YEAR III
SEMESTER - V

College of Biomedical Engineering & Applied Sciences

Microsyllabus

NUMERICAL METHODS

BEG 389 CO

Semester V **Year III**

Teaching Schedule Hours/Week			Examination Schedule						Total Marks	Remarks
			Final				Internal Assessment			
			Theory		Practical		Theory Marks	Practical Marks		
L	T	P	Duration	Marks	Duration	Marks				
3	1	2	3	80			20	50	150	

Course Objectives: To solve the engineering problems by using the theory of numerical computational procedures.

Unit 1: Introduction (2 hrs)

1.1 Introduction to numerical method

1.2 Needs of numerical method

1.3 Characteristics of numerical computing

1.4 Approximations and errors in computing

- 1.4.1 Significant digits
- 1.4.2 Errors
  - *1.4.2.1 Absolute and Relative errors*
  - *1.4.2.2 Round off errors*
  - *1.4.2.3 Truncation errors*
  - *1.4.2.4 General error formula*
- 1.4.3 Convergence of iterative processes
- 1.4.4 Minimizing the total error

Unit 2: Solution of Nonlinear Equations (8 hrs)

2.1 Introduction

2.2 Methods of solution

- 2.2.1 Direct analytical methods
  - Introduction
- 2.2.2 Graphical methods
  - Introduction
- 2.2.3 Trial and error methods
  - Introduction
- 2.2.4 Iterative methods
  - Introduction

2.3 Iterative methods

- 2.3.1 Starting and Stopping an iterative method
- 2.3.2 Bisection method
  - 2.3.2.1 Introduction
  - 2.3.2.2 Algorithm
  - 2.3.2.3 Derivation
  - 2.3.2.4 Problems
  - 2.3.2.5 Programming
- 2.3.3 Newton Raphson method
  - 2.3.3.1 Introduction
  - 2.3.3.2 Algorithm

2.3.3.3 Derivation
2.3.3.4 Problems
2.3.3.5 Programming
2.3.4 Secant method
2.3.4.1 Introduction
2.3.4.2 Algorithm
2.3.4.3 Derivation
2.3.4.4 Problems
2.3.4.5 Programming
2.3.5 Fixed point iteration
2.3.5.1 Introduction
2.3.5.2 Algorithm
2.3.5.3 Derivation
2.3.5.4 Problems
2.3.5.5 Programming
2.3.6 False position method
2.3.3.1 Introduction
2.3.3.2 Algorithm
2.3.3.3 Derivation
2.3.3.4 Problems
2.3.3.5 Programming

Unit 3: Curve Fitting: Interpolation and Regression (10 hrs)

3.1 Introduction
3.2 Polynomial forms
3.3 Methods of interpolation
3.3.1 Linear interpolation
3.3.1.1 Introduction
3.3.1.2 Derivation
3.3.1.3 Problem
3.3.1.3 Programming
3.3.2 Lagrange interpolation polynomial
3.3.2.1 Introduction
3.3.2.2 Derivation
3.3.2.3 Problem
3.3.2.4 Programming
3.3.3 Newton's divided difference interpolation for non-equidistant data points
3.3.3.1 Introduction
3.3.3.2 Problem
3.3.4 Newton-Gregory forward and backward interpolation
3.3.4.1 Introduction
3.3.4.2 Problem
3.3.5 Spline interpolation
3.3.3.1 Introduction
3.3.3.2 Problem
3.4 Least squares method of fitting continuous and discrete data or functions
3.4.1 Fitting linear equations
3.4.1.1 Introduction
3.4.1.2 Derivation
3.4.1.3 Problem
3.4.2 Fitting transcendental equations
3.4.2.1 Introduction
3.4.2.2 Derivation of the form $y=ax^b$, $y=ae^{bx}$
3.4.2.3 Problem
3.4.3 Fitting polynomial equations

3.4.1.1 Introduction
3.4.1.2 Derivation
3.4.1.3 Problem
3.4.4 Programming

Unit 4: Numerical Differentiation and Integration (5 hrs)

