Government of Pakistan

National Vocational and Technical Training Commission

Prime Minister's Hunarmand Pakistan Program

"Skills for All"

Course Contents / Lesson Plan

Course Title: Advanced Electronics & PCB Design and fabrication

Duration: 3 Months

Revised Edition

Trainer Name	
Author Name	**Engr.t. Saba Wahab Instructor Electronics GCTW,LHR(TEVTA)**
Course Title	**Advanced Electronics & PCB Design and fabrication**
Objectives and Expectations	**Employable skills and hands-on practice in Advanced Electronics & PCB Design and fabrication)** This is a special course designed to address unemployment in the youth. The course aims to achieve the above objective through hands on practical training delivery by a team of dedicated professionals having rich market/work experience. This course is therefore not just for developing a theoretical understanding/back ground of the trainees. Contrary to that, it is primarily aimed at equipping the trainees to perform commercially in a market space in independent capacity or as a member of a team. The course therefore is designed to impart not only technical skills but also soft skills (i.e. interpersonal/communication skills; personal grooming of the trainees etc.) as well as entrepreneurial skills (i.e. marketing skills; free lancing etc.). The course also seeks to inculcate work ethics to foster better citizenship in general and improve the image of Pakistani work force in particular. **Main Expectations:** In short, the course under reference should be delivered by professional instructors in such a robust hands-on manner that the trainees are comfortably able to employ their skills for earning money (through wage/self-employment) at its conclusion. This course thus clearly goes beyond the domain of the traditional training practices in vogue and underscores an expectation that a market-centric approach will be adopted as the main driving force while delivering it. The instructors should therefore be experienced enough to be able to identify the training needs for the possible market roles available out there. Moreover, they should also know the strengths and weaknesses of each trainee to prepare them for such market roles during/after the training. **i.** Specially designed practical tasks to be performed by the trainees have been included in the Annexure-I to this document. The record of all tasks performed individually or in groups must be preserved by the management of the training Institute clearly labeling name, trade, session, etc. so that these are ready to be physically inspected/verified through monitoring visits from time to time. The weekly distribution of tasks has also been indicated in the weekly lesson plan given in this document. **ii.** To materialize the main expectations, a special module on **Job Search & Entrepreneurial Skills** has been included in the latter part of this course through which, the trainees will be made aware of the Job search techniques in the local as well as international job markets (Gulf countries). Awareness around the visa process and immigration laws of the most favored labor destination countries also form a part of this

module. Moreover, the trainees would also be encouraged to venture into self-employment and exposed to the main requirements in this regard. It is also expected that a sense of civic duties/roles and responsibilities will also be inculcated in the trainees to make them responsible citizens of the country.

iii. A module on **Work Place Ethics** has also been included to highlight the importance of good and positive behavior in the workplace in the line with the best practices elsewhere in the world. An outline of such qualities has been given in the Appendix to this document. Its importance should be conveyed in a format that is attractive and interesting for the trainees such as through PPT slides +short video documentaries. Needless to say that if the training provider puts his heart and soul into these otherwise non-technical components, the image of the Pakistani workforce would undergo a positive transformation in the local as well as international job markets.

To maintain interest and motivation of the trainees throughout the course, modern techniques such as:

- Motivational Lectures
- Success Stories
- Case Studies

These techniques would be employed as an additional training tool wherever possible (these are explained in the subsequent section on Training Methodology).

Lastly, evaluation of the competencies acquired by the trainees will be done objectively at various stages of the training and a proper record of the same will be maintained. Suffice to say that for such evaluations, practical tasks would be designed by the training providers to gauge the problem-solving abilities of the trainees.

