



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma in Engineering

Level: Diploma

Branch: Electronics & Communication Engineering /  
Information and Communication Technology

Course / Subject Code: DI02000081

Course / Subject Name: PCB Designing & Electronics workshop

w. e. f. Academic Year:	2024-25
Semester:	2 <sup>nd</sup>
Category of the Course:	ESC

<b>Prerequisite:</b>	<b>Basic of Electronics components</b>
<b>Rationale:</b>	In this subject, students will learn how to handle various general-purpose tools and measuring instruments to build and test electronic circuit. They will learn how to test various electronics components using appropriate measuring equipment's. They will practice on soldering and de-soldering electronic components on printed circuit board (PCB). Students will learn how to design schematic layout of miniature electronic circuit using openly available PCB designing software. Students will attain skills to assemble and test electronics circuit on PCB which will be benefited them to execute micro project in each subject in subsequent semester and major project in final year. This course will help student to develop skills regarding safety aspects of individual while working with electrical and electronics gazettes.

- **Course Outcome:**

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Test various electronic components by using appropriate instruments with safety concern.	R, U, A
02	Use various types of cables, connectors and switches.	R, U, A
03	Assemble electronic circuit on bread board and PCB with safety concern.	R, U, A
04	Develop micro project based on sensors, Actuators, Electronics components and Arduino IDE with safety concern.	R, U, A
05	Desing and develop PCB using open-source software.	R, U, A

\*Revised Bloom's Taxonomy (RBT)



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• **Teaching and Examination Scheme:**

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR		C	Theory		Tutorial / Practical	
			ESE (E)		PA / CA (M)	PA/CA (I)	ESE (V)	
0	0	6	3	00	00	20	30	50

(\*): For this practical only course, 25 marks under the practical CA have two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15 marks are for the assessment of practical. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

**Legends:** L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

• **Course Content:**

Unit No.	Content	No. of Hours	% of Weightage
1.	Identification and Testing of Electronics components		N.A.
2.	Working and Applications of different types of cables, connectors and switches		
3.	Soldering – de-soldering practices and Types of component packages		
4.	Identifying Application specific Sensors, Actuators and Arduino based Micro-project		
5.	PCB Design and E-waste recycling		

• **Suggested Specification Table with Marks (Theory):**

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
20	40	40	-	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

• **References/Suggested Learning Resources:**

(a) **Books:**



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Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Basic Electronics and Linear Circuits	N.N. Bhargava, D.C. Kulshreshtha, S.C. Gupta	McGraw Hill Education, ISBN: 9781259006463
2	Electronic Devices and Circuit	Maini, Anil K.	Wiley India, New Delhi, ISBN: 9788126518951
3	Transistor Selector Handbook	TAB books	Tower's International Foulsham, London, 1974, ISBN: 9780572008888
4	Encyclopedia of Electronic Components Volume 1 Resistors, Capacitors, Inductors, Switches, Encoders, Relays, Transistors.	Charles Platt	O'Reilly, United States of America-2013. ISBN: 978-1-449-33389-8
5	Printed Circuit Boards: Design and Technology	Bossart	TMH, latest edition ISBN-10: 0074515497 ISBN-13: 0074515495-978
6	Printed Circuit Boards	R S KHANDPUR	Tata McGraw Hill ISBN: 9780070588141
7	Build Your Own Printed Circuit Board	Al Williams	Mc Graw Hill, latest edition ISBN-10: 0070054088 ISBN-13: 0070054080-978
8	Arduino Cookbook	Michael Margolis	O'Reilly Media, Inc., 3rd Edition ISBN: 9781491903520
7	E-waste: implications, regulations, and management in India and current global best Practices.	Rakesh Johri	TERI Press, New Delhi, ISBN: 9788179931530, 29/09/2015
8	Handbook of Electronic Waste Management 1st Edition	M.N.V. Prasad, Meththika Vithanage, Anwasha Borthakur.	Butterworth-Heinemann, eBook ISBN: 9780128170311, Paperback ISBN: 9780128170304, 21/11/2019



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Sr. No.	Title of Book	Author	Publication with place, year and ISBN
9	E-waste Recycling and Management Edition Number-1	Anish Khan, Inamuddin, AbdullahM. Asiri	Springer, Cham, ISBN: 978-3-030-14183-7, 2020

## (b) Open-source software and website:

### Software:

1. <https://www.arduino.cc/en/software> (Open-source Arduino Software (IDE))
2. <https://www.kicad.org/download/> (KiCad free and open-source electronic design automation (EDA) suite.)

