**EMT2101 Engineering Mathematics III**

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| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | 40 | 100 | 4 |

**Rationale**

Drawing from the concepts covered in Engineering Mathematics I and II, this course is designed to consolidate and advance analytical techniques for solution of ordinary differential equations; and introduces concepts fundamental to the study of other courses in Computer Engineering. The major themes covered include integral transforms, series solutions to ordinary differential equations and special functions. **Objectives**

 Introduce the student to Integral Transforms and their application to the solution of Ordinary Differential Equations

 Introduce the Power Series solution technique to Ordinary Differential Equations

 Expose the student to some special functions fundamental to engineering specifically Gamma, Beta, Bessel and Legendre

**Course Content**

***1. Fourier Integrals and Transformations***

 Motivation for the Fourier Integral

 Definition of Fourier Integral as a limit to the Fourier Series with period tending to infinity

 Conditions for existence of a Fourier Integral representation (Dirichlet’s conditions, Existence of the absolute integral for the entire real axis)

 Complex exponential Fourier Integral representation, Standard Fourier

Integral representation, Fourier Cosine and Sine Integral representations

 Definition of the Fourier Transform and its Inverse

 Frequency spectrum of periodic and continuous functions

 Distinction between the Fourier Transform and Integral

 Properties of the Fourier Transform Transform: Linearity, First Shift Theorem, Second Shift Theorem, t- duality, Time differentiation, Frequency Differentiation, Convolution, Correlation

 Fourier Transform of special functions: Delta function (Sifting property), Heaviside Step function,

 Applications: Parseval’s theorem, RCL circuits, Frequency shifting in

Communication theory (carrier signals and Antenna design)

 Solution of Ordinary Differential Equations with constant coefficients

***2. Laplace Transformations***

 Motivation for the Laplace transform

 Definition of the Laplace transform

 Comparison of the Laplace and Fourier Transforms

 Conditions for existence of the Laplace transform (Dirichlet’s conditions, Piecewise continuity of thee function)

 Properties of Laplace Transforms: Linearity, First Shift Theorem, Second Shift Theorem, Time differentiation, s-domain Differentiation, s-domain Integration

 Laplace Transforms of special functions: Delta function and Heaviside function

 Solutions of Ordinary Differential Equations by Laplace Transform

Techniques

 Solutions of Simultaneous Linear Ordinary Differential Equations with constant coefficients

 Applications in RLC Circuit Analysis

***3. Power Series Solutions to Ordinary Differential Equations***

 Motivation of the Power Series solution method

 Concept of the Power Series method (Ordinary points, Singular points)

 Series solutions about Ordinary points

 Series solutions about Regular Singular points (Method of Frobenius)

***4. Gamma and Beta Functions***

 Integral Definition of Gamma and Beta Functions

 Properties of Gamma and Beta Functions

 Generalisation of the factorial by Means of the Gamma function

 Relations Between Gamma and Beta Functions

 Definition of Gamma Function for Negative Values of Argument

***5. Bessel Functions***

 Bessel’s Equation and its Solutions.

 Familiarisation with Characteristics and Graphs of Bessel Functions

 Properties of Bessel Functions of the First Kind: Differentiation, Recurrence relationships, Generating functions

 Ordinary Differential Equations solvable using the notion of Bessel’s equations

 Integral Representations of Bessel Functions

 Integrals Involving Bessel Functions

 Laplace Transforms of Bessel functions

***6. Legendre Functions***

 Legendre’s Equation and its Solutions

 Legendre’s Polynomials; the Generating Function for Legendre’s

Polynomials; Orthogonality of Legendre’s Polynomials

 Rodriguez’s formula

 Orthogonality Relations for the Associated Legendre Functions,

 Familiarisation with Characteristics and Graphs of Legendre’s Polynomials and Associated Legendre Functions

 Integrals involving Legendre Polynomials

**Learning Outcomes**

On completion of this course the student should be able to:

 Demonstrate a firm understanding of the solution techniques for Linear Ordinary

Differential Equations, Properties of Integral Transforms and Special functions

 Use the Integral Transforms in Circuit Analysis

**References**

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*[4]* Mary L. Boas, 1983. *Mathematical Methods in the Physical Sciences*. 2nd

Edition. John Wiley & Sons, INC. New York

*[5]* Thomas M. Creese and Robert M. Haralick, 1978. *Differential Equations for*

*Engineers*. McGraw-Hill, N. Y. US

*[6]* L. R. Mustoe, 1988. *Worked Examples in Advanced Engineering*

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