Government of Karnataka

DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Electronics & Communication	**Semester**	IV
Course Code	20EC41P	**Type of Course**	Programme Core
Course Name	PCB Design & Fabrication	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

1. Rationale

Printed Circuit Boards (PCBs) are the core component in almost all the electronic gadgets used either for domestic or industrial purposes. PCBs hold almost all electronic components necessary for a device to function. Using a PCB has many advantages such as compact design, ease of testing and repair, low noise and interference, and improved reliability. Apart from electrically connecting, it also gives mechanical support to the electrical components. Using PCBs, a highly complicated circuit can be designed in a very small package which helps in reducing the size of electronic devices.

PCB design can be done either manually or using software. Electronic design automation tools are software tools used for designing the schematic and layout of PCB. Large number of PCBs can be fabricated at the same time after the layout is designed once. With consumers pushing for slimmer and faster devices, and with industries seeking improved functionality, the PCB will continue to develop in the future.

2. Course Outcomes: On successful completion of the course, the students will be able to:

CO-1	Identify different types of Printed Circuit Board (PCB), list the differences between them and its adequacy for specific application.
CO -2	Draw the schematic and PCB layout for an analog circuit to be used for a given application.
CO-3	Select the right components for a designed circuit, build the circuit and fabricate it using the appropriate tools following all necessary safety protocols.
CO-4	Test the fabricated circuit, identify the problem and troubleshoot to ensure the circuit provides the desired output.

3. Course Content

Week	CO	PO	Lecture (Knowledge Criteria)	Tutorial (Activity Criteria)	Practice (Performance Criteria)
			3 hours/week	1 hour/week	4 hours/week (2 hours/batch twice in a week)
1	1	1	1. Introduction to PCB, need and evolution of PCBs. 2. Classes of PCB – First Class (RF, microwave, and analog PCB) & Second Class (digital based PCB) – characteristics. 3. Types of PCB - Single sided, double sided and multilayer PCBs, rigid and flexible PCBs.	Refer Table 1	1. Familiarization of any Electronic design automation (EDA) software -Open source EDA Tool KiCad. 2. Practice the PCB design steps for a simple analog circuit: Schematic design-Familiarization of schematic editor, schematic creation, annotation, electrical rule check, mapping of components, netlist generation.
2	1,2	1	1. Comparison between single layer, double layer and multilayer PCBs. 2. Importance of grounding in PCBs, impedance matching, reflection, ground bounce, SSN. 3. Materials used for multilayer PCBs, PCB thickness, aspect ratio.	Refer Table 1	1. Practice placement of components. 2. Practice the routing (normal tracks -10 mils and power tracks-50 mils).
3	1,2	1,2	1. Component package types - Through-Hole, Surface-Mount, Fine Pitch, FPGA, QFT, TFP, BGA, Press Fit. 2. Calculation of track width required for different types of packages. 3. Types of Planes in PCB.	Refer Table 1	1. Learn how to create symbols for diodes, transistors, connectors, ICs. 2. Create the footprint for diodes, transistors, connectors,ICs.
4	2	2,3,4	1. Design for manufacturability (DFM). 2. Electromagnetic Interference (EMI), Electromagnetic Compatibility (EMC). 3. Thermal issues in PCB	Refer Table 1	1. Design Schematic for Regulated Power supply. 2. Design PCB layout for Regulated Power supply.

