GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. SEMESTER : VIII

ELECTRICAL & ELECTRONICS ENGINEERING

Subject Name: **MODELLING AND SIMULATION TECHNIQUES**

Sr. No.	Course Contents	Total Hrs
	Preamble: This elective course is unique in its scope and emphasis, and provides a solid grounding in modelling tools that can be applied not only to electrical engineering problems, but also to a variety of other problems addressed by engineering graduates. Modelling and simulation are a vital part of many areas of engineering, allowing engineers to reason about the expected behaviour of a system without having to physically implement it. Simulation pervades much of electrical engineering, for example models of individual electronic devices, circuit simulation, network modelling, compression of speech/audio/image/video signals, design of biomedical devices, and modelling of physical systems for control purposes. The aim of the course is to provide a thorough grounding in aspects of constructing and applying models and their simulation using a well-known simulation package Simulink® (MATLAB and Simulink are registered trademarks of The MathWorks, Inc.). In particular, the course looks at how continuous-time systems can be represented and simulated using (discrete-time) computers. This also provides an interesting insight into the relationship between physical systems and computing algorithms. The course is designed to have a strong practical focus, with extensive laboratory work serving to develop key skills in computing and applications of mathematics.	
1.	**Introduction to Modelling and Simulation:** Simulink Software Basics, Starting Simulink Software, Simulink User Interface, Getting Help with Simulink Software, Simulation programming in MATLAB,	**4**
2.	**Modelling Dynamic Systems:** Block Diagram Semantics, Creating Models, Time, States, Block Parameters, Tunable Parameters, Block Sample Times, Custom Blocks, Systems and Subsystems, Signals, Block Methods, Model Methods	**4**
3.	**Simulating Dynamic Systems:** Model Compilation, Link Phase, Simulation Loop Phase, Solvers, Zero-Crossing Detection, Algebraic Loops, techniques to try to eliminate an algebraic loop, Understanding Circuits as dynamic systems, Understanding Transfer functions, poles and zeroes, Numerical solutions to differential equations, meaning of time-based block diagrams, Runge-Kutta method,	**8**
4.	**Modelling Best Practices:** General Considerations when Building Simulink Models, Modelling a Continuous System, Best-Form Mathematical Models, Series RLC Example, Solving Series RLC Using Resistor Voltage, Solving Series RLC Using Inductor Voltage,	**8**
5.	**Modelling Physical Networks with SimElectronics Blocks:** Overview of SimElectronics Libraries, Overview of DC Motor Example, Selecting Blocks to Represent System Components, Building the Model, Specifying Model Parameters, Configuring the Solver Parameters, Running the Simulation and Analyzing the Results, Overview of Triangle Wave Generator Example, Selecting Blocks to Represent System Components, Building the Model, Specifying Model Parameters, Configuring the Solver Parameters and running the Simulation and Analyzing the Results	**8**

6.	**Modelling Electronic Components:** Parameterizing Blocks, Additional Parameterization Workflows, Adding SimElectronics Blocks to a Model, Connecting Model Blocks, Selecting the Output Model for Logic Blocks,	**6**
7.	**Simulating an Electronic System:** Selecting a Solver, Specifying Simulation Accuracy/Speed Trade-off, Avoiding Simulation Issues, Running a Time-Domain Simulation, Running a Small-Signal Frequency-Domain Analysis	**6**

Laboratory & Assignments:

- Hands-on experience of MATLAB and SIMULINK and Model editing tools
- Hands-on experience of Modelling Dynamic Systems and Creating Models
- To model the equation that converts Celsius temperature to Fahrenheit
- To model Series RLC circuit to solving for either the resistor voltage or inductor voltage.
- To create any Simulink model that includes electronic or electromechanical components.
- To study model of a DC motor driven by a constant input signal that approximates a pulse-width modulated signal and look at the current and rotational motion at the motor output.
- Modelling Electronic Components
  a. Parameterizing a Piecewise Linear Diode Model
  b. Parameterizing an Exponential Diode from a Datasheet
  c. Parameterizing an Exponential Diode from a SPICE Netlist
  d. Parameterizing an Op-Amp from a Datasheet

Text Books:

1. Klee, H., "Simulation of Dynamic Systems with MATLAB and Simulink", CRC Press, 2007.
2. Woods, R. L., and Lawrence, K. L., "Modelling and simulation of dynamic systems", Prentice-Hall, 1997.

Reference Books:

Unfortunately there is no single text that covers all topics in a satisfactory depth. Additional references, listed below and MATLAB help and user manuals, will in combination provide complete coverage of the course.

1. MATLAB, Simulink®, SimElectronics® User's Guide http://www.mathworks.com
2. Alexander, C. K., and Sadiku, M. N. O. (2007). Fundamentals of Electric Circuits, McGraw-Hill, New York.
3. Bobrow, L. S. (1987). Elementary Linear Circuit Analysis, Holt, Rinehart and Winston, New York.
4. Van den Bosch, P. P. J., and Van der Klauw, A. C., "Modelling, Identification and Simulation of Dynamical Systems", CRC Press, 1994.
5. Gershenfeld, N. "The Nature of Mathematical Modelling, Cambridge University Press, Cambridge, UK, 1999.