(i) Motivational Lectures

The proposed methodology for the training under reference employs motivation as a tool. Hence besides the purely technical content, a trainer is required to include elements of motivation in his/her lecture. To inspire the trainees to utilize the training opportunity to the full and strive towards professional excellence. Motivational lectures may also include general topics such as the importance of moral values and civic role & responsibilities as a Pakistani. A motivational lecture should be delivered with enough zeal to produce a deep impact on the trainees. It may comprise of the following:

- Clear Purpose to convey the message to trainees effectively.
- Personal Story to quote as an example to follow.
- Trainees Fit so that the situation is actionable by trainees and not represent a just idealism.
- Ending Points to persuade the trainees on changing themselves.

A good motivational lecture should help drive creativity, curiosity, and spark the desire needed for trainees to want to learn more.

The impact of a successful motivational strategy is amongst others commonly visible in increased class participation ratios. It increases the trainees' willingness to be engaged on the practical tasks for a longer time without boredom and loss of interest because they can see in their mind's eye where their hard work would take them in short (1-3 years); medium (3 -10 years) and long term (more than 10 years).

As this tool is expected that the training providers would make arrangements for regular well planned motivational lectures as part of a coordinated strategy interspersed throughout the training period as suggested in the weekly lesson plans in this document.
Course-related motivational lectures online link is available in **Annexure-II**.

(ii) Success Stories

Another effective way of motivating the trainees is using Success Stories. Its inclusion in the weekly lesson plan at regular intervals has been recommended till the end of the training.
A success story may be disseminated orally, through a presentation, or using a video/documentary of someone that has risen to fortune, acclaim, or brilliant achievement. A success story shows how a person achieved his goal through hard work, dedication, and devotion. An inspiring success story contains compelling and significant facts articulated clearly and easily comprehendible words. Moreover, it is helpful if it is assumed that the reader/listener knows nothing of what is being revealed. The optimum impact is created when the story is revealed in the form of:-

- Directly in person (At least 2-3 cases must be arranged by the training institute)
- Through an audio/ videotaped message (2-3 high-quality videos must be arranged by the training institute)

It is expected that the training provider would collect relevant high-quality success stories for inclusion in the training as suggested in the weekly lesson plan given in this document.
The suggestive structure and sequence of a sample success story and its various shapes can be seen in **Annexure III**.

(iii) Case Studies

Where a situation allows, case studies can also be presented to the trainees to widen their understanding of the real-life specific problem/situation and to explore the solutions.
In simple terms, the case study method of teaching uses a real-life case example/a typical case to demonstrate a phenomenon in action and explain theoretical as well as practical aspects of the knowledge related to the same. It is an effective way to help the trainees comprehend in depth both the theoretical and practical aspects of the complex phenomenon in depth with ease. Case teaching can also stimulate the trainees to participate in discussions and thereby boost their confidence. It also makes the classroom atmosphere interesting thus maintaining the trainee interest in training till the end of the course.
Depending on suitability to the trade, the weekly lesson plan in this document may suggest case studies be presented to the trainees. The trainer may adopt a PowerPoint presentation or video format for such case studies whichever is deemed suitable but only those cases must be selected that are relevant and of a learning value.
The Trainees should be required and supervised to carefully analyze the cases.
For this purpose, they must be encouraged to inquire and collect specific information/data, actively participate in the discussions, and intended solutions to the problem/situation.
Case studies can be implemented in the following ways: -