### Website:

1. [www.youtube.com/@circuitshala](http://www.youtube.com/@circuitshala) (PCB design Playlist)
2. [www.arduino.cc](http://www.arduino.cc)
3. <https://www.electrical4u.com/types-of-resistor/>
4. [https://www.electronics-tutorials.ws/resistor/res\\_1.html/](https://www.electronics-tutorials.ws/resistor/res_1.html/)
5. <https://www.electronicshub.org/>
6. <https://circuitdigest.com/electronic-circuits/>
7. <https://www.circuitstoday.com/simple-electronics-projects-and-circuits/>
8. [https://circuiteasy.com /](https://circuiteasy.com/)
9. [www.findchip.com/](http://www.findchip.com/)
10. <https://nptel.ac.in/> (for online courses and video of all engineering branches)
11. [www.electronicsforu.com/](http://www.electronicsforu.com/) (for basic electronic projects and technical videos)
12. <https://www.vlab.co.in/> (Virtual Lab for all engineering branches)
13. [https://www.engineersgarage.com /](https://www.engineersgarage.com/)
14. <https://fritzing.org/> (Fritzing – PCB Designing Open-Source Software).
15. <https://www.kicad.org/> (KiCAD – PCB Designing Open-Source Software).
16. <https://www.tinkercad.com/> (Tinker cad open-source software for Arduino and sensor-based Applications)
17. <https://ecstudiosystems.com/> (Electronic Circuit Studio – Android Application for Circuit Design an Analysis).



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• **Suggested Course Practical List:**

Sr. No.	Practical Outcomes (PrOs)	Unit	CO	Approx. Hrs.	
		No.		Required	
1	Identify the terminals and test the functionality of the following devices: Transformer, Diode, Zener diode, Varactor diode, LED, Photo diode, BJT, Photo transistor, FET, DIAC, TRIAC, LDR, Solar cell, Photocell, Opto-coupler, 7 Segment Display, Relays	I	CO1	4	
2	Identify different types of batteries with their specifications	I		2	
3	Use and interpret Data sheets with respect to Specifications, package and applications as literature survey of any five components listed below: (a) Diodes IN4001 to 1N4007, IN4148, 2N5402, 2N5408, BY127 (b) Zener Diode - 5V6 (c) Photo diode - BPW10 (d) LED - & Multi colored LED (e) Varactor diode (f) Seven segment LED (g) Transistors BC107, BC177, BC547/548, (h) Transistors SL100, SK100, AC127/128, BF194, TIP122 (i) IC 78XX, 79XX (j) LM317 (k) SMD components: Resistor, Capacitor, Inductor & Diode-LL4148, SM4007, Chip transistor, Chip Darlington transistor, Bridge rectifier.	I		4	
4	Demonstration of working of all kind/category of workshop tools, materials and measuring equipment as stated in Unit 1 in Underpinning theory section.	I		2	
5	Test electronic components using “Component Test “tab of CRO.	I		2	
6	1. Demonstration of male and female type connectors and cables. 2. Fabricate probe for CRO, ETHERNET LAN cable (straight and cross) and patch cord.	II		CO2	2
7	Demonstration and implementation of various Cable and connectors for suitable application.	II			2



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8	Connection of different switches in simple circuits on breadboard	II		2
9	Practicing of soldering and De soldering of resistor, capacitor and other components electronics component on General Purpose PCB.	III	CO3	2
10	Demonstrate various types of IC packages and their soldering techniques (Through video or any ICT source)	III		2
11	Demonstrate the working of Different electronics sensors with applications	IV	CO4	2
12	Demonstrate and test the working of different type of Actuators used in different applications	IV		2
13	Demonstrate Arduino IDE: Installation, setup, and basic usage.	IV		2
14	Implement different I/O functions of Arduino board	IV		2
15	Implement LED blinking code on Arduino board.	IV		2
16	Implement code to interface switch and LED on Arduino board.	IV		2
17	Demonstrate working of various sensors and actuators on Arduino board.	IV		4



