiegel, 1981. *Applied Differential Equations*. 3rd Edition. Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632

[6] Mary L. Boas, 1983. *Mathematical Methods in the Physical Sciences*. 2nd Edition. John Wiley & Sons, INC. New York

[7] G. Stephenson, 1988. *Mathematical Methods for Science Students*. 2nd Edition. Longman Group UK

[8] Thomas M. Creese and Robert M. Haralick, 1978. *Differential Equations for Engineers*. McGraw-Hill, N. Y. US

[9] Shepley L. Ross, 1966. *Introduction to Ordinary Differential Equations*. Blaisdell Publishing Company, Massachusetts, US.

[10] L. R. Mustoe, 1988. *Worked Examples in Advanced Engineering Mathematics*. John Wiley & Sons Ltd. Great Britain.