i. A good quality trade-specific documentary (At least 2-3

	documentaries must be arranged by the training institute) ii. Health &Safety case studies (2 cases regarding safety and industrial accidents must be arranged by the training institute) iii. Field visits(At least one visit to a trade-specific major industry/ site must be arranged by the training institute)
Entry-level of trainees	Matric Science
Learning Outcomes of the course	By the end of this course, students will be able to: • Students can explore different aspect of Printed Circuit Board • Design and fabrication. • Students can learn various types of PCBs. Schematic Design. • entry Rules for Schematic Entry, Component Layout methods • Placement Rules, Routing Techniques for Single Sided Board. • Post Processing of design and Fabrication documents. • After completing this course students can design and fabricate • their own PCB for their Project and can also work in PCB • Designing and Fabrication area.
Course Execution Plan	The total duration of the course: **3 months (12 Weeks)** Class hours: **4 hours per day** Theory: **20%** Practical: **80%** Weekly hours: **20 hours per week** Total contact hours: **260 hours**
Companies offering jobs in the respective trade	• Public/Private industries including: 1. Berjaya Electronics 2. Elite-PCB 3. Electromech Engineering Pakistan 4. PCB Fabrication & Design Pakistan
Job Opportunities	• PCB Designer • PCB Developer • PCB Tester • PCB Service Technician, • Supervisor-Electronics Product Assembly Section • Supervisor-PCB Manufacturing / testing Section • Technicians/ Electronic Lab In charge in Academic Institute.
No of Students	25
Learning Place	Classroom / Lab
Instructional Resources	1. Introduction to Electronics: https://youtu.be/xgAZVHIk_s4?si=m_6yCCtRtDEOSfJE This video provides an Electronics, including Atom history 2. PCB Design layout https://projectiot123.com/2019/03/07/pcb-design-in-proteus/ This video provides a process of designing the printed circuit board

	in Proteus. 3. **How a Transistor Working**: https://youtu.be/1OD-NsFabk0 This video provides different types of transistor amplifiers operated by using an AC signal input. 4. **OPERATIONAL AMPLIFIER** **https://youtu.be/HfDUyUwKG8w** This video provides OPERATIONAL AMPLIFIER AS AN INVERTING APMLIFIER. 5. **FULL WAVE RECTIFIER** https://youtu.be/2FbJjmRbykY This video describes full wave rectifier circuit diagram with all signals and voltages. 6. **EasyEDA SOFTWARE FREE FOR PCB DESIGNING** **https://easyeda.com/page/download** 7. **pcb design in proteus** https://youtu.be/_UzO2CRRx90 This video describes pcb design in proteus ||how to convert schematic to pcb layout in proteus

MODULES

Scheduled Weeks	Module Title	Days	Hours	Learning Units	Home Assignment
Week 1	Introduction to Electronics & PCB Design and fabrication	Day 1	Hour 1	Introduction Basic Electronics Components	• Task 1 *Details may be seen at Annexure-I*
			Hour 2	Understanding the role of component	
			Hour 3	Overview of Advanced Electronics	
			Hour 4	Introduction to advanced electronic components.	
	Basic Electronic Components Resistors & Resistance	Day 2	Hour 1	Understand the Concept of Resistance	
			Hour 2	Identify and Classify Resistors	
			Hour 3	Understand Color Coding	
			Hour 4	Explore Types of Resistors	
	capacitor and its types	Day 3	Hour 1	What is capacitor	
			Hour 2	Basic types of capacitors	
			Hour 3	Capacitance	
			Hour 4	Capacitance in Series and parallel circuits.	
	Series and Parallel Circuits	Day 4	Hour 1	What is series circuit	

			Hour 2	What is parallel circuit	
			Hour 3	Analysis of series and parallel circuits.	
			Hour 4	Resistor and capacitor in series an parallel circuit	
	Ohm's Law	Day 5	Hour 1	What is Current and its units	
			Hour 2	What is Voltage and its units	
			Hour 3	Ohm's Law	
			Hour 4	Basic circuit problems using Ohm's Law.	
Week 2	Semiconductor Devices	Day 1	Hour 1	Basics of semiconductor materials.	
			Hour 2	Intrinsic and extrinsic material	
			Hour 3	P type material	
			Hour 4	N type material	
	Semiconductor Devices – Diodes	Day 2	Hour 1	P.N junction	Task 2
			Hour 2	What is Diode and its working symbol	
			Hour 3	Characteristics of Diodes	
			Hour 4	Characteristics of Diodes	

