Skill Enhancement Courses (SEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EC21	PCB Design	FC			2	2	50	50	100	-
2501EC94	Soft Computing Tools	IC			2	2	50	50	100	-
2501EC15	Android Applications	AC			2	2	50	50	100	-
2501EC16	ECAD Tools	AC			2	2	50	50	100	VLSI
2501EC17	Verification using Verilog & UVM	AC			2	2	50	50	100	VLSI
Total					**10**	**10**				

Skill Enhancement Courses (SEC)

PCB Design

Course Code:2501EC21	L	T	P	C
	0	0	2	2

Course Outcomes:

At the end of the course, student will be able to:

- **CO1:** Illustrate the equipment and components used in PCB design.
- **CO2:** Apply the procedural steps for PCB preparation.
- **CO3:** Make use of chemicals for Etching process.
- **CO4:** Make use of Soldering gun for components mounting.
- **CO5:** Construct PCB for different circuits.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	2	2	-	1
CO2	2	2	-	-	-	-	-	2	2	-	1
CO3	2	2	-	-	-	-	-	2	2	-	1
CO4	2	2	-	-	-	-	-	2	2	-	1
CO5	2	2	2	-	-	-	-	2	2	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	1
CO2	-	1
CO3	-	1
CO4	-	1
CO5	-	1

Practice:

1. Study of LaboratoryEquipments and Electronic components: (1 Week)
   a) CRO
   b) Digital Multimeter
   c) Function Generator
   d) Regulated Power Supply
   e) Active Components (Diode, BJT, ICs)
   f) Passive Components (Resistors, Capacitors, Inductors)
   g) Breadboard
   h) Soldering Gun
   i) Sensors
2. Study of PCB Design and Fabrication Using Autodesk EAGLE Tool and Toner Transfer (Ironing) Method (1 Week)
   a) Schematic Design in EAGLE software
   b) PCB Layout Design
   c) Artwork Generation

d) Toner Transfer (Ironing) Method
e) Etching and Drilling of PCB.
f) Component Mounting & Soldering
g) Continuity Check & Testing

List of Experiments:

1. Design, Fabrication and Verification of PCB for Diode as a Switch Circuit (2 Weeks)
2. Design, Fabrication and Verification of PCB for Bridge Rectifier Circuit (2 Weeks)
3. Design, Fabrication and Verification of PCB for Transistor as a Switch Circuit (1 Week)
4. Design, Fabrication and Verification of PCB for Common Emitter (CE) Amplifier (2 Weeks)
5. Design, Fabrication and Verification of PCB for Astable Multivibrator Using IC 555 (2 Weeks)
6. Design, Fabrication and Verification of PCB for 4-Bit Up Counter Using IC 74×393 (1 Week)

Cornerstone Projects:

1. **Touch-Based ON/OFF Switch**

   Description: Design and fabricate a touch switch circuit using a touch sensor / transistor logic to turn a load ON or OFF by human touch. Implement the circuit on a PCB.

   Expected Outcome: A working PCB-based touch switch that toggles output on every touch.

2. **Automatic Night Lamp using LDR**

   Description: Design and fabricate an automatic night lamp circuit using an LDR to sense ambient light and a transistor/driver stage to switch an LED/lamp ON in darkness and OFF in daylight. Set the switching level using a preset/potentiometer and implement the complete circuit on a PCB.

   Expected Outcome: A working PCB-based night lamp that turns ON automatically at low light and OFF automatically in bright light, with proper demonstration and explanation of LDR sensing and switching operation.

3. **Clap-Activated Relay Switch**

   Task Description: Design and fabricate a clap-activated relay switch using a microphone sensor, signal conditioning stage, and a 555 timer to toggle a relay when a clap sound is detected. Implement the complete circuit on a PCB.

   Expected Outcome: A working PCB-based clap switch in which the relay turns ON/OFF with each clap, suitable for controlling a small load, and students are able to explain the sensing, triggering, and relay operation during viva.

4. **Water Level Indicator with Buzzer**

   Description: Design and fabricate a water level indicator using level sensing probes and a simple transistor/IC-based switching circuit to detect water at preset levels and activate a buzzer/LED indication. Implement the complete circuit on a PCB.