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18	<p>Create Mini project Based on Arduino Some Suggested projects:</p> <ol style="list-style-type: none"> <li>a. Use a DHT11/DHT22 sensor to monitor and display temperature and humidity on a 16x2 LCD screen.</li> <li>b. Create a traffic light system with red, yellow, and green LEDs to simulate traffic light sequencing.</li> <li>c. Use a PIR sensor to detect motion and turn on an LED.</li> <li>d. Control an LED based on ambient light levels using a Light Dependent Resistor (LDR).</li> <li>e. Simulate a dice roll using a 7-segment display and a push button</li> <li>f. Generate different tones on a piezo buzzer using Arduino.</li> <li>g. Use a soil moisture sensor to water plants automatically when the soil is dry.</li> <li>h. Use a temperature sensor (e.g., LM35) to control a fan (relay-based) depending on the temperature.</li> <li>i. Mix colors using an RGB LED controlled by potentiometers.</li> <li>j. Measure distance using an ultrasonic sensor and display the result on the Serial Monitor or LCD screen.</li> <li>k. Control the brightness of an LED using a button.</li> <li>l. Create a simple counter on an LCD that increases or decreases when a button is pressed.</li> </ol> <p>etc</p>	IV		10
19	Demonstrate the basic terms of PCB (Pad, Track, Footprint, Via, DRC, ERC, Silk screen, Cu layers, Mask)	V	CO5	2
20	Demonstrate various types of PCBs and their uses.	V		2
21	Overview of KiCad User Interface (project manager, schematic editor, PCB editor)	V		2



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22	<p>Design the sample schematic using KiCad schematic design option. (Understanding symbols and libraries, placing components, wiring components)</p> <p>Schematic Suggestions:</p> <p>a. 555 based Timer circuit</p> <p>b. Bridge Rectifier with voltage regulator</p> <p>d. Demonstration circuit of Ohm's Law</p> <p>e. Demonstration circuit of Resistor Series Parallel</p> <p>g. Circuit related to basic electronics.</p> <p>f. op-amp based mini projects</p> <p>etc</p>	V	4
23	<p>Annotating the schematic and Electrical rules check (ERC) in KiCad tool. (Create and resolve the different Electrical errors) (Perform annotating and ERC on same schematic which is designed in Practical 22)</p>	V	2
24	<p>Demonstrate various types of Through-Holes and SMD Footprints.</p> <p>(a) Resistor Footprint: For through-hole (e.g., 1/4W, 1/2W) or SMD resistors (e.g., 0805, 0603, 1206).</p> <p>(b) Capacitor Footprint: For through-hole or SMD capacitors (e.g., 0805, 1206, Tantalum).</p> <p>(c) Integrated Circuits (ICs): IC footprints vary greatly depending on package types like DIP, SOIC, QFN, BGA, etc.</p> <p>(d) Connectors: Varies based on the type of connector (e.g., pin headers, USB, RJ45).</p> <p>(e) Transistors: For both through-hole and SMD packages like TO-220, SOT-23.</p>	V	4
25	<p>Perform the foot print allotment process for all the components of schematic. (Perform this process on same schematic which is designed in Practical 22)</p>	V	2
26	<p>Perform the process of Converting the schematic to PCB and Setting board dimensions, Board Edge and Optimal placement of footprints using KiCad PCB design option. (Perform this process on same schematic which is designed in Practical 22)</p>	V	2