	Diode Applications	Day 3	Hour 1	Half wave rectifiers	
			Hour 2	Half wave rectifiers	
			Hour 3	Full wave rectifiers	
			Hour 4	Full wave rectifiers	
	Diode Applications	Day 4	Hour 1	Clipper circuits	
			Hour 2	Clamper circuits	
			Hour 3	Voltage-multiplier circuits and applications	
			Hour 4	Voltage-multiplier circuits and applications	
	Diode Applications	Day 5	Hour 1	Photodiodes	
			Hour 2	Design circuit using various types of photodiode	
			Hour 3	Zener Diodes	
			Hour 4	working of Zener Diodes	
Week 3	Bipolar Junction Transistors	Day 1	Hour 1	Introduction Bipolar Junction Transistors	Task 3
			Hour 2	Construction operation	
			Hour 3	operation	

	Bipolar Junction Transistors		Hour 4	Types of BJT	
		Day 2	Hour 1	Common-Emitter configurations of BJT	
			Hour 2	Common-Emitter configurations of BJT	
			Hour 3	Common-Base	
			Hour 4	Collector configurations of BJT	
	Field Effect Transistor	Day 3	Hour 1	Introduction to FETs	
			Hour 2	JFETs	
			Hour 3	MOSFETs	
			Hour 4	Applications of MOSFETs	
	Differential Amplifiers	Day 4	Hour 1	Introduction to Differential Amplifiers	
			Hour 2	DC and AC analysis of differential amplifier	
			Hour 3	Design of simple differential amplifier	
			Hour 4	Applications of Differential Amplifiers	
		Day 5	Hour 1	Class A amplifier	
			Hour 2	Class B amplifier Class AB amplifier	

			Hour 3	Class C amplifier	
			Hour 4	Push-pull amplifier	
Week 4	Introduction to Operational Amplifiers (Op-Amps)	Day 1	Hour 1	Basics of operational amplifiers.	
			Hour 2	Symbol of operational amplifiers.	
			Hour 3	Circuit of operational amplifiers.	
			Hour 4	Applications of operational amplifiers.	
	Digital Systems	Day 2	Hour 1	Digital Systems	Task 4
			Hour 2	Binary and Decimal Number- Base Conversion	
			Hour 3	Binary and Hexadecimal Numbers	
			Hour 4	Binary logic	
	Digital Circuits	Day 3	Hour 1	Digital Logic Gates	
			Hour 2	AND, OR	
			Hour 3	XOR and NOT logic operations.	
			Hour 4	Draw a truth table for a simple logic circuit that has two inputs (A and B) and one output (Y).	

	Registers and Counters	Day 4	Hour 1	Registers	TASK 4
			Hour 2	Shift Register	
			Hour 3	Ripple Counter	
			Hour 4	Synchronous Counters	
	Power Electronic Devices	Day 5	Hour 1	Power diodes	
			Hour 2	Power transistors	
			Hour 3	Thyristors	
			Hour 4	Rectifiers (Uncontrolled, Semi- controlled & Fully controlled)	
Week 5	Introduction to PCB Design	Day 1- Day 2	Hour 1-4 Hour 1-4	Introduction to printed circuit boards (PCBs) and their importance	TASK 5
		Day 3- Day 4	Hour 1-4 Hour 1-4	Overview of the PCB design process	

		Day 5	Hour 1-4	Study a flowchart illustrating the step-by-step Process of designing a PCB.	
Week 6	Introduction to PCB Design Software	Day 1	Hour 1-4	Introduction to PCB design software(Any available)	TASK 6
		Day 2-	Hour 1-4	Understanding the PCB design environment and interface Basic tools and commands for schematic capture and PCB layout.	
		Day 3	Hour 1-4	Explore PCB design software and create a document highlighting the software's main capabilities, user interface, and available tools for Schematic capture and PCB layout.	
		Day 4- Day 5	Hour 1-4 Hour 1-4	Basic tools and commands for schematic capture and PCB layout	
Week 7		Day 1	Hour 1-4	Schematic capture techniques and best practices	TASK 7