4.1 Introduction
4.2 Numerical differentiation
4.2.1 Differentiating Continuous Function
4.2.1.1 Forward Difference Quotient
4.2.1.2 Backward Difference Quotient
4.2.1.3 Central Difference Quotient
4.2.1.4 Comparison of Errors
4.2.1.5 Higher-Order Derivatives
4.2.2 Differentiating Tabulated Function
4.2.2.1 Two-point Forward Difference Quotient
4.2.2.2 Three-point Forward Difference Quotient
4.2.2.3 Three-point Backward Difference Quotient
4.2.2.4 Three-point Central Difference Quotient
4.2.2.5 Error Analysis
4.2.2.6 Higher-Order Derivatives
4.3 Numerical integration
4.3.1 Introduction
4.3.2 Trapezoidal Rule
4.3.3 Composite Trapezoidal Rule
4.3.4 Simpson's 1/3 Rule
4.3.5 Composite Simpson's 1/3 Rule
4.3.6 Simpson's 3/8 Rule
4.3.7 Higher Order Rules
4.3.7.1 Introduction
4.3.7.2 Boole's Rule
4.3.8 Problems
4.3.9 Programming
4.4 Numerical double integration
4.4.1 Introduction
4.4.2 Problem

Unit 5: Matrices and Linear Systems of Equations (10 hrs)

5.1 Introduction
5.2 Solution of linear systems-direct methods
5.2.1 Gauss elimination method (Basic)
5.2.1.1 Introduction
5.2.1.2 Algorithm
5.2.1.3 Problem
5.2.2 Gauss elimination method with pivoting
5.2.2.1 Introduction
5.2.2.2 Algorithm
5.2.2.3 Problem
5.2.3 Gauss-Jordan method
5.2.3.1 Introduction
5.2.3.2 Algorithm
5.2.3.3 Problem
5.2.4 LU decomposition method
5.2.4.1 Introduction
5.2.4.2 Algorithm
5.2.4.3 Problem

5.2.5 Programming
5.3 Solution of linear systems-interactive methods
5.3.1 Jacobi iteration method
5.3.1.1 Introduction
5.3.1.2 Algorithm
5.3.1.3 Problem
5.3.1.4 Programming
5.3.2 Gauss-Seidel method
5.3.2.1 Introduction
5.3.2.2 Algorithm
5.3.2.3 Problem
5.3.2.4 Programming
5.4 The Eigen value problems
5.4.1 Introduction
5.4.2 Problem

Unit 6: Numerical Solution of Ordinary Differential Equations (7 hrs)

6.1 Introduction
6.2 Euler's method for solving ordinary differential equations of 1^{st} order
6.3 Heun's Method
6.4 Fourth Order Runge-Kutta Method
6.5 Prediction-Corrector methods
6.5.1 Introduction
6.5.2 Milne-Simpson Method
6.5.3 Adams-Bashforth-Moulton Method
6.6 Simultaneous and higher order equations
6.7 Initial value problem
6.8 Boundary value problems
6.9 Programming

Unit 7: Numerical Solution of Partial Differential Equations (3 hrs)

7.1 Introduction
7.2 Finite-difference approximates to derivatives
7.3 Laplace's equation
7.4 Parabolic equation
7.5 Hyperbolic equation
7.6 Iterative methods for the solution of equations

Chapters	**Lectures (in hours)**	**Marks**
Unit 1: Introduction	2	0-5
Unit 2: Solution of Nonlinear Equations	8	10
Unit 3: Curve Fitting: Interpolation and Regression	10	10
Unit 4: Numerical Differentiation and Integration	5	10
Unit 5: Matrices and Linear Systems of Equations	10	10
Unit 6: Numerical Solution of Ordinary Differential Equations	7	10
Unit 7: Numerical Solution of Partial Differential Equations	3	10
Programming in C (Includes flow chart and algorithm)	-	15-20
Total	**45**	**80**

BIOMEDICAL EMBEDDED SYSTEM DESIGN

BEG 3C2 BM

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			Final				Internal Assessment			
			Theory		Practical		Theory Marks	Practical Marks		
L	T	P	Duration	Marks	Duration	Marks				
3	1	2	3	80			20	25	125	