   Expected Outcome: A working PCB-based water level indicator that gives a clear alarm/indication when water reaches the selected level(s), and students are able to explain the sensing method and buzzer operation.

5. **Rain Alarm Indicator**

   Description: Design and fabricate a rain alarm circuit using a rain sensor/probe plate to detect water droplets and a transistor/driver stage to activate a buzzer/LED alert. Implement the complete circuit on a PCB.

   Expected Outcome: a working PCB-based rain alarm that gives an alarm indication when rain is detected and students are able to explain the sensing and switching operation.

6. **Fire Alarm Indicator**

   Description: Design and fabricate a fire alarm circuit using a temperature sensor / thermistor to detect abnormal heat levels and a transistor/IC-based switching stage to activate a buzzer/LED alert. Implement the complete circuit on a PCB.

   Expected Outcome: A working PCB-based fire alarm that produces an alarm indication when high temperature is detected, and students are able to explain the sensing and alarm operation.

7. **IR-Based Object Detection Alarm**

   Description: Design and fabricate an IR object detection alarm using an IR transmitter and IR receiver to sense the presence of an object and a driver stage to activate a buzzer/LED alert. Implement the complete circuit on a PCB.

   Expected Outcome: A working PCB-based IR alarm that gives an alert when an object is detected, and students are able to explain the IR sensing and switching operation.

8. **Invisible Burglar Alarm**

   Description: Design and fabricate an invisible burglar alarm using an infrared beam pair (IR transmitter and receiver) placed across an entry path. Interruption of the invisible beam triggers a driver circuit to activate a buzzer/LED alert. Implement the complete circuit on a PCB.

Expected outcome: A working PCB-based invisible burglar alarm that gives an alert when the IR beam is interrupted and students are able to explain the beam sensing and alarm operation.

9. **Electronic Dice**

   Description: Design and fabricate an electronic dice circuit using a 555 timer / clock generator and counter or logic ICs to generate random numbers from 1 to 6, which are displayed using LEDs or 7-segment display. Implement the complete circuit on a PCB.

   Expected Outcome: A working PCB-based electronic dice that displays a random number between 1 and 6 on each trigger, and students are able to explain the clocking, counting, and display operation.

10. **Simple Audio Amplifier**

    Description: Design and fabricate a simple audio amplifier using a transistor or audio amplifier IC to amplify a low-level audio signal from a microphone to drive a speaker. Implement the complete circuit on a PCB.

    Expected Outcome: A working PCB-based audio amplifier that produces a clear and audible output sound and students are able to explain the amplification principle and circuit operation.

11. **Wireless Call Bell**

    Description: Design and fabricate a wireless call bell system with a transmitter unit (push button + RF module) and a receiver unit (RF module + buzzer/indicator). When the button is pressed at the transmitter, the receiver activates the bell/buzzer. Implement the circuit on a PCB.

    Expected Outcome: A working PCB-based wireless call bell in which pressing the transmitter button produces a clear buzzer/alert at the receiver, and students are able to explain the transmitter–receiver operation and working during viva.

12. **LED Chaser Circuit using 555 Timer and CD4017**

    Description: Design and fabricate an LED chaser circuit using a 555 timer to generate clock pulses and a CD4017 counter to switch LEDs sequentially. Control the chasing speed using RC components or a potentiometer and implement the complete circuit on a PCB.

    Expected Outcome: A working PCB-based LED chaser in which LEDs glow one after another with adjustable speed, and students are able to explain the working of the 555 timer and CD4017.

Guidelines for Cornerstone Project:

- The Cornerstone Project is to be carried out batch-wise with three students in each batch.
- Each batch may select any one of the above prescribed projects or a project of their own choice with the prior permission of the Course instructor.
- The selected project must be implemented strictly using PCB design and fabrication techniques learned in the laboratory.
- The project must be fully completed and ready for demonstration on the day of the external examination.
- The Semester End Examination (SEE) – Lab shall be evaluated for 50 marks based on video presentation, project demonstration, project report, and viva-voce as follows.