5	2	2,3,4	1. Conduction, convection, radiation in thermal issues. 2. Heat Dissipation in PCB, Heat sinks. 3. RF PCB-introduction.	Refer Table 1	1. Design Schematic for inverting /summing amplifier using op-amp. 2. Design PCB layout for inverting /summing amplifier using op-amp.
6	2	2,3,4	1. High-speed digital basics. 2. General design factor for digital and analog PCBs. 3. Voltage and current considerations in PCBs.	Refer Table 1	1. Design Schematic for astable multivibrator using IC 555. 2. Design PCB layout for astable multivibrator using IC 555.
7	2	2,3,4	1. Transmission lines, significance of transmission line and its effects. 2. Types of Transmission lines. 3. Different types of termination techniques, simple problems.	Refer Table 1	1. Design Schematic for RC coupled amplifier. 2. Design PCB layout for RC coupled amplifier.
8	2	2,3,4	1. Crosstalk in transmission lines, minimization of crosstalk. 2.ENIG and ENEPIG. 3. Noise budget.	Refer Table 1	1. Design Schematic for a given circuit (Ex: proximity sensor/ LED blinking/+ or -12v power supply using 7812 IC and 7912 IC) 2. Design PCB layout for a given ckt (Ex:proximity sensor/LED blinking circuit/+or - 12v power supply using 7812 and 7912 IC)
9	2,3	3,4,,5	1. Preparation of Manufacturing Drawing (MD). 2. Importance of Solder mask, assembly drawing, silkscreen, Gerber file. 3. Board origin, component origin, importance of origin.	Refer Table 1	1.Familiarisation of copper clad sheet, drilling machine, drill bits, required chemicals .(links) 2. Generate the Gerber file of works done in weeks 4 - 8 and take printouts on glossy paper.

10	2,3,4	4,5	1. Importance of CNC machines. CNC machines for component pick and place, drill file. 2. Design for Testing(DFT) 3. Design specification standards.	Refer Table 1	Fabrication process.
11	2,3,4	7	1. Steps involved in fabrication of single side PCB. 2. Steps involved in fabrication of double sided PCB. 3. Steps involved in fabrication of multilayer PCB.	Refer Table 1	Fabrication process.
12	2,3,4	7	1. Steps involved in fabrication of multilayer PCB- continued. 2. Soldering techniques. 3. Testing of PCB.	Refer Table 1	Fabrication process.
13	2,3,4	7	1. Importance of RoHS (Restriction of use of Hazardous Substances). 2. Waste management of hazardous materials in PCB. 3. Environment Management Standards (EMS).	Refer Table 1	Fabrication process.
Total in hours			**39**	**13**	**52**

TABLE 1: Suggested activities for tutorials.

The list is shared as an example and not inclusive of all possible activities of the course.

The list of activities for one week can be shared among teams in a batch of students.

Week no.	**Suggested activities for tutorials**
01	1. Prepare a report on reference designators for components used in PCB. 2. Give a presentation on general guidelines for designing the PCB. 3. Prepare a report on comparison of different types of PCBs.

02	1. Collect information on different electronic design automation (EDA) tools and their comparison (Cadstar, Orcad, Pads). 2. Collect the information on materials used for multilayer PCB, drill holes, vias, aspect ratio and present it.
03	1. Collect the datasheets of electronic components such as diode, regulator IC, DIP IC and study their mechanical dimension and their projection (first angle/ third angle projection, top view, front view). 2. Give a presentation on through-hole and surface-mount technology.
04	1. Collect a case study on DFM issues and present it. 2. Give a presentation on Electromagnetic Interference in real life and provide solution to solve the problem.
05	1. Collect details of different types of heat sinks used in PCBs. 2. Collect any frequency synthesizer circuit and explain it.
06	1. Prepare a report on comparison of analog and digital PCBs and present it. 2. Give a presentation on the importance of spacing and thickness of the tracks in PCB's.
07	1. Give a presentation on the importance of transmission lines. 2. Discuss selection of transmission lines for optimum design.
08	1. Write a report on how to analyse the presence of crosstalk in signals. 2. Give a presentation on advantages and disadvantages of ENIG and ENEPIG.
09	1. Collect information on different types of solder paste. 2. Collect any completed PCB file and explain it.
10	1. Prepare a report on comparison of manual soldering and machine soldering and present it. 2.Collect information on design standards used in India for designing PCBs.
11	1. Collect different types of manufacturing techniques and explain them. 2. What are the different parameters to be considered to decide the cost of manufactured PCB?
12	1. Give a presentation on the failures of PCB due to improper soldering. 2. Write a report on testing of PCB.