SN	Chapters	Descriptions	Time, hrs	Hours	Weight
1	Unit 1. Background	Introduction to Embedded System	0.5	3	4
		Introduction to Real Time System • Feature of Real Time System	1		
		Architecture and design of an Embedded System	0.5		
		Example of Embedded system	1		
2	Unit 2. Hardware Fundamentals	Terminology • PCB • schematic diagrams • VCC • Ground	0.5	3	4
		Gates and its implementation in Practical consideration • Review of Gates(AND,OR,NOT, NAND,NOR)	0.5		
		Other Basic Consideration • Power and Decoupling • decoupling capacitor • Open Collector • Tri-Stating Outputs • Floating Signals ▪ Pull up Resistor ▪ Pull Down Resistor	1		
		Memory • ROM Design • SRAM Definition with circuit diagram • DRAM definition with circuit diagram	1		
3	Unit 3Advanced Hardware Fundamentals	Microprocessors Introduction	0.5	5	8
		Buses • Introduction • Bus Handshaking • No Handshaking • Wait state	1		
		DMA • Architecture of System with DMA	1.5		

		• Read Operation with timing Diagram • Write Operation with timing Diagram			
		Interrupts • Interrupts Connection • Operation	1		
		Timer • Watch dog Timer • Timer in watch mode • Timer in Counter mode	1		
4	Unit 4:Assembly Language Programming	Basic Concepts of MASM and NASM	0.5	6	Only used for Practical
		Optimization	2		
		Construction of Graphics Routine	2		
		Device Driver Concepts Examples	1		
		Recent Software Tools for ALP	0.5		
5	Unit 5. Microcontroller	Introduction	1	6	16
		Architecture of Microcontroller AT89c51/52/55 Architecture • Pin Diagram • Function of Pin			
		8255 PPI • Block Diagram • Interfacing with Microcontroller • Modes of operation • Example	1		
		Microcontroller Based Medical Instruments • Block Diagram and function of Medical Meter • Blood Pressure Monitor • End Scope • Infusion pump	4		
6	Unit 6. Embedded software Development Tools	Cross Assemblers	0.5	2	Only used for Practical
		Cross Compilers	0.5		
		Debuggers	0.5		
		Downloader	0.5		
7	Unit 7. System design with microcontrollers	Design and build a bioelectric amplifier • Block Diagram • Operation	3	10	24
		Pulse Oximeters • Block Diagram • Function	3.5		
		Doppler Ultrasound • Block Diagram and Design Consideration	3.5		
8	Unit 8. Emerging concept	VLSI • Introduction	1	10	24

		• Building blocks of VLSI system on chip			
		VLSI application in machine	1		
		VLSI sensors for biomedical signals • Block diagram of a generic VLSI sensor • Operation	1		
		VLSI design with VHDL/Verilog • PLD Design Flow Steps • Design Entry • State Diagram • HDL Code Entry • Compilation • Functional Simulation/ Verification • Synthesis • Implementation • Features of VHDL • Examples • Adder • Subtractor • Decoder • Encoder • Counter	7		
			Total	45	80

Laboratory:

1. Interfacing standard Parallel and serial port
2. Real life Projects with Microcontrollers
    a. Simple Flashing LED
    b. Flashing LED with Push Buttons
    c. Seven Segment Display Interfacing
    d. Keypad Interfacing
    e. Keypad with Seven Segment Display
    f. Stepper Motor Control
3. LCD Display using Microcontroller Programming
    a. Introduction to LCD and its Programming Protocols
    b. LCD with Microcontroller
    c. LCD programming with Keypad
4. System Interfacing with Microcontroller
    a. Serial Data Communication
    b. Interrupts and Interrupts Service routine
    c. ADC with Microcontroller
    d. Activity and Posture recorder
5. Interfacing on PIC Microcontroller
6. Simple projects on VHDL in FPGA Board

Project:

Students have to prepare one project using FPGA or Microcontroller related to Biomedical instruments.

Text Books:

1. Embedded System Primer, Simon
2. The 8051 microcontroller Architecture, Programming and Application, Kenneth J. Ayala
3. IBM PC Assembly Language and Programming, Peter Abel
4. The 8051 Microcontroller and Embedded System, Muhammad Ali Mazidi & Janice Gillispie Mazidi

Reference Books:

1. Biomedical Digital Signal Processing, Willis J. Tompking

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