Component	Description	Marks
Video Presentation	The video presentation should consist of the working procedure of the project along with contribution of each student for a minimum of 2 minutes.	10
Project Demonstration	During the external examination, the batch shall demonstrate their working model in proper working condition and explain it using charts, posters, or other suitable visual aids.	20
Project Report	Submission of project report in the prescribed format.	10
Viva-Voce	Oral examination based on the project work and PCB fundamentals.	10
	Total Marks	**50**

Reference Books:

1. Printed Circuits Handbook,Clyde F. Coombs Jr., Happy T. Holden, Seventh Edition, McGraw Hill publications, ISBN: 978-0071833950.
2. PCB Design and Layout Fundamentals for EMC, RogerHu, 2019, ISBN:978-1082079252.
3. The Hitchhiker's Guide to PCB Design, David Ruff, Mike Brown, Cadence Documents, ISBN:978-0368246968.

Web Links:

1. http://www.nptelvideos.com/lecture.php?id=14721 by Prof. Santhanu Bhattacharya, IIT, Kanpur

Soft Computing Tools

	L	T	P	C
Course Code: 2501EC94	**0**	**0**	**2**	**2**

Course Outcomes:

At the end of the Course, Student will be able to:

CO1: Perform basic matrix operations and random data manipulation using MATLAB.
CO2: Make use of MATLAB to generate Gaussian noise and compute its basic statistical measures.
CO3: Design filters with the help of Simulink toolbox.
CO4: Apply the concepts of convolution and filters to remove noise.
CO5: Utilize the Fuzzy tool box to perform different operations

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2			2			2	2		1
CO2	2	2			2			2	2		1
CO3	2	2			2			2	2		1
CO4	2	2			2			2	2		1
CO5	2	2			2			2	2		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	
CO2	1	
CO3	1	
CO4	2	
CO5	1	

Practice:

1. Create a 10x10 random matrix with the command A= rand (10). Now do the following operations.
    a. Multiply all elements by 100 and then round off all elements of the matrix to integers with the command A=fix(A).
    b. Replace all elements of A<10 with Zeros.
    c. Replace all elements of A>90 with infinity (int).
    d. Extract all $30 \leq a_{ij} \leq 50$ in a vector b, that is find all elements between 30 and 50 and put them in a vector b.
2. Generation of Gaussian noise (Real and Complex), Computation of its mean, Variance, Mean Square Value and Probability Distribution Function.
3. Removal of noise by Autocorrelation / Cross correlation.

4. Removal of noise by Filters (Wiener/LMS).
5. Introduction to Simulink toolbox
6. Design of Filters using Simulink (LPF, HPF, BPF, BRF)
7. Introduction to Fuzzy Logic toolbox
8. Write a program in MATLAB to perform Union, Intersection and Complement operations.
9. Write a program using Fuzzy Logic to perform arithmetic and Logic Operations
10. Write a program in MATLAB to implement De-Morgan's Law.
11. Write a program in MATLAB to plot various membership functions.
12. Implement Fuzzy Inference System (FIS)

Additional Practice:

1. Identify a relevant problem in your domain and develop an appropriate solution using the Simulink toolbox, applying the knowledge you have gained so far.
2. Identify a relevant problem in your domain and develop an appropriate solution using the Fuzzy Logic toolbox, applying the knowledge you have gained so far.

Web Links:

1. Soft Computing Tools in Engineering (iitkgp.ac.in)

Android Applications

Course Code:2501EC15	L	T	P	C
	0	0	2	2

Course Outcomes:

At the end of the course, student will be able to:

- **CO1:** Utilize the android studio for a mobile application
- **CO2:** Demonstrate the android application
- **CO3:** Develop the android User Interface
- **CO4:** Make use android app for gaming apps
- **CO5:** Demonstrate home automation using android app

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1	-	1	-	-	1	1	-	1
CO2	2	3	1	-	1	-	-	1	1	-	1
CO3	2	2	1	-	1	-	-	1	1	-	1
CO4	2	2	3	-	2	-	-	1	1	-	1
CO5	2	2	3	-	2	-	-	1	1	-	1

Practice:

1. Familiarization with Kotlin programming.
2. Familiarization with Android Studio.
3. Creation of "Hello World" Android App, Running on Android Emulator, connecting the Android device.
4. Basic UI design.
5. Layout design.
6. Advanced UI design
7. JetPack Compose App Design.
8. Accessing Mobile sensors data in android app.
9. API Design.
10. Simple Game App design.