	Schematic Design and Component Placement	Day 2	Hour 1-4	Learn Simple circuit schematic.	
		Day 3	Hour 1-4	Simple circuit schematic that includes multiple components, such as resistors, capacitors, and an integrated circuit.	
		Day 4	Hour 1-4	Understanding and applying design constraints and specifications	
		Day 5	Hour 1-4	Study to Design a PCB layout with specific design constraints, such as a maximum board size, minimum trace width, and clearance requirements.	
Week 8	Schematic Design and Component Placement	Day 1	Hour 1-4	Component selection and datasheet analysis	TASK 8
		Day 2- Day 3	Hour 1-4	Select components for a given circuit design by researching their specifications and datasheets. Consider factors such as voltage ratings, capacitance values, and package types.	
		Day 4	Hour 1-4	Study a PCB layout for a simple circuit	
		Day 5	Hour 1-4	PCB layout for a simple circuit and focus on optimizing component placement.	

Week 9		**Day 1**	**Hour 1-4**	**Select components for a given from library.**	
		Day 2- Day 3	**Hour 1-4 /Hour 1-4**	**Select components for a given circuit from library circuit design by researching their specifications and datasheets.**	**TASK 9**
		Day 4- Day 5	**Hour 1-4/ Hour 1-4**	**Consider factors such as voltage ratings, capacitance values, and package types.**	
Week 10	**PCB Layout and Routing**	**Day 1**	**Hour 1-4**	**PCB stack-up and layer management**	**TASK 10**
		Day 2	**Hour 1-4**	**Design a PCB stack-up for a single-layer board Considering the requirements.**	
		Day 3	**Hour 1-4**	**Design a PCB stack-up for a two-layer board Considering the requirements.**	
		Day 4	**Hour 1-4**	**Study about routing guidelines.**	
		Day 5	**Hour 1-4**	**routing guidelines for different types of components (Passive, active, connectors, etc.)**	
Week 11	**P.C.B Fabrication**	**Day 1**	**Hour 1-4**	**Practice of etching Silk screen-printing**	
		Day 2	**Hour 1-4**	**Routing techniques and considerations for signal integrity and EMI/EMC compliance**	**TASK 11**
		Day 3	**Hour 1-4**	**Power requirements for the given circuit**	
		Day 4	**Hour 1-4**	**Grounding and power plane design**	

		Day 5	**Hour 1-4**	**Utilizing design rules and constraints for efficient routing and error checking**	
Week 12	**Design Validation, Manufacturing, and Assembly**	**Day 1**	**Hour 1-4**	**Design rule checking and electrical rule checking**	**TASK 12**
		Day 2	**Hour 1-4**	**Generating manufacturing files**	
		Day 3	**Hour 1-4**	**Understanding the fabrication and assembly processes**	
		Day 4	**Hour 1-4**	**Practice soldering and de-soldering on PCB.**	
		Day 5	**Hour 1-4**	**Design considerations for soldering, assembly, and testing**	

Tasks for Certificate in AI Advanced Electronics & PCB Design and fabrication

Annexure-I:

