GUJARAT TECHNOLOGICAL UNIVERSITY

MECHATRONICS (20)
SIMULATION AND DESIGN TOOLS
SUBJECT CODE: 2132002
B.E. 2nd YEAR

Type of Course: Engineering

Prerequisite: NA

Rationale: This subject is related to the simulation tools available for various electronics devices used in Mechatronics engineering. The basic concept of working principles and other characterization of electronics elements will be taught in this subject through practically with the help of simulation using different soft-wares.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	PA (V)		PA (I)	
						ESE	OEP		
0	0	3	3	0	0	50	30	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE End Semester Examination; PA- Progressive Assessment.

Content for Experiments / Practicals:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	**Introduction to SPICE** Introduction to PSpice software, file types, netlist commands. Basic analyses: DC, AC, Transient. Analog behavioral models (ABM): equations setup, IF statement, voltage/current/ frequency dependent sources. Advanced analyses: noise, Monte-Carlo, worst-case. Spectral description of signals (FFT), measuring the total harmonic distortion (THD). Circuit optimization using PSpice Optimizer software. Models of resistor, capacitor, inductor, energy sources (VCVS, CCVS, Sinusoidal source, pulse, etc), transformer, DIODE, BJT, FET, MOSFET, etc. sub circuits.	18	50%
2.	**Introduction to PCB DesignUsing OrCAD, Altium, Eagle, PowerPCB or others Package** • Principles of circuit design, design tools, layout techniques. • Characteristics and materials of printed boards, layout and simulation • PCB Fabrication : Mechanical production, pick and place, conventional components and	3	8.33%

	• SMD, via and • Plated through connections, soldering, surface coating, multilayer boards, thermal effects. • HYBRID PCBs: Thick film and thin film technology, material properties and fabrication. • PACKAGING: Packaging of ICs, PCBs and hybrids, cases and thermal effects.		
3.	**Introduction to MATLAB** **Learning objectives** Introduction to Matlab, study of matlab functions. Writing simple programs using matlab, for handling arrays, files, plotting of functions etc. Writing M files for Creation of analog & discrete signals, plotting of signals etc. Filtering of analog & digital signals using convolution. Generation of noise signals (Gaussian, random, Poisson etc) Simulation using Simulink.	15	41.67%

Reference Books:
Online help and tutorials are available for study purpose.

Course Outcomes:
Students will learn the following at the end of this course.
CO1: Simulation and analysis of circuits based on resistor, capacitor, inductor, energy sources, DIODE, BJT, FET, MOSFET
CO2: Writing simple programs and M-files using MATLAB, for handling arrays, files, plotting of functions, signal generation and signal processing.
CO3: to design, carry out simulation and manufacture the printed circuit board.

Open Ended Problem:
Student may be asked to
a) Select any complex circuit(e. g Control project),simulate that project circuit in any simulator and make its single/double layer PCB design.
b) Make MATLAB GUI for control systems (e.g. Stepper motor control etc).

Major Equipments:
Workstations with simulation software to be used in labs and PCB design kit.
For PSPICE: Laboratories should include
Simulation of following circuits using spice (Schematic entry of circuits using standard packages Analysis- transient, AC, DC, etc.):
a) Potential divider.
b) Integrator & Differentiator (I/P PULSE) – Frequency response of RC circuits.
c) Diode, BJT, FET, MOSFET Characteristics.
d)Simulate and study half-wave, full-wave, and bridge-rectifier using PSPICE windows
e) Simulate and study diode clipper and clamper circuits using PSPICE windows
f) Voltage Regulators.
g) Simulate and study emitter bias and fixed bias BJT and JFET circuits using PSPICE Windows, and determine quiescent conditions.
h) Simulate a common emitter amplifier using self biasing and study the effect of variation in emitter resistor on voltage gain, input and output impedance using PSPICE windows.

i) Determine the frequency response of Vo/Vs for CE BJT amplifier using PSPICE windows. Study the effect of cascading of two stages on band width.

j) Simulate and study Darlington pair amplifier circuit using PSPICE windows and determine dc bias and output ac voltage.

k) Simulate RC Coupled amplifiers - Transient analysis and Frequency response.

l) Simulate FET & MOSFET amplifiers.

m) Simulate Multi-vibrators.

n) Simulate Oscillators (RF & AF).

o) Study an operational amplifier using PSPICE windows and find out: CMMR, gain band width product, slew rate, 3-db frequency, and input offset voltage.

p) Simulate and study active low pass, high pass, and band pass filters using PSPICE windows.

q) Simulate and study class A, B, C, and AB amplifier using PSPICE windows.

r) Study the operation of 555 timer oscillator using PSPICE.

s) Simulate logic expression..and determine its truth table.

t) Simulate logic expression of full adder circuit and determine its truth table.

u) Simulate a synchronous 4-bit counter and determine its count sequence.

v) Simulate a master-slave flip-flop using NAND gates and study its operation. Study the operation of asynchronous preset and clear.

For PCB design: Laboratories should include
- Schematic Entry
- Netlist Creation
- Working with component libraries
- Design of Boards
- Layout of Parts
- Optimizing Parts Placements
- Pads and Via
- Manual and Auto Routing
- Handling Multiple Layers

For MATLAB: Laboratories should include
- Design of analog low pass, bandpass, high pass and band elimination filters using Butterworth, Chebyshev etc.
- Anti-aliasing filters
- Bode plot
- Steady state and Transient analysis
- Z Transforms
- Fourier Analysis

Active learning Assignments (AL) : Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.