Additional Practice:

1. Android App Compose UI Testing.
2. Write a mobile application that makes use of RSS feed.

Reference Books:

1. Android application development all-in-one for dummies by Burd B. John Wiley & Sons, 2021, ISBN:978-9354245787.

Web Links:

1. https://developer.android.com/courses
2. Udemy Android App Development - Complete Course online https://www.udemy.com/topic/android-development/
3. Coursera Android app development specialization course https://www.coursera.org/specializations/android-app-development

ECAD Tools

	L	T	P	C
Course Code:2501EC16	**0**	**0**	**2**	**2**

Course Outcomes:

At the end of the course, student will be able to:

- **CO1:** Comprehend the insight of CAD Tools in modern design.
- **CO2:** Develop combinational logic circuits by using CAD tools.
- **CO3:** Build sequential logic circuits using Verilog HDL operators.
- **CO4:** Analyze the performance of logic schematics using CAD simulation tools.
- **CO5:** Infer the performance of logic circuits using DRC, LVS and PEX.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-		2	-	-	1	1	-	1
CO2	3	2	-	-	2	-	-	1	1	-	1
CO3	2	2	-	-	2	-	-	1	1	-	1
CO4	3	2	-	-	2	-	-	1	1	-	1
CO5	3	2	-	-	2	-	-	1	1	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	2
CO2	-	2
CO3	-	2
CO4	-	2
CO5	-	2

Practice:

1. Understanding the working platform with Xilinx Vivado and its device, family and package Selection.
2. Design and Implementation of Combinational Circuits Priority Encoder and Comparator using data flow & structural style.
3. Design and Implementation of Sequential Circuits to detect a given sequence using with and without overlapping (Mealy & Moore machines).
4. Design and Implementation of a traffic light controller in a three road & four road junctions.
5. Exercise on Concatenation, Replication operators, Reduction and Conditional operators in Verilog HDL.
6. Plotting the (i) output characteristics (ii) Transfer characteristics of an n-channel and p-channel MOSFET with Cadence.
7. Working with Schematic for Ring Oscillator with variable amounts of Pull up to pull down ratios.

8. Design a full adder by instantiating the logic gates. Make a comment on design style on its performance.
9. Design a NAND gate by using NMOS, PMOS and CMOS technologies and make a comment on its performance.
10. Design a layout for given logic and test for its DRC, LVS and PEX. Make a note on change in propagation delay with respect to PEX data.

Additional Practice:

3. Design and plot the characteristics of a 4x1 digital multiplexer using pass transistor logic and TG logic.
4. Design and plot the characteristics of a positive and negative latch based on multiplexers

Text Books:

1. CMOS Digital Integrated Circuits : Analysis and Design, S. M. Kang and Y. Leblebici, McGraw-Hill Education, 3rd Edition, ISBN: 978-0071243421.
2. Silicon VLSI Technology: Fundamentals, Practice & Modeling, James D. Plummer, Micheal Deal , Peter B. Griffin, Pearson India, 1st Edition, ISBN: 978-0130850379.

Reference Books:

1. Microchip Fabrication: A Practical Guide to Semiconductor Processing, Peter Van Zant, McGraw-Hill Professional, 6th Edition, ISBN: 978-0071821018.
2. CMOS Circuit Design, Layout and Simulation, R. Jacob Baker, Wiley-IEEE Press, 4th Edition, ISBN: 978-0780334168.
3. J. M. Rabaey, A. P. Chandrakasan and B. Nikolic, Digital Integrated Circuits: A Design Perspective, Pearson Education India, 2nd Edition,ISBN: 978-9332573925.

Web Links:

1. https://www.cadence.com/en_US/home/company/cadence-academic-network/educators/vlsi-fundamentals.html, Cadence Design Systems.
2. https://www.xilinx.com/video/hardware/getting-started-vivado-high-level-synthesis.html , Xilinx Vivado High Level Synthesis.
3. https://onlinecourses.nptel.ac.in/noc23_ee137/preview.

