Course Syllabus
Gyanmanjari Institute of Technology
Semester – 3

Subject: Simulation Tools Practice – BETEE10201

Type of course: Skill Enhancement Course (SEC)

Prerequisite: Basic knowledge of computer

Rationale:

This course provides hands-on experience with simulation tools used in electrical engineering. Students will learn to model, simulate, and analyze electrical circuits and systems using industry-standard software. The course covers both fundamental concepts and advanced techniques, emphasizing practical applications in various sub-disciplines of electrical engineering.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	100
0	0	4	2	0	0	10	40	50	

Legends: CI-Class Room Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment;

Course Content:

Sr. No.	Course Content	% Weightage
1	**Introduction to Simulation Tools** • Overview of simulation in electrical engineering • Introduction to key simulation software (e.g., MATLAB/Simulink, PSIM, Multisim) • Installation and basic setup of simulation environment	05%
2	**Basic Circuit Simulation** • Simulation of DC and AC circuits • Transient and steady-state analysis • Simulation of resistive, capacitive, and inductive components • Introduction to SPICE (Simulation Program with Integrated Circuit Emphasis)	15%
3	**Advanced Circuit Analysis** • Nonlinear circuit simulation (diodes, transistors) • Frequency response analysis (Bode plots, Nyquist plots) • Harmonic analysis and distortion • Noise analysis in circuits	20%
4	**Digital & Mixed-Signal Circuit Simulation** • Simulation of digital circuits and logic gates • Mixed-signal simulation (combining analog and digital circuits) • Timing analysis and signal integrity in digital circuits	15%
5	**Power Electronics Simulation** • Simulation of power converters (DC-DC, AC-DC, DC-AC)) • Thermal analysis and efficiency optimization • EMI/EMC (Electromagnetic Interference / Compatibility)	15%
6	**Renewable Energy & Power System Simulation** • Simulation of renewable energy systems (solar, wind)	25%

	• Power system analysis (load flow, fault analysis) • Smart grid and distributed generation simulations	
7	**Capstone Project** • Comprehensive project involving the simulation and analysis of a complex electrical system • Presentation and defense of project findings	05%

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**Collaborative Project Design:** In groups, design a complete electrical system for a small commercial building. Each group member is responsible for a different aspect (e.g., lighting, power distribution, data systems)	10
2	**Real-World Problem Solving:** Analyze a provided faulty electrical schematic and identify and correct the errors. Document the errors and the steps taken to correct them	10
3	**Custom Symbol Creation and Implementation:** Create a custom symbol library for specialized components not available in the standard library. Use these symbols in a schematic for a specific project.	10
4	**Simulation and Analysis:** Design a circuit in PSIM and then import it into an electrical simulation tool. Perform a basic analysis and report the findings	10
5	**Industry Standards Application**: Research and apply the latest industry standards and codes (e.g., NEC, IEC) to an electrical design project. Prepare a report detailing how the design complies with these standards.	10
Total		**50**

Suggested Specification table with Marks (Theory): NA

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	NA	NA	NA	NA	NA	NA

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes:

After learning the course the students should be able to:	
CO1	Master industry-standard simulation tools for electrical circuit modeling and analysis
CO2	Apply theoretical concepts to accurately simulate and optimize electrical systems
CO3	Design and analyze complex electrical systems using advanced simulation techniques
CO4	Integrate simulation into real-world engineering projects with effective documentation and communication

List of Practicals:

Sr. No.	Descriptions	Unit. No	Hrs
1	Model and analyze simple DC circuits using simulation tools	1	2
2	Simulate and analyze AC circuits, including impedance and phasor analysis	1	2
3	Study the transient response of RC and RL circuits using time-domain simulations.	1	2
4	Analyze the frequency response of circuits using Bode plots and Nyquist plots.	2	2
5	Use SPiCE to simulate and analyze resistor networks for voltage and current distributions.	2	2
6	Model and analyze the I-V characteristics of diodes in various configurations	2	2
7	Simulate common-emitter and common-collector amplifier configurations and analyze their performance	3	2

8	Design and simulate digital logic circuits using gates and flip-flops	3	2
9	Implement and analyze mixed-signal circuits that combine analog and digital components	3	2
10	Simulate basic DC-DC converters (buck, boost) and analyze efficiency and performance	4	2
11	Design and simulate digital filters (low-pass, high-pass) and analyze their frequency response	4	2
12	Implement a PID controller in a simulation environment and analyze its response to step inputs	4	2
13	Use simulation tools to model the electromagnetic fields around transmission lines or antennas	5	2
14	Conduct thermal simulations for power devices and analyze heat dissipation	5	2
15	Simulate and analyze three-phase systems, including load flow and fault analysis	5	2
16	Model a photovoltaic system and simulate its performance under varying conditions	6	2
17	Analyze a wind turbine system, focusing on energy output and efficiency	6	2
18	Simulate smart grid components and analyze their interaction with renewable energy sources	6	2
19	Design a simple PCB layout and simulate its performance, considering parasitic effects	7	2
20	Develop a comprehensive simulation project that integrates multiple concepts learned throughout the course	7	2

Instructional Method:

- Introduce theoretical concepts and basic principles of Simulation and electrical drafting.
- Follow up with live demonstrations of Simulation software.
- Combine PowerPoint presentations with real-time software demonstrations.
- Provide practical, hands-on experience using Simulation software.
- Schedule regular lab sessions with guided step-by-step lab instructions.
- Encourage collaboration, communication, and teamwork through group projects.
- Assign roles to each member in projects, such as component placement, wiring, or documentation.
- Engage students in assignments requiring critical thinking and problem-solving.
- Design tasks like analysing and correcting faulty schematics, creating custom symbols, and simulating electrical circuits. Provide instructional content (videos, readings) for pre-class review.
- Use class time for interactive exercises, Q&A sessions, and collaborative activities.

- Present real-world case studies to show Simulation application in electrical engineering.
- Have students work on similar projects, analysing challenges and solutions.
- Integrate simulation tools with Simulation for design analysis and validation.
- Teach students to use these tools for verifying and improving their electrical designs.

Reference Books:

[1] "The SPICE Book" by Andrei Vladimirescu

[2] "Circuit Simulation with SPICE OPUS: Theory and Practice" by Tadej Tuma and Árpád Buermen

[3] Access to software tutorials and online resources

Software:

- MATLAB/Simulink
- PSIM
- Multisim
- ANSYS
- FEMM
- Lab facilities equipped with necessary hardware for simulation validation