GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: **Electrical and Electronic Workshop**
(Course Code: 4302401)

Diploma programmer in which this course is offered	Semester in which offered
Power Electronics	First
Bio-Medical Engineering	Second

1. RATIONALE

Electrical, Electronic and allied engineering diploma holders are expected to handle various electrical and electronics tools in the workshop. They have to supervise work related to fitting of electrical components and soldering of electronic components and circuits in the workshop. This course will help to develop skills to use and test different types of electrical and electronics components, carry out simple electrical wiring, understanding basics of PCB and use of different basic electrical instruments.

2. COMPETENCY

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

- **Test various electrical and electronics components and circuits.**

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:

1. Select basic electrical& electronic components.
2. Fabricate staircase wiring, one room wiring and main board wiring.
3. Adopt precautionary steps while testing, operating and maintaining electrical system.
4. Design PCB for basic electronic circuit.
5. Select batteries for different applications.

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	-	4	2	00	00	25*	25	50

(*): For this practical only course, 25 marks under the practical CA has 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'.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Identify various electrical and electronic component symbols.	I	02
2	Identify various types of Resistor, Capacitor and Inductor, Relay, Diode, Zener diode, LED, Photo diode, BJT, Photo transistor, LDR, Solar cell, Photocell, Opto-coupler from the group of electronic components.	I	02
3	Test Capacitor, Diode, Transistor and JFET using multimeter.	I	01
4	Use multimeter for measurement of voltage and current in basic electrical and electronic circuits.	I	02*
5	Measure voltage, current and power of 6-0-6 and 12-0-12 transformer.	I	01*
6	Use different types of relay for basic switching circuits.	I	04*
7	Use different types of electrical and electronics workshop tools.	I	04*
8	Make a chart of different electronic component by reading their datasheet for particular application.	I	04
9	Carryout Staircase wiring.	II	02*
10	Carryout one room wiring.	II	04*
11	Carry out main board wiring: wiring with fuse, MCB and ELCB/RCCB.	II	04*
12	Make a Pipe and Plate Earthing in your college building.	II	02
13	Demonstrate the Pipe and Plate Earthing Schemes using Charts/Site Visit.	II	02
14	Use 2-pole voltage tester for connectivity of 1 phase and 3 phase wiring.	III	02*
15	Use megger to measure insulation resistance for 1 phase and 3 phase wiring.	III	02*
16	Demonstrate precautionary steps to adopt Safe work practices.	III	04*
17	Manually Prepare PCB layout on paper.	IV	02
18	Prepare PCB layout using computer software.	IV	04*
19	Trace electronic circuit from the given PCB layout of an electronic Circuit.	IV	02
20	Make a simple electronic mini project by soldering on designed PCB.	IV	04
21	Test different types of batteries using multimeter.	V	02
	Minimum Practical Hours		**56**

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match theCOs.The above table is only a suggestive list.*

*ii. 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 set-up.	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 EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment 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.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Variable DC power supply 0- 30V, 2A, Short Circuit protection, display for voltage and current.	5,6,20
2	Discrete Component Trainer/ Analog component Trainer: 2mm patch cords in interconnecting components, Collection of utilities like fixed and variable D.C. supplies, electrical 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, ± 12V / 500 mA, fixed DC power supply +5V/500mA, Built in AC supply.	7, 8, 9,10,11,20
3	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 MΩ) , Capacitance.	3, 4, 5, 6 , 9, 10, 11, 21
4	Demonstration Board for staircase wiring.	9
5	Demonstration Board for different wires & cables.	10
6	Demonstration Board for operation of fuse, MCB and ELCB.	11
7	Copper Plate for earthing: Size: 300 mm to 1200 mm, 25mm diameter GI pipe with 2meter length.13mm to 19mm GI pipe for watering, Bolt, Nut, wire, lugs, 30cm2 cast iron cover and frame, charcoal, cement, salt.	12
8	2-Pole Voltage Tester: Voltage Measuring Range AC 12 Volt to 600 Volt. Operating Temperature range: -5 to 40 Degree Celsius.	14
9	Megger- Digital Insulation Tester, Up-to 5 Kv 200 G-Ohm with Calibration Certificate	15
10	Insulating mate, Hand gloves, electrical safety helmet, arc flash shoot, electric safety shoes, rescue hook.	16
11	Primary Cells, Rechargeable batteries, Reserve batteries and Fuel Cells.	21
12	Battery tester- for 12.8V/13.2V (Lithium), 12V (Lead Acid).	21

