

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**

Semester-II

Course Title: Electronics Workshop

(Course Code: 4321101)

Diploma programmer in which this course is offered	Semester in which offered
Electronics and Communication Engineering	Second

1. RATIONALE

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 plastic 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.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Build electronic circuits on Plastic Circuit Board (PCB) using relevant tools following appropriate safety measures.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

- a) Test various electronic components by using appropriate measuring instruments.
- b) Assemble electronic circuit on bread board or general purpose PCB using appropriate tools.
- c) Create schematic & layout on Plastic Circuit Board (PCB) using PCB design Software.
- d) Follow safety practices along with disposal of E- Waste.**
- e) Build miniature Electronic Circuit as a minor Project.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	CA	ESE	CA	ESE	
0	0	4	2	00	00	25*	25	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.

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). Some of the PrOs marked ‘*’ are compulsory, as they are crucial for that particular CO at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Demonstration/Introduction of working of all kind/category of workshop tools, materials and measuring equipments as stated in Unit 1 in Underpinning theory section.	I	02
2	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	04
3	Practicing of soldering and De soldering of resistor, capacitor and other components electronics component on General Purpose PCB.	I	02
4	Test all the components used in Simple linear capacitive filtered DC power supply up to 12 Volt and build it on bread board.	II	02
5	1. Build and test DC power supply using IC 78xx, IC 79xx or IC 317 on general purpose PCB (Any One IC) 2. Find out line regulation using VARIAC.	II	02
6	Test the functionality of Light Operated Relay, an electronics circuit fabricated either on breadboard or on general purpose PCB.	II	02
7	Download and interpret Data sheets with respect to Specifications, package and applications of following components from using internet (For any five component in laboratory): (a) Diodes 1N4001 to 1N4007, 1N4148, 2N5402, 2N5408,BY127 (b) Zener Diode - 5V6 (c) Photo diode - BPW10 (d) LED - & Multi colored LED	I	04

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	(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.		
8	1. Demonstration of male and female type connectors and cables. 2. Prepare BNC to BNC, BNC to crocodile pin cable , ETHERNET LAN (RJ 45) cable and various patch cord used in trainer kits.	I	02
9	Create schematic and layout of given electronic circuit using any PCB design software and fabricate complete PCB (with Drill) (Circuits given as a guideline only): (a) +/-12V Regulated Power supply Using IC 7812 , 7912 & 317 (b) Light operated Relay (c) TV remote checker using transistor ,IR photo diode, red LED (d) Touch switch using transistor (e) Door safety using Reed and magnet (f) Water level alarm using single transistor (g) Opaque Object sensing alarm using LDR, transistor & Buzzer (h) Infrared Motion detector. (i) Lead-acid battery charger (j) AC to DC 12V LED Strip Driver Circuit (k) Street Light Circuit using LDR (l) Automatic Washroom Light Switch (m) Auto Intensity Control of LED Lights (n) Cell Phone Detector Circuit (o) Basic Logic Gates using NAND Gate (p) Basic Logic Gates using NOR Gate (q) Binary to Grey Code converter circuit (r) Half Adder and Full Adder Circuit (s) JK flip flop and SR flip flop circuit (t) Multiplexer circuit 8x1	III	06

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	(u)Clapp switch		
10	Trace electronic circuit from the given PCB layout or Soldered PCB of an electronic circuit.	III	02
11	Prepare and test AC power extension board (5 Amp.) with 4 plugs ,Power indication facility and safety precaution (Fuse)	IV	02
12	Demonstration of Wiring of single phase AC power distribution arrangement in which MCB / ELCB / RCCB, Energy meter and various electrical loads are connected to understand power utilized.	IV	02
13	Demonstration on usage of series lamp and clip on meter to test functioning of electrical gazettes.	IV	02
14	Demonstrate precautionary steps by using different type of safety aid and equipment to adopt Safe work practices on electronics assembly line .	IV	02
15	Draw symbols of various electronic components on drawing sheets.	I	02
16	Draw the circuit diagrams of various (Simple to Complex) electronic circuits on drawing sheets.	I	02
17	Identify different types of batteries with their specifications and study battery charger circuit	I	02
18	Make a chart or presentation on E-Waste management, Electronic Waste Recycling and its Disposal	IV	02
19	Mini project: <ol style="list-style-type: none"> For basic/Simple real time electronic applications, Select electronics circuit, Develop PCB layout using any PCB designing software Build it on PCB (Which must be self prepared) Test/Debug/Run it . Prepare small Project report describing above procedure. 	II V	06
20	Perform mock-drill for fire safety in workshop.	IV	02
21	Prepare the table of different steps to recycle the electronic waste.	IV	02
	Minimum 14 Practical Exercises		28

