GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021) Semester-II

Course Title: Electronics Workshop for ICT
(Course Code: C4323201)

Diploma programme in which this course is offered	Semester in which offered
Information and Communication Technology	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 practices on mounting, soldering and de-soldering electronic components on printed circuit board (PCB). Students will attain fundamental skills of selection of appropriate components and devices, 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.

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 and test different electronic applications based on PCB using electronic components, Sensors, actuators and relevant hardware and software tools along with fulfillment of necessary 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 instruments.
b) Use various types of cables, connectors and switches.
c) Identify various sensors and actuators and their usage for different real time applications.
d) Assemble electronic circuit on bread board and PCB.
e) Develop micro project based on sensors, Actuators, Electronics components and Arduino IDE.
f) Follow safe practices to prevent accidents/ hazards to personnel and environment.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	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	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
2	Identify different types of batteries with their specifications	I	02
3	Use of Electronics Application Software for different electronic circuit design.	I	04

4	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	04
5	Demonstration of working of all kind/category of workshop tools, materials and measuring equipments as stated in Unit 1 in Underpinning theory section.	II	02
Sr. No.	**Practical Outcomes (PrOs)**	**Unit No.**	**Approx. Hrs. Required**
6	Measure value of fixed and variable resister, (potentiometer) inductor and capacitor (Trimmers) using LCR-Q meter.	II	01
7	Test electronic components using “Component Test “tab of CRO.	II	01
8	1. Demonstration of male and female type connectors and cables. 2. Fabricate probe for CRO, ETHERNET LAN cable (straight and cross)and patch cord.	III	02
9	Demonstration and implementation of various Cable and connectors for suitable application.	III	02
10	Presentation on Cables and Connectors and their implementation.	III	02
11	Connection of different switches in simple circuits on breadboard	III	02
12	Identify different types of sensors.	IV	02

13	Identify different types of Actuators	IV	02
14	Practicing of soldering and De soldering of resistor, capacitor and other components electronics component on General Purpose PCB.	V	02
15	Demonstrate various types of PCBs and their uses.	V	01
16	Practicing of soldering and De soldering of resistor, capacitor and other electronics components on General Purpose PCB.	V	02
17	Demonstrate various types of IC packages and their soldering techniques (Through video or any ICT source)	V	02
18	Introduction to Arduino IDE as open-source tool.	VI	04
19	Implement different I/O functions of Arduino board	VI	02
20	Implement LED blinking code on Arduino board.	VI	02
21	Implement code to interface switch and LED	VI	02
22	Demonstrate working of various sensors and actuators on Arduino board.	VI	04
23	Make a chart or presentation on E-Waste management, Electronic Waste Recycling and its Disposal	VII	02
24	Perform mock-drill for fire safety in workshop.	VII	02
25	Prepare the table of different steps to recycle the electronic waste.	VII	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. *Micro-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.*

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
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	5,6,12,13,16,17,18 ,19,20,21,22
2.	DC power supply (0-5V/5A, 0-12V/5A, +/-15V/3A)	1,4,5,6,12,13,16,1 7,18,19,20,21,22
3.	**Cathode Ray Oscilloscope** (CRO) with component testing facility	1,4,,5,6,7,8

4.	**LCR-Q meter**	6

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
5.	**Function generator:** different arbitrary signals Sine, Triangle, Square with amplitude and frequency variation facility with digital display.	1,4,5,6,12,13,18,19,20,21,22
6.	**Discrete Component Trainer/ Analog component Trainer:** various types of components display trainer boards like: resisters, capacitors, Inductors, diodes, transistors, switches, cables, connectors, fuses etc..	1,4
7.	**Electronic Components** ● Different types/ values of Resistors, Capacitors, Inductors (Fixed value & Variable) ● Step down transformers, Center tapped transformers (12-0-12) ● 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,AC128,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	1,4,6
8.	**Workshop Tools :** 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	11,14,15,16,17

9.	**Soldering practice related**: 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.	14,15,16,17
10.	Demonstration chart for different category of measuring instruments, electronic component sensors and actuators.	12,13,22
Sr. No.	**Equipment Name with Broad Specifications**	**PrO. No.**
11.	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 Halleffect 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.	12,22
12.	**Actuators:** 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.	13,22
13.	Arduino Uno, Arduino Nano, Arduino Mega boards.	18,19,20,21,22
14.	Various IC packages samples: DIP, TSSOP, QFP, QFN, BGA,SMT.	17
15.	Guidelines for E-waste management by Ministry of Environment and Forest, and Restriction of Hazardous Substance Directive (RoHS).	23,24,25