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27	Demonstrate the Manufacturing Constraints of PCB (a) Layer Count and Stack-up (b) Minimum Trace Width and Spacing (c) Component Placement (d) Hole Sizes	V		2
28	Demonstrate the Electrical Safety Constraints and Mechanical Constraints of PCB (a) Board Shape and Size (b) Mounting Holes and Cutouts (c) Electrical Isolation (d) Clearance for high-voltage circuits	V		2
29	Setting trace widths, clearance and via size in KiCad tool (Perform this process on same schematic which is designed in Practical 22)	V		2
30	Perform the layout design and manual routing using KiCad PCB design option. (Perform this process on same schematic which is designed in Practical 22)	V		4
31	Perform Design Rule Check (DRC) and Finalizing the PCB Design (Perform this process on same schematic which is designed in Practical 22)	V		2
32	Perform Generating Gerber Files and inspection of Gerber file using Gerber inspection tool of KiCad. (Perform this process on same schematic which is designed in Practical 22)	V		2
33	Demonstrate the Preparing for Prototyping. (a) Choosing a PCB manufacturer (b) Costs and lead times	V		2
34	Make a chart or presentation on E-Waste management, Electronic Waste Recycling and its Disposal	V	CO1,3,4	2
35	Prepare the table of different steps to recycle the electronic waste.	V		2
<b>Total</b>				<b>90</b>

**Note**



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- i. More Practical Exercises can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- ii. Utmost Care must be taken while students are doing experiments related to electrical appliances. All safety precautions must be observed while dealing with 230 V AC. Also, while doing soldering practices student must avoid the direct contact of tip of soldering iron on body or on table/platform. Teacher has to discuss about latest type of electronics components used in consumer electronics gazettes.
- iii. For more facilitate and familiar with building electronics circuit every student should purchase basic workshop tools like soldering iron, de soldering pump, bread board and good quality Digital Multi-meter.
- iv. For better soldering practices, in a group maximum four student should allowed.
- v. Micro-project should be made individually by student to develop practical skill related to goal of this subject.
- vi. Interested student can assemble the electronic projects which are ready made available as discrete component and PCB in commercial market.
- vii. Every institute must possess different variety of latest electronics components, measuring instruments and consumable materials to give enough justice to teach this subject as suggested in Unit 1 of underpinning theory section.
- viii. Students are advised to search more knowledge of typical components on U tube or internet where so many demonstration videos are available.

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare of experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safety measures and practices	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
<b>Total</b>		<b>100</b>



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## • List of Laboratory/Learning Resources Required:

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practicals in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	<b>Digital Multimeter:</b> 3 1/2 digit display, 9999 counts digital multimeter measures: Vac, Vdc (1000V max), A <sub>dc</sub> , A <sub>ac</sub> (10 amp max), Resistance (0 - 100 M) , Capacitance. hfe measurement	1 to 18
2.	DC power supply (0-5V/5A, 0-12V/5A, +/-15V/3A)	1 to 18
3.	<b>Cathode Ray Oscilloscope (CRO)</b> with component testing facility	4,5,8
4.	<b>Function generator:</b> different arbitrary signals Sine, Triangle, Square with amplitude and frequency variation facility with digital display.	4,5,8
5.	<b>Discrete Component Trainer/ Analog component Trainer:</b> various types of components display trainer boards like: resistors, capacitors, Inductors, diodes, transistors, switches, cables, connectors, fuses etc..	1 to 18
6.	<b>Electronic Components</b> <ul style="list-style-type: none"><li>• Different types/ values of Resistors, Capacitors, Inductors (Fixed value &amp; Variable)</li><li>• Step down transformers, Center tapped transformers (12-0-12)</li><li>• Diode, LED, Diac, Traic, Photo Diode, LDR, Zener Diode, Varactor Diode, 7 Segment LED, Photodiode</li><li>• Transistors (BC-547, BC-548, 2N2222, BC847, TIP122)</li><li>• SMD components Resistors, Capacitors, Diode</li><li>• Chip transistors, Bridge rectifier, Resister arrays</li><li>• Digital ICs NAND.NOR, NOT, EX-OR, HALF ADDER, FULL ADDER, DRIVER, DECODER, 7 SEGMENT LED, ENCODER,MUX,DE-MUX</li><li>• ICs 74XX and 79XX SERIES</li><li>• IC 78XX series, IC555, IC741, IC 317</li><li>• Breadboards</li><li>• Buzzers, Loudspeaker, Microphone, Crystals</li></ul>	1 to 18