Verification Using Verilog & UVM

Course Code:2501EC017	L	T	P	C
	0	0	2	2

Course Outcomes:

At the end of the course, student will be able to:

- **CO1:** Develop Basic Testbench using UVM.
- **CO2:** Apply assertion based and Coverage – Driven verification techniques to the testbench.
- **CO3:** Implement Functional Coverage models and verify complex protocols like AXI, PLle etc.,
- **CO4:** Implement TLM interfaces for communication and advanced constrained Networks.
- **CO5:** Verify designs using multiple interfaces and mixed signals.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	-	2	-	-	1	1	-	1
CO2	3	2	-	-	2	-	-	1	1	-	1
CO3	2	2	-	-	2	-	-	1	1	-	1
CO4	3	2	-	-	2	-	-	1	1	-	1
CO5	3	2	-	-	2	-	-	1	1	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	2
CO2	-	2
CO3	-	2
CO4	-	2
CO5	-	2

Practice:

1. Basic Testbench:
   a. Develop a simple Verilog testbench to simulate a digital design.
   b. Create stimuli and check responses manually.
2. Basic UVM Testbench
   a. Develop a simple UVM testbench framework.
   b. Implement basic UVM components: env, agent, driver, sequencer, and monitor.
3. Stimulus Generation:
   a. Use UVM sequences to generate stimuli.
   b. Create constrained random test cases.
4. Score boarding:

a. Implement a scoreboard in UVM to compare expected vs. actual results.
b. Use functional coverage to track verification progress.

5. Assertion-Based Verification:
   a. Write System Verilog assertions to check protocol compliance.
   b. Integrate assertions into a UVM testbench.
6. Coverage-Driven Verification:
   a. Develop coverage models using cover groups and cover points.
   b. Analyse coverage results to identify untested scenarios.
7. VIP Integration:
   a. Integrate UVM Verification IP (VIP) into the testbench.
   b. Verify complex protocols like AXI, PCIe, etc.
8. Functional Coverage:
   a. Define and implement functional coverage models.
   b. Analyse coverage data to ensure all design functionalities are tested.
9. Reusable UVM Components:
   a. Create reusable UVM components for different testbenches.
   b. Parameterize components for flexibility.
10. Transaction-Level Modelling (TLM):
    a. Implement TLM interfaces for communication between UVM components.
    b. Use TLM for high-level transaction Modelling.
11. Advanced Stimulus Generation:
    a. Implement advanced constrained random techniques.
    b. Use UVM sequences to control stimulus generation dynamically.
12. Debugging and Logging:
    a. Utilize UVM reporting mechanisms for debugging.
    b. Implement custom error and status messages.

Additional Practice:

1. Multiple Interface Verification:
   a) Verify designs with multiple interfaces.
   b) Develop agents and drivers for each interface.
2. Mixed-Signal Verification:
   a) Integrate Analog models with digital testbenches.
   b) Use Real-number modelling (RNM) techniques.
3. Performance and Timing Verification:
   a) Measure and verify timing constraints.
   b) Use UVM to simulate and check timing behaviours
4. Interoperability Testing:
   a) Test interoperability between different modules or IP blocks.
   b) Use UVM to create complex test scenarios.

Text Books:

1. A Practical Guide to Adopting the Universal Verification Methodology (UVM) Second Edition, ISBN: 978-1300535935.
2. The UVM Primer:A Step-by-Step Introduction to the Universal Verification Methodology by Ray Salemi, ISBN: 978-0974164939.

Reference Books:

1. A Practical Guide for System Verilog Assertions by Srikanth Vijayaraghavan & Meyyappan Ramanathan, ISBN:978-1489992796.
2. Getting Started with UVM: A Beginner's Guide by Vanessa R. Coppe, ISBN:978-0615819976.

Web Links:

1. https://www.cadence.com/en_US/home/training/all-courses/86070.html
2. https://www.chipverify.com/tutorials/uvm
3. https://verificationacademy.com/forums/t/systemverilog-or-uvm/39566