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 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	
Unit-I Identification and Testing of Electronics components	1a. Demonstrate and Identify terminals of different Electronics components 1b. Read and interpret Specifications, parameter values and ratings of electronic components. 1c. Interpretation of Data sheets. 1d. Drawing symbols of electronic components.	**1.1**	**Passive Electronic Components:**
			All category of fixed and variable Resistor, Inductor, Capacitor, Rheostat, Resistor Arrays.
		1.2	**Active/ Semiconductor components:**
			Diode, Zener Diode, Varactor diode, LED, Bridge rectifier, Photo diode, BJT, Photo transistor, FET, LDR, Solar cell, Photocell, Opto-coupler, DIAC, TRIAC, laser, 7- segment Display, NTC Thermistor, SMD Components.
		1.3	**Miscellaneous Components**
			AC Source: Single phase, and Three Phase.
			DC Source: All kind DC Battery, and Variable DC Source.
			Transformer: Step down transformer, Auto transformer, Pulse transformer, Inter mediate Frequency Transformer (IFT)
			Fuse: AC fuse, DC fuse, Glass, Ceramic fuse, Metal Oxide Varistor (MOV) fuse, High Rupturing Capacity (HRC)fuse, Switch fuse, Resettable/poly fuse, Automotive fuse, SMD fuse.

		1.4	**Interpretation of Manufacturer's Datasheet of:**
			- 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.
		1.5	**Drawing**:
			Symbols and electronics Circuits on drawing sheets.

Unit– II Testing of different Electronics components using appropriate tools and measuring Instruments	2a. Test different electronic component's parameters 2b. Use of measuring instruments 2c. Use of various Workshop Tools.	**2.1**	**Measuring Instruments:**
			Analog Multi meter, wattmeter, Digital Multi meter, 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
		2.2	**Use of electronics Application Software:**
			Selection, connection of electronic components, design electronic circuit and simulation of circuit using open-source application
Unit– III Working and Applications of different types of cables,	3a. Types of wires/cables, Sizes and Installation 3b. Connectors and their specifications.	**3.1**	**Cables:**
			Multi core, multi strand, Co axial, Twisted pair, Optical fiber cable, Flat ribbon cable, printer cable, Power cable, AV cable, flexible wires
		3.2	**Connectors**

connectors and switches	3c. Different types of switches and their applications.		BNC, DC Connector, Screw terminal, Banana Connector, DIN connector, JST connector, Jack pin, XLR Pin for microphone, RJ-45, RJ-11, connectors, Insulation Displacement Connector (IDC), RS232, HDMI, USB 2.0,USB 3.0,Micro USB, Type C , OTG connector, FRC, Berg strip 2.3
		3.3	**Switches**
			SPST, SPDT, DPDT, Membrane, Push button with latch, Toggle, Rotary, Tactile, Micro switch, Limit switch, DIP switch, Thumb wheel switch, Level switch, Touch switch, Thermal fuse (Bi metallic strip) Relay, Static switches, Proximity switch, Hall effect switch, MCB, ELCB
Unit-IV Identifying Application specific Sensors and Actuators	4a. Identify sensors and actuators for various applications. 4b. describe input and output of different sensors and actuators.	**4.1**	**Sensors**
			Identify and test the working of different type of sensors used in different applications: Temperature Sensor (Thermistor, Thermocouple), Humidity Sensor, Gas Sensors, Light Sensors (LDR, Photodiode, Phototransistor), Piezo pressure sensors, Strain gauge, Color Sensor, Capacitive Touch Sensors, Magnetic Hall-effect sensor, IR Proximity Sensor, PIR Motion Sensor, IR based object range measurement sensor HC-SR04,
	4c. Test sensors and actuators for various applications.		vibration sensors, Microphone, Biometric Sensors (Figure print, face recognition).
		4.2	**Actuators**
			Identify and test the working of different type of Actuators used in different applications: DC Motors, AC motors, Servo Motors, Stepper Motors, Relays, SSR, solenoid valves, Piezoelectric actuators, LEDs (different color, RGB), alphanumeric displays, Speakers, buzzers.
Unit-V		**5.1**	**Use of soldering and disordering tools and practice:**

Soldering – de-soldering practices and types of PCBs:	5a. Use deferent tools for soldering and desoldering. 5b. Use deferent materials for soldering and desoldering. 5c. Perform different soldering and desoldering steps on GP board. 5d. Inspect the soldering joints and its defects. 5e. learn safety and precautions during soldering and desoldering. 5f. Describe different types of PCBs and their uses. 5g. Identify different packages of electronic components.		1. Introduction 2. The Soldering Iron: Temperature controller iron, non Temperature controller iron. 3. The Solder: Tin-lead, lead-free (RoHS), Rosin core (60/40 Sn/Pb and 63/37 Sn/Pb), Silver, Acid-core, various diameter of soldering wire. 4. use of soldering iron stand. 5. use of de-soldering Pump and de-soldering wick 6. Need of soldering flux. 7. Use of soldering tip cleaner, solder-stand, flat cutter, Wire Stripper, Nose Plier, helping hand, single core connecting wire. 8. steps to achieve zero defect soldering. 9. Safety precautions and What to do and What not to do when soldering.
		5.2	**Types of PCBs:**
			1. Differentiate GP board and PCB and their specific uses 2. Various types of PCB based on printing layers: Single-Sided PCBs, Double-Sided PCBs, Multilayer PCBs 4. Various types of PCBs based on material used: FR4 epoxy, Teflon, polyimide, glass.
		5.3	**Types of component packages:**
			Identify various Packages of electronic components: DIP, TSSOP, QFP, QFN, BGA
Unit-VI Arduino based Microproject and E-	6a. Overview of opensource embedded development board (Arduino).	**6.1**	**Arduino:**
			Birth, Open-Source community, Arduino IDE, Functional Block Diagram of Arduino, interfacing basic sensors and actuators with Arduino board,
waste recycling	6b. Explain working of open-source embedded		develop micro project based on Arduino board and various sensors and actuators.
		6.2	**E-Waste Management**
			Components of Electronic waste