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Sr. No.	Equipment Name with Broad Specifications	PrO. No.
	<ul style="list-style-type: none"><li>● cables and connectors of Different category</li><li>● Fuses of Different category</li><li>● Relays of Different category</li><li>● Switches of Different category</li></ul>	
7.	<b>Workshop Tools:</b> Bread board, Copper clad laminate sheet, Solder iron, soldering wire, solder-stand, Cutter, Nose Plier, Flat cutter, Combination Plier, Screwdriver set, Tweezers, Wire stripper, Allen key set, Flat chisel, De-solder pump, De-solder wick, Portable Drilling machine, crimping tool, Drawing sheets, Drafters	6,8,9 to 18
8.	<b>Soldering practice related:</b> Soldering Iron, De-soldering pump, Soldering and De-soldering Station with temperature-controlled iron and Hot air Gun, Flux, Bread boards, General Purpose PCB, different types of PCB samples.	9,10,18
9.	Demonstration chart for different category of measuring instruments, electronic component sensors and actuators.	11,12,17
10.	Different Sensors: Temperature Sensor (LM35) Humidity Sensor (DHT11), Gas Sensors (MQ-2, MQ-5, MQ135), Light Sensors (LDR, Photodiode(PT334), Phototransistor(L14G1)), Piezo pressure sensors, Strain gauge (Load-Cell), Color Sensor (AS7341), Capacitive Touch Sensors module, Magnetic Hall-effect sensor (AH49E, SS49E), IR Proximity Sensor, PIR Motion Sensor, IR based object range measurement sensor HC-SR04, Rotary encoders, vibration sensors, Microphone, Accelerometer(ADXL345), XY-axis joystick, Gyroscope sensor (ITG3200), micro switch, Tilt Sensor, Laser Sensors, Image Sensors, Biometric Sensors.	11,12,17
11.	<b>Actuators:</b> Identify and test the working of different type of Actuators used in different applications: DC Motors, AC motors, Servo Motors (SG90), Stepper Motors, Relays, SSR, solenoid valves, pneumatic valves, Piezoelectric actuators, LEDs (different color, RGB), alphanumeric displays, Speakers, buzzers, Heaters, Coolers, Compressors.	12,17
12.	Arduino Uno, Arduino Nano, Arduino Mega boards.	13 to 18



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Sr. No.	Equipment Name with Broad Specifications	PrO. No.
13.	Various IC packages samples: DIP, TSSOP, QFP, QFN, BGA, SMT.	19 to 31
14.	Guidelines for E-waste management by Ministry of Environment and Forest, and Restriction of Hazardous Substance Directive (RoHS).	34,35

- **Suggested Project List:**

**Only one micro-project** is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student should maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16 (fourteen to sixteen) student engagement hours** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

- Different types of electronic component:** Prepare a board consist of different Resistor, Capacitor, Inductor, chokes, transformer, fuse, diode, and transistor.
- Charts of Sensors and actuators:** Prepare charts of different sensors and actuators with their characteristics, working and uses in different applications.
- Arduino based small applications:** Prepare small applications which uses Arduino board, sensors, actuators, general purpose board along with component soldering.
- Sorting of waste:** Compile a report for sorting different types of electronic and plastic waste.
- Design PCB of any electronics circuit using Ki-cad.**



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## Suggested Activities for Students:

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

- a) Prepare specification of some electrical and electronic components.
- b) Give seminar on reading a datasheet of latest electronic components.
- c) Practice sessions of soldering and de-soldering practices.
- d) Prepare charts of different components and its symbols.
- e) Give seminar on various Sensors and actuators.
- f) Give seminar on open-source Arduino IDE.
- g) **Arrange workshop on PCB design.**
- h) Prepare Job Hazard Analysis report for soldering techniques used in industry.
- i) **Visit any factory where student can see assembly line or PCB fabrication.**
- j) Prepare the Charts that classify recycling process for electronic waste and plastics.

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