Note

- 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 must 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. *Miniature project as stated in unit 5 must 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. Many mobile android apps are available related to electronics components, explore them .*

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 safe practices measures	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
Total		100

6. Major Equipments , Tools and Consumables Required

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

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Digital Multimeter: 3 1/2 digit display, 9999 counts digital multimeter measures: Vac, Vdc (1000V max), A _{dc} , A _{ac} (10 amp max) ,Resistance (0 - 100 M) , Capacitance. hfe measurement	1,4,6,7,8,10,13,14, 21
2.	Cathode Ray Oscilloscope (CRO) with component testing facility,	1,3

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
	Function generator, Signal Generator, DC power supply	
3.	Discrete Component Trainer/ Analog component Trainer: 2mm patch cords in interconnecting components, Collection of utilities like fixed and variable D.C. supplies, electronic Components like, LDR, Transistor, Photo diode, IC 78XX, IC 79XX resistors, capacitors, inductors, LED's, Built in variable DC supply dual ± 0 to 15V/ 500mA, fixed DC power supply, $\pm 12V / 500$ mA, fixed DC power supply +5V/500mA, Built in AC supply.	2,3,4,5,6,7
4.	Electronic Components <ul style="list-style-type: none"> • Different types/ values of Resistors, Capacitors, Inductors (Fixed value & Variable) • Step down transformers, Center tapped transformers • Diode, LED, Diac, Traic, Photo Diode, LDR, Zener Diode, Varactor Diode, 7 Segment LED, Photodiode • Transistors(BC-547,BC-548,BC-107,BC-108,AC-127,AC-128,SC-100 • SMD components Resistors, Capacitors, Diode • Chip transistors, Bridge rectifier ,Resister arrays • Digital ICs NAND.NOR,NOT,EX-OR,HALF ADDER,FULL ADDER, DRIVER, DECODER, 7 SEGMENT LED, ,ENCODER,MUX,DE-MUX • ICs 74XX and 79XX SERIES • IC 78XX series, IC555, IC741, IC 317 • Breadboards • Buzzers, Loudspeaker, Microphone, Crystals • cables and connectors of Different category • Fuses of Different category • Relays of Different category • Switches of Different category 	2,3,4,5,6,7,8,12,21
5.	Workshop Tools : Bread board , Copper clad laminate sheet, Solder iron, solder-stand, Cutter, Nose Plier, 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	1,5,6,7,8,10,13,21
6.	Soldering Practice Related : Soldering Iron, De-soldering pump, Soldering and De-soldering Station with temperature controller, Hot air soldering and soldering station, Bread	5,6,7,8,21

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
	boards , General Purpose PCB, PCB Boards	
7.	Demonstration chart for different category of measuring instruments, electronic component and materials.	1,4
8.	Demonstration Board for operation of Relay .	8
9.	Demonstration Board for operation of MCB, ELCB, RCCB, with electrical load items like lamp, fan and tube light with electric watt meter.	14
10.	Series Test Lamp to test electrical gazettes. Mini clip ON meter	13,14,15
11.	Portable Mini PCB Drilling machine used for drilling hole in PCB	11,21
12.	Variable AC output transformer (VARIAC)	7
13.	Crimping Tool and LAN cable tester.	10
14.	Guidelines for E-waste management by Ministry of Environment and Forest, and Restriction of Hazardous Substance Directive (RoHS).	20,22,23

7. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

- a) Work as a leader/a team member.
- b) Follow safety practices while using electrical, electronic instruments and tools.
- c) Realize importance of E-waste management. (Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- i. 'Valuing Level' in 1st year
- ii. 'Organization Level' in 2nd year.
- iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
<p style="text-align: center;">Unit-I</p> <p>Identification and Testing of Electronics components</p>	<p>1a. Identify and Demonstrate terminals of different Electronic components</p> <p>1b. Test different Electronic components</p> <p>1c. Use of test and measuring instruments</p> <p>1d. Usage of various Workshop Tools</p> <p>1e. Interpretation of Data sheets</p> <p>1f. Drawing of symbols and electronic Circuits</p>	<p>1.1 Passive Electronic components</p> <ul style="list-style-type: none"> • All category of fixed and variable Resistor, Inductor, Capacitor, Rheostat, Resistor Arrays, <p>1.2 Active / Semiconductor components</p> <ul style="list-style-type: none"> • Diode, Zener, Diode, Varactor diode, LED, Bridge rectifier, Photo diode, BJT, Photo transistor, FET, LDR, Solar cell, Photocell, Opto-coupler, DIAC, TRIAC, 7 segment LED, NTC Thermister, SMD Components. <p>1.3 Miscellaneous Components</p> <ul style="list-style-type: none"> • Cables Multi core, multi strand, Co axial, Twisted pair, Optical fiber cable, Ribbon wire, printer cable, Power cable, AV cable, Aux Cable, XLR cable, VGA Cable, DVI cable, HDMI cable, • Transformer Step down transformer, Auto transformer, Pulse transformer, Inter mediate Frequency Transformer (IFT) • Fuse AC fuse, DC fuse, Glass, Ceramic fuse, Metal Oxide

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		<p>Varistor (MOV) fuse, High Rupturing Capacity (HRC)fuse, Switch fuse, Resettable/poly fuse, Automotive fuse, SMD fuse,</p> <ul style="list-style-type: none"> • Switches SPST, DPDT, Membrane, Push button with latch, Toggle, Rotary Tactile, Micro switch, Limit switch, DIP switch, Thumbwheel switch, Membrane switch, Touch switch, Thermal switch (Bi metallic strip) • Connectors BNC, DC Connector, Screw terminal, Banana Connector, DIN connector, JST connector, Micro USB, Type C, OTG connector, Jack pin, XLR Pin for microphone, RJ-45 connectors, Insulation Displacement Connector (IDC) • AC Source: Single phase, and Three Phase. • DC Source: All kind DC Battery (AA,AAA, Rechargeable), Mobile batteries, Variable DC Power supply • Relay Electro-mechanical, solid state, Thermal relay, Hybrid relay, Reed General purpose relay, specifications of relay

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		<ul style="list-style-type: none"> • IC : Linear IC, Digital IC, Various IC packages like SIP,DIP,ZIP,TO 5, TO 92,TO 18, TO 220,TO 2205,BGA,SMD packages. • Condenser Microphone • Magnetic Buzzers, Piezzo buzzer • Loudspeaker ,Miniature speaker • Crystals • EMI Filters • Heat sink , silicon grease <p>1.4 Measuring Instruments: Analog Multimeter, wattmeter, Digital Multimeter, LCR-Q meter, CRO, DSO, Function Generator, Digital Field strength meter, Frequency counter ,Portable Digital Clamp ON meter, Electric tester, Series test lamp, Electronic Continuity tester, Non contact AC voltage tester, Digital Voltage tester</p> <p>1.5 Workshop Tools Bread board , Copper clad laminate sheet, Solder iron, solder-stand, Cutter, Nose Plier, Combination Plier, Screwdriver set, Tweezers, Wire stripper, Allen key set, Flat chisel, De-solder pump , De-solder wick , Portable Drilling machine , Crimping tool</p> <p>1.6 Workshop materials : Solder-wire, flux, Flexible wire , Hookup wire ,Ribbon wire, General Purpose PCB,</p>