Task No.	Task	Description	Week
1.	**Basic of Electronics**	Solve basic circuit problems using Ohm's Law.	**Week 1**
2.	**Semiconductor Devices**	Implement Half and Full wave rectifier circuits	**Week 2**
3.	**Bipolar Junction Transistors**	Explore construction of transistors with the help of diode model	**Week 3**
4.	**Digital Circuits**	Build logic circuits using basic logic gates (AND, OR NOT) to implement a given Boolean expression. Draw the logic diagram and verify its functionality by comparing the truth table of the circuit with the desired output.	**Week 4**
5.	**Introduction to PCB Design**	Develop a flowchart illustrating the step-by-step Process of designing a PCB.	**Week 5**
6.	**Introduction to PCB Design Software**	Create a simple schematic diagram consisting of common electronic components and save it as a project file.	**Week 6**
7.	**Design a PCB layout**	Design a PCB layout with specific design Constraints, such as a maximum board size, minimum trace width, and clearance requirements.	**Week 7**
8.	**Schematic Design**	Design a simple circuit schematic that includes multiple components, such as resistors, capacitors, and an integrated circuit.	**Week 8**
9.	**Component Placement**	Design a PCB layout for a simple circuit and focus on optimizing component placement.	**Week 9**
10.	**PCB Layout and Routing**	Design a PCB layout for a simple circuit with various components and consider signal flow and minimize trace lengths for better performance.	**Week10**
11.	**P.C.B Fabrication**	Design a PCB with a proper grounding and power plane arrangement.	**Week11**
12.	**Design Validation, Manufacturing, and Assembly**	Design a circuit that includes through-hole components (e.g., resistors, capacitors, ICs) on a PCB.	**Week12**
13.	**Final Project**	Combining all the topics covered in the course to build a complete PCB.	**Week12**

Annexure-II:

Motivational Lectures
Advanced Electronics & PCB Design and fabrication

EasyEDA SOFTWARE FREE FOR PCB DESIGNING

https://easyeda.com/page/download

LIFE LESSONS

https://youtu.be/Et5F2C04xIc

This video provides a motivational video about life and how to live with others.

What is planning

https://www.youtube.com/shorts/y1Lt-DnqaxE?feature=share

This video provides a motivational video about plans And Allah's Plan.

Annexure-IV:

Workplace/Institute Ethics Guide

Work ethic is a standard of conduct and values for job performance. The modern definition of what constitutes good work ethics often varies. Different businesses have different expectations. Work ethic is a belief that hard work and diligence have a moral benefit and an inherent ability, virtue, or value to strengthen character and individual abilities. It is a set of values-centered on the importance of work and manifested by determination or desire to work hard.

The following ten work ethics are defined as essential for student success:

1. **Attendance:**
   Be at work every day possible, plan your absences don't abuse leave time. Be punctual every day.
2. **Character:**
   Honesty is the single most important factor having a direct bearing on the final success of an individual, corporation, or product. Complete assigned tasks correctly and promptly. Look to improve your skills.
3. **Team Work:**
   The ability to get along with others including those you don't necessarily like. The ability to carry your weight and help others who are struggling. Recognize when to speak up with an idea and when to compromise by blend ideas together.
4. **Appearance:**
   Dress for success set your best foot forward, personal hygiene, good manner, remember that the first impression of who you are can last a lifetime
5. **Attitude:**
   Listen to suggestions and be positive, accept responsibility. If you make a mistake, admit it. Values workplace safety rules and precautions for personal and co-worker safety. Avoids unnecessary risks. Willing to learn new processes, systems, and procedures in light of changing responsibilities.
6. **Productivity:**
   Do the work correctly, quality and timelines are prized. Get along with fellows, cooperation is the key to productivity. Help out whenever asked, do extra without being asked. Take pride in your work, do things the best you know-how. Eagerly focuses energy on accomplishing tasks, also referred to as demonstrating ownership. Takes pride in work.
7. **Organizational Skills:**

Make an effort to improve, learn ways to better yourself. Time management; utilize time and resources to get the most out of both. Take an appropriate approach to social interactions at work. Maintains focus on work responsibilities.

8. **Communication:**

   Written communication, being able to correctly write reports and memos. Verbal communications, being able to communicate one on one or to a group.

9. **Cooperation:**

   Follow institute rules and regulations, learn and follow expectations. Get along with fellows, cooperation is the key to productivity. Able to welcome and adapt to changing work situations and the application of new or different skills.

10. **Respect:**

    Work hard, work to the best of your ability. Carry out orders, do what's asked the first time. Show respect, accept, and acknowledge an individual's talents and knowledge. Respects diversity in the workplace, including showing due respect for different perspectives, opinions, and suggestions.