13	1. Study the latest technological changes in this course and present the impact of these changes on industry. 2. Give a presentation on the role of students for protecting environment from hazardous materials. 3. Find different methods for disposing of PCB lab wastes and dispose it.

4. CIE and SEE Assessment Methodologies

Sl. No	Assessment	Test Week	Duration In minutes	Max marks	Conversion
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill tests 20
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Activity through Rubrics	1-13		10	10
				Total CIE Marks	60
	Semester End Examination (Practice)		180	100	40
				Total Marks	**100**

5. Format for CIE (1, 2, 3) Written Test

Course Name	**PCB Design & Fabrication**	Test	I/II/III	Sem	III/IV
Course Code	**20EC41P**	Duration	80 Min	Marks	30
Note: Answer any one full question from each section. Each full question carries 10 marks.					
Section	Assessment Questions		Cognitive Levels	Course Outcome	Marks
I	1				
	2				
II	3				
	4				
III	5				
	6				
Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.					

5. (a) Format for CIE-4 Skill Test - Practice.

SL. No.	COs	Particulars/Dimension	Marks
1	1	Identification of different types of PCB.	10
2	2	Schematic Design of the given Analog Circuit using EDA tool(KiCad)	40
3	2	Layout Design of the given Analog Circuit using EDA tool (KiCad)	40
4	1,2	Portfolio evaluation of Practice sessions through Rubrics	10
		Total Marks	**100**

5. (b) Format for CIE-5 Skill Test - Practice.

SL. No.	COs	Particulars/Dimension	Marks
1	2	Design of the given Analog Circuit Schematic Design -5 Marks Layout Design -5 Marks	10
2	3	Fabrication of the given Analog Circuit Fabrication -30 Marks Component mounting & soldering -20 Marks	50
3	4	Testing & Troubleshooting of a given PCB. Testing - 10 Marks Troubleshooting - 20 Marks	30
4	2,3,4	Portfolio evaluation of Practice sessions through Rubrics	10
		Total Marks	**100**

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
					Average Marks= (8+6+2+2)/4=4.5		**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. Reference:

Sl. No.	Description
1	Printed Circuits Handbook - 6th edition Clyde F. Coombs,Jr.
2	PCB Design & Technology - Walter C. Bosshart
3	Printed Circuit Board by RS Khandpur, Tata McGraw Hill Education Pvt Ltd., New Delhi
4	Electronic Product Design Volume-I by S D Mehta, S Chand Publications
5.	Open source EDA Tool KiCad Tutorial: http://kicad-pcb.org/help/tutorials/
6	PCB Fabrication user guide page: http://www.wikihow.com/Create-Printed-Circuit-Boards http://www.siongboon.com/projects/2005-09-07_home_pcb_fabrication http://reprap.org/wiki/MakePCBInstructions#Making_PCBs_yourself

8. SEE Scheme of Evaluation

SL. No.	COs	Particulars/Dimension	Marks
1	1	Identification of Types of PCB.	10
2	2	Design of the given Analog Circuit Schematic Design -15 Marks Layout Design -15 Marks Routing -10 Marks	40
3	3	Fabrication of the given Analog Circuit Fabrication -10 Marks Component mounting & soldering -10 Marks	20
4	4	Testing & Troubleshooting of PCB.	10
5	1,2,3, 4	Viva Voce	20
		Total Marks	**100**

9. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
1	Computers	Intel Core i5 11th gen/8GB RAM/1 TB HDD/256GB SSD/ Graphics 2 GB	20
2	Open source EDA Tool KiCad.		20
3	Single-sided copper clad sheet.		100
4	Diluted Acidic solution for copper etching purpose with plastic tray.		5
5	Tapes and pads for layout design of different dimensions.		
6	Glossy paper		60
7	Hand drilling/Power drilling machine.		10
8	Tool kit (Tray, Brush, PCB Laminate, tong, hand gloves etc.)		20