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		<p>Breadboard of Different size.</p> <p>1.7 Interpretation of Manufacturer's Datasheet of:</p> <ul style="list-style-type: none"> - Diodes IN4001 to 07, IN4148; 2N5402, 2N5408, BY127 - Zener Diode, Photo diode, LED, Varactor diode, Seven segment LED - Transistors BC107, BC177, BC547/548, SL100, SK100, AC127/128, BF194, TIP122, Photo transistor - voltage regulator IC78XX, 79XX, LM317 - Packages of various SMD components: Resistor, Capacitor, Inductor, Diode-LL4148, SM4007, Chip transistor, Chip Darlington transistor, Bridge rectifier. <p>1.8 Drawing : Symbols and electronics Circuits on drawing sheets.</p>
<p>Unit– II</p> <p>Assemble Electronics Circuit</p>	<p>2a. Implement Electronic circuit on breadboard</p> <p>2b. Implement Electronic circuit on General purpose Board</p>	<p>2.1 Soldering of Electronics components on General Purpose PCB with observing all safety precautions.</p> <p>2.2 Implement miniature circuit on bread boards and test it.</p> <p>2.3 Implement miniature circuit on General Purpose PCB board and test it.</p> <p>2.4 Zero defect soldering</p>
<p>Unit-III</p> <p>PCB Design</p>	<p>3a. Create PCB layout manually.</p> <p>3b. Create schematic layout of Printed Circuit Board (PCB) using open source PCB design Software.</p> <p>3c. Trace circuit from given PCB layout on the PCB.</p>	<p>3.1 Design manually and fabricate single sided PCB with manual etching (FeCl3) and perform drilling for a chosen electronic circuit.</p> <p>3.2 Create a schematic of the chosen circuit using PCB design software.</p> <p>3.3 Generate net lists and arrange</p>

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		<p>components in a neat manner.</p> <p>3.4 Route nets, and finalize Layout with proper placement of copper pours, labeling, mounting holes.</p> <p>3.5 Generate design files (Gerber files) and solder components on made PCB.</p> <p>3.6 Fabricate PCB with drilled holes</p> <p>3.7 Tracing of circuit from a given soldered PCB</p>
<p>Unit-IV</p> <p>Safety</p> <p>Precautions and E-waste Recycling</p>	<p>4a. Electrical safety Practices.</p> <p>4b. Describe the components of Electronic waste.</p> <p>4c. Disposal of E- Waste.</p> <p>4d. Explain the steps of recycling process of electrical and Electronic waste.</p>	<p>4.1 Concept of electrical Wiring diagram of Domestic home</p> <p>4.2 Specifications and usages of MCB,ELCB and RCCB</p> <p>4.3 Wiring of extension board</p> <p>4.4 a) Need of earthing b) Static Charge removal technique</p> <p>4.5 Components of Electronic waste</p> <p>4.6 Steps for Recycling process of electronic and electrical waste: a) Collection and Transportation b) Shredding and sorting, c) Dust Extraction, d) Magnetic separation, e) Water separation, f) Purification of Waste (Plastic, Metal, Glass)</p> <p>4.7 Prepare the recycled material for useful utilization</p>
<p>Unit-V</p> <p>Mini Project</p>	<p>5a. Build Electronic Circuit on the PCB.</p> <p>5b. Test/ Debug/ Run the Project.</p>	<p>5.1 Fabrication/Drilling of PCB for a selected electronic circuit.</p> <p>5.2 Component selection & testing.</p> <p>5.3 Component mounting & Soldering.</p> <p>5.4 Testing and trouble shooting of circuit.</p> <p>5.5 Prepare report in proper format.</p>

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Testing of Electronic component		Not Applicable			
II	Assemble Electronic circuit					
III	Preparing schematic and Layout using PCB design software					
IV	Safety precautions & E-waste recycling					
V	Mini project					

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

10. SUGGESTED STUDENT ACTIVITIES

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:

- Seminar on specification of some electrical and electronic components/ Gazettes.
- Prepare Job Hazard Analysis report for soldering techniques used in industry.
- Give seminar on any PCB designing software.
- Visit any factory where student can see assembly line or PCB fabrication.
- Prepare the Charts that classify recycling process for electronic waste and plastics.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- Guide student(s) in undertaking micro-projects.
- 'L' in section No. 4 means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- About **20% of the topics/sub-topics** which are relatively simpler or descriptive in nature is to be given to the students for **self-learning**, but to be assessed using different assessment methods.
- With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- Introduce E-waste recycling technology among the students.
- Guide students for reading data sheets.
- Motivate student to install and use different open source PCB designing software.

