I. Course Title : Systems Simulation and Computer Aided Problem Solving in Engineering

II. Course Code : FMPE 514

III. Credit Hours : 1+1

IV. Aim of the course

To give the student orientation in simulation of continuous and discrete systems especially using computer programme and software.

V. Theory

Unit I

Mathematical modeling and engineering problem solving: Conservation laws and engineering. Computers and software: Software development, structured programming, logical representation. Modular programming. Approximation: Round off errors, truncation errors, significant figures, accuracy and precision.

Unit II

Nature of simulation: Systems models and simulation, discreet event simulation, time advance mechanisms, components of discrete event simulation model, simulation of single server queuing system. Program organization and logic, development of algorithm. Simulation of an inventory system.

Unit III

Solving roots of equation using computers. Application in: Ideal and non-ideal gas laws, open channel flows, design of an electric circuit, vibration analysis. Solving linear algebraic equation on computers: Naïve Gauss Elimination, techniques for improving solutions, LU decomposition and matrix inversion. Application in: Steady state analysis of chemical reactors, statically determinate truss, current and voltage in circuits, spring mass systems.

Unit IV

Optimization techniques. Search techniques: Golden Sections, quadratic interpolation. Application: Optimum design of tank, least cost treatment of waste water, power transfer for circuits. Solving ordinary differential equation on computers: Modeling engineering systems with ordinary differential equation, solution techniques using computers.

VI. Practical

Comparison of analytical and numerical solutions using Spread sheet. Generation of random variables. Generation of discreet and continuous random variate-coding. Implementation of single server queue on computer. Exercises with software packages for roots of equation: Solving linear algebraic equation, curve fitting and optimization. Solving simultaneous equation through Gauss elimination, solving steady state analysis of chemical reactors, statically determinate truss, current and voltage in circuits, spring mass systems on computers. Application of ordinary differential equation to solve mixed reactor problems, predator prey models and chaos.

VII. Learning outcome

Ability to analyze problems from a systems perspective and apply the principles to simulation of continuous and discrete engineering systems.

VIII. Lecture Schedule

S.No.	Topic	No. of Lectures
1.	Introduction to mathematical modeling in engineering problem solving, comparison of analytical and numerical approaches.	1
2.	Conservation laws applied to engineering, modeling simple system	1
3.	Computer modeling, computing environments software development process.	1
4.	Modular design, top down design, structured programming, – algorithm design.	1
5.	Program composition, quality control- testing and documentation software strategy.	1
6.	Approximation- round off errors- accuracy and precision – definitions, number system in the computer- truncation errors.	1
7.	Nature of simulation, systems models and simulation.	1
8.	Discreet event simulation, time advance mechanisms, components of discreet event simulation model.	1
9.	Principles of simulation of singular server queuing system.	1
10.	Programme organization and logic for single server queuing system.	1
11.	Development of algorithm, single server queuing system.	1
12.	Solving roots of equation in computers, graphical method.	1
13.	Developing algorithm for bisection method, false position method.	1
14.	Application of roots of equation to gas laws, open channel flows.	1
15.	Application of roots of equation to electric circuits, vibration analysis.	1
16.	Solving linear algebraic equation in engineering practices.	1
17.	Developing algorithm for Gaussian elimination.	1
18.	Pitfalls of elimination methods and remedies.	1
19.	Overview of LU decomposition.	1
20.	LU decomposition algorithms, calculating inverse of matrix.	1
21.	Application of linear algebraic equation to statically determinate truss.	1
22.	Application of linear algebraic equation to Circuit analysis.	1
23.	Application of linear algebraic equation to spring mass system.	1
24.	Introduction to optimization in engineering, Formulation of Problems.	1
25.	One dimensional unconstrained optimization, development of algorithm for golden sections.	1
26.	One dimensional unconstrained optimization quadratic interpolation.	1
27.	Application of optimization to design of tank.	1
28.	Application of optimization to waste water treatment problem.	1
29.	Application of optimization to power transfer circuits.	1
30.	Formulating engineering problems using ordinary differential equation.	1
31.	Solving ordinary differential equation using computers, Euler's method.	1
32.	Solving ordinary differential equation using modeling engineering systems, computers, Runge-kutta method.	1
	Total	**32**

IX. List of Practicals

S.No.	Topic	No. of Practicals
1.	Exercises in developing simple programmes in C.	1
2.	Demonstration of solutions using analytical and numerical methods for simple problems.	1
3.	Development of programmes for generation of random variables.	1
4.	Writing programme for generating random variates.	1

S.No.	Topic	No of Practicals
5.	Writing programme for event advance mechanism of single server queuing system.	1
6.	Writing programme for arrival module of single server queuing system.	1
7.	Writing programme for departure module of single server queuing system and statistical performance.	1
8.	Writing programme for solution of roots of equation.	1
9.	Solving simple engineering problems using roots of equation.	1
10.	Development of algorithm for Gaussian elimination.	1
11.	Application of Gaussian elimination to mass balance problems and statically determinate truss.	1
12.	Application of Gaussian elimination to analysis of electrical circuits.	1
13.	Development of algorithm for Golden Sections and application.	1
14.	Application of optimization technique to design of tank.	1
15.	Application of optimization technique to waste water treatment.	1
16.	Predator prey models and chaos.	1
	Total	**16**

X. Suggested Reading

- Balagurusamy E. 2000. *Numerical Methods.*Tata McGraw Hill Publishing Company limited, New Delhi.
- Chapra SC and Canale RP. 1994. *Introduction to Computing for Engineers*. 2nd Edition McGraw Hill International Edition, New York.
- Dent JB and Blackie MJ. 1979. *System Simulation in Agriculture.* Applied Science Publishers Ltd., London.
- Law AM. 2015. *Simulation Modeling and Analysis.* McGraw Hill International Edition, New York.
- Schilling RJ and Harries SL. 2002. *Applied Numerical Methods for Engineers Using MATLAB and C.*Thomson Asia Pvt. Ltd. Singapore.
- Veerarajan T and Ramachnadran T. 2004. *Numerical Methods with Programmes in C and C++.* Tata McGraw Hill Publishing company limited, New Delhi.

I. Course Title : Computer Aided Design of Machinery

II. Course Code : FMPE 515

III. Credit Hours : 0+2

IV. Aim of the course

To learn the practice of designing components and assemblies based on computer aided drafting technique.

V. Practical

Learning 2D drafting: Controlling display settings, setting up units, drawing limits and dimension styles. Drawing and dimensioning simple 2D drawings, keyboard shortcuts. Working with blocks, block commands. Exercise in simple assembly in orthographic. Exercise in measuring and drawing simple farm machinery parts. Learning 3D Drafting: Advantages of virtual prototyping-starting the 3D drafting environment, self learning tools, help and tutorials. Familiarizing with user interface, creating files and file organization, structuring and streamlining. Features of document window. Concept of coordinate system: Working coordinate system, model coordinate system, screen coordinate system, graphics exchange standards and