	6c. development board using block diagram 6d. Identify pins of embedded development board. 6e. Perform various I/O functions on Arduino board. 6f. Develop micro project based on Arduino. 6g. Describe the components of electronic waste. 6h. Explain the steps of recycling process of electrical and electronic waste.		Steps for Recycling process o electrical waste.

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	Identification and Testing of Electronics components	Not Applicable				
II	Testing of different Electronics components using appropriate tool; and measuring Instruments					
III	Working and Applications of different types of cables, connectors and switches					
IV	Identifying Application specific Sensors and Actuators					
V	Soldering – de-soldering practices and types of PCBs					
VI	E-					

	Arduino based Micro-project and waste recycling	

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 studentrelated ***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/ Gazettes.
b) Give seminar on reading a datasheet of latest electronic components.
c) Undertake a market survey of different electronic gazettes.
d) Give seminar on soldering and de-soldering practices.
e) Prepare charts of different components and its symbols.
f) Give seminar on various Sensors and actuators.
g) Give seminar on open-source Arduino IDE.
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.

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:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) 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.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Introduce E-waste recycling technology among the students.
g) Guide students for reading data sheets.
h) Motivate student to install and use different open-source Arduino 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 **1416** ***(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) **Charts of Sensors and actuators:** Prepare charts of different sensors and actuators with their characteristics, working and uses in different applications.

c) **Arduino based small applications:** Prepare small applications which uses Arduino board, sensors, actuators, general purpose board along with component soldering.

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	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 : 9907414700 ISBN-13 : 9907414704-009
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 : 9909947999 ISBN-13 : 9909947999-009
8	Arduino Cookbook	Michael Margolis	O'Reilly Media, Inc., 3rd Edition ISBN: 9781491903520
Sr. No.	**Title of Book**	**Author**	**Publication with place, year and ISBN**
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, Anwesha Borthakur.	Butterworth-Heinemann, eBook ISBN: 9780128170311, Paperback ISBN: 9780128170304, 21/11/2019
9	E-waste Recycling and Management Edition Number-1	Anish Khan,Inam uddin, AbdullahM. Asiri	Springer, Cham, ISBN: 978-3-030-14183-7, 2020

14. SOFTWARE/LEARNING WEBSITES

- www.datasheets.com
- https://electronicsclub.info/
- www.arduino.cc
- https://www.electrical4u.com/types-of-resistor/
- https://www.electronics-tutorials.ws/resistor/res_1.html/
- https://www.electronicshub.org/

- https://circuitdigest.com/electronic-circuits/
- https://www.circuitstoday.com/simple-electronics-projects-and-circuits/
- https://circuiteasy.com /
- www.findchip.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)
- https://www.engineersgarage.com /
- https://fritzing.org/ (Fritzing – PCB Designing Open Source Software).
- https://www.kicad.org/ (KiCAD – PCB Designing Open Source Software).
- https://www.tinkercad.com/ (Tinker cad open source software for Arduino and sensor based Applications)
- https://ecstudiosystems.com/ (Electronic Circuit Studio – Android Application for Circuit Design an Analysis).

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, Experimen-	PO 5 Engineering practices for society,	PO 6 Project Management	PO 7 Life-long learning

				tation & Testing	sustainability & environment		
Competency	**Built electronic circuits on PCB using relevant tools following appropriate safety measures**						
Course Outcomes CO 1) Test various electronic components by using appropriate instruments.	3	1	1	3	2	1	3
CO 2) Use various types of cables, connectors and switches.	2	1	1	3	2	1	3
CO 3) Identify various sensors and actuators and their usage for different real time applications.	3	2	2	3	2	1	3
CO 4) Assemble electronic circuit on bread board and PCB	3	2	3	3	2	2	3
CO 5) Develop mini project based on sensors, Actuators, Electronics components and Arduino IDE.	3	3	3	3	3	3	3
CO 6) Follow safe practices to prevent accidents/ hazards to personnel and environment	1	1	1	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

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Mr.T P Chanpura BOS Member ICT & HOD EC	Government Polytechnic for Girls,Ahmedabad	9824280515	tchanpura@gmail.com
2	Ms. Gireeja D Amin	Government Polytechnic for Girls, Ahmedabad	7574850311	gireeja.amin@gmail.com

3	Mr. S. M. Kataria	Government Polytechnic, Ahmedabad	9998991632	Smkataria.ec@gmail.com