12. SUGGESTED MICRO-PROJECTS

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 will have to 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:

- a) **Different types of electronic component:** Prepare a board consist of different Resistor, Capacitor, Inductor, chokes, transformer, fuse, diode, and transistor.
- b) **Designing electrical wiring** for a auditorium ,department or own home, : Prepare a detailed budget report that consist of all consumables covering switches, ELCB, MCB, plug point, AC /Heater/Geyser point and wires.
- c) **Electronic Trainer** : Prepare training board that could be used in laboratory of other electronic subject with due guidance of concern subject faculty.
- d) **Sorting of waste:** Compile a report for sorting different types of electronic and plastic waste.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	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
2	Printed Circuit Boards: Design and Technology	Bossart	TMH, latest edition ISBN-10 9907414700 : ISBN-13 9907414704-009 :
3	Printed Circuit Boards	R S KHANDPUR	Tata Mcgraw Hill ISBN : 9780070588141
4	Build Your Own Printed Circuit Board	Al Williams	Mc Graw Hill, latest edition ISBN-10 9909947999 : ISBN-13 9909947999-009 :

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
5	Making Printed Circuit Boards	Jan Axelsen	Mc Graw Hill, latest edition
6	PCB Design: Printed Circuit Board.	Michael Dsouza	Kindle Edition
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
9	E-waste Recycling and Management Edition Number-1	Anish Khan, Ina muddin, AbdullahM. Asiri	Springer, Cham, ISBN: 978-3-030-14183-7, 2020
10	ROHS Compliance A Complete Guide - 2020 Edition	Gerardus HYPERLINK "https://www.amazon.in/s/ref=dp_byline_sr_book_1?ie=UTF8&field-author=Gerardus+Blokdyk&search=alias=stripbooks "Blokdyk	5starcooks, ISBN-10,9044029794 : ISBN-13,9044029790-009 : 23/09/2019

14. SOFTWARE/LEARNING WEBSITES

- <https://shaileshdhoriyani.webs.com/apps/blog> (for basic electronic components)
- <https://www.electrical4u.com/types-of-resistor> (for Resistor)
- https://www.electronics-tutorials.ws/resistor/res_1.html (for Resistor)
- <https://www.electronicshub.org/types-of-diodes/> (for Diodes)
- <https://www.electronicshub.org/design-of-basic-logic-gates-using-nand-gate/>
- <https://circuitdigest.com/electronic-circuits>
- <https://www.circuitstoday.com/simple-electronics-projects-and-circuits>
- <https://circuiteasy.com/>
- <https://nptel.ac.in> (for online courses and video of all engineering branches)

- www.electronicsforu.com (for basic electronic projects and technical videos)
- <https://www.vlab.co.in>(Virtual Lab for all engineering branches)
- Fritzing – PCB Designing Open Source Software.
- KiCAD – PCB Designing Open Source Software.
- <http://dl.mitsubishielectric.com/dl/fa/document/catalog/lvcb/yn-c-0729/y07291307.pdf> (for MCB)
- <https://www.electricaltechnology.org/2019/07/mcb-mccb-elcb-rcb-rcc-rccb-rcco.html> (for MCB, ELCB,RCCB)
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2963874/> (E-waste in Electronics)
- https://cpcb.nic.in/uploads/Projects/E-Waste/e-waste_amendment_notification_06.04.2018.pdf (For E-waste Recycle guidelines)
- <https://cpcb.nic.in/displaypdf.php?id=RS1XYXN0ZS9FLVdhc3RITV9SdWxlc18yMDE2LnBkZg==> (For E-waste Recycle guidelines)
- <https://cpcb.nic.in/e-waste/> (For E-waste Recycle guidelines)
- <https://www.rohsguide.com/> (For E-waste Recycle guidelines)
- https://www.meity.gov.in/writereaddata/files/1035e_eng.pdf (For E-waste Recycle guidelines)
- <https://www.meity.gov.in/content/gazettes> (For E-waste Recycle guidelines)

15. PO-COMPETENCY-CO MAPPING

Semester II	Electronics Workshop (Course Code: 4321101)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Built electronic circuits on PCB using relevant tools following appropriate safety measures						
Course Outcomes							
CO 1) Identification and testing of various electronic components by using appropriate measuring instruments.	3	2	2	3	1	1	2
CO 2) Assemble electronic circuit on bread board or general purpose PCB using appropriate tools.	3	2	3	3	1	1	2
CO 3) Create schematic & layout .0on Plastic Circuit Board (PCB) using PCB design Software.	3	3	3	3	1	1	2
CO 4) Follow safety practices along with disposal of E-	1	1	1	2	3	1	2

Waste.							
CO 5) Building miniature Electronic Circuit as a minor Project.	3	3	3	3	2	3	3

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

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