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 instruments and tools.
c) Realize importance of battery in electrical vehicle system. (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) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I Electrical and Electronic Components	1a. Identify electrical and electronic component from given group of components with their ratings. 1b. Test electrical and electronic components. 1c. Use electronic workshop toolsf or building and wiring electronic circuits. 1d. Interpret the specification of electronic component from data sheet/data manual. 1e. Select appropriate component from given specifications.	1.1 Passive components 1.2 Resistors: General-purpose resistors, Power resistors, Wire-wound resistors, Thick film resistors, Surface-mount resistors, ceramic resistor, Axial resistors, Precision resistors, Variable resistors, Thermistor, resistor array, standard resistor values. 1.3 Inductors: Iron core, Ferrite core, Toroidal core inductor, Variable with slug, Air core. 1.4 Capacitors: cylindrical capacitor, disc capacitor, ceramic capacitor, capacitor array, electrolytic capacitor, tantalum capacitors 1.5 Transformer: 12-0-12, 6-0-6 center tap transformer. 1.6 Electronic components: Relay, Diode, Zener diode, LED, Photo diode, BJT, Photo transistor, LDR, Solar cell, Photocell, Opto-coupler. 1.7 Testing of Resistor, Capacitor,

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		Diode and Transistor, Inductor using multimeter. 1.8 Electronic Workshop Tools: Bread board, Solder iron, solder-stand, solder-wire, flux, Cutter, plier, screwdriver set, wire stripper, de-solder pump, De-solder wick, drilling machine. 1.9 Manufacturer's Datasheet of: - Diodes IN4001 to 07, IN4148; 2N5402, 2N5408, BY127 - Zener Diode, Photo diode, LED, Seven segment LED. 1.10 Transistors BC107, BC177, BC547/548, SL100, SK100, AC127/128, BF194, TIP122, Photo transistor. 1.11 Voltage regulator IC78XX, 79XX. 1.12 Select general purpose mechanical relay- single pole (SPDT, SPST), double pole (DPDT, DPST) and 3-pole (3PDT) relay.
Unit– II Electrical Wiring and Electrical Safety Devices	2a. Identify different types of cables, wires, fuses, MCB, MCCB, ELCB and RCCB with ratings. 2b. Demonstrate Earthing Schemes. 2c. Wire light/fan circuit using two way switches (Staircase wiring). 2d. Wire light and power circuits. 2e. Wire power distribution arrangement using single phase MCB distribution board with Fuse, ELCB, RCCB and main switch.	2.1 Cable and Wire: Classification of power cables; flexible, armored and unarmored, Classification of wire as per insulation code and color code, Standard Wire Gauge, 1-core,2-core,3-core, and 4-core. 2.2 Electrical Safety: Fuse, MCB, ELCB, and RCCB. 2.3 Earthling: Pipe and Plate Earthing. 2.4 Domestic wiring: staircase wiring, Sample example of one room electrification. 2.5 Main Board Wiring: wiring of main board using fuse, MCB and ELCB/RCCB.
Unit– III Electrical	3a. Use 2-pole voltage tester.	3.1 2-Pole voltage tester: Test voltage

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Testing Devices and Precautionary system	3b. Use megger to measure insulator resistance. 3c. Adopt precautionary steps in case of electrical shocks.	and continuity using 2-Pole voltage tester. 3.2 Megger: Test insulator resistance of 1-phase and 3-phase windings. 3.3 Precautionary steps: 3.4 Use of Protective Equipment and tools: Insulating mate, Hand gloves, helmet, arc flash suit, electric safety shoes, arc flash boundaries, rescue hook. 3.5 Adopt safe work practices: Job Hazard Analysis for electric equipment and wiring system, SOP for electric equipment and wiring system.
Unit– IV PCB Design	4a. Create PCB layout manually on paper. 4b. Create schematic and layout of given electronic circuit using any Simple PCB design software. 4c. Trace circuit from given PCB layout on the PCB. 4d. Make a soldering in General purpose PCB.	4.1 PCB layout. 4.2 PCB design software. 4.3 PCB layout - Component side and copper side. 4.4 Tracing for PCB Fabrication. 4.5 Soldering - types - selection of materials, soldering practice in connectors and general purpose PCB.
Unit– V Cells and batteries	5a. Classify Cells and Batteries. 5b. Identify cells and batteries from the given group of cells and batteries. 5c. Compare given battery technologies used for Electrical Vehicles. 5d. Test given batteries using multimeter and battery tester.	5.1 Classification: Primary Cells, rechargeable batteries, Reserve Batteries, Fuel Cells. 5.2 Battery as per IEC standard, Battery capacity. 5.3 Battery Technology used for Electrical Vehicles.: Ni-MH, Pb-$Pb0_2$, Na-Nicl, Nicd, Zn-Br_2, Li-Ion, Na-S.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Electrical & Electronic Components	Not Applicable				
II	Electrical Wiring & Electrical Safety Devices					
III	Electrical Testing Devices and Precautionary system.					
IV	PCB Design					
V	Cells and batteries					

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:

a) Prepare specification of some electrical and electronic components.
b) Give seminar on reading a datasheet of electronic components.
c) Undertake a market survey of different semiconductor components.
d) Prepare Job Hazard Analysis report for installing electrical motor.
e) Prepare Standard Operating Procedure for installing/Changing Capacitor in a power electronic converter based system.
f) Prepare chart that classify electric battery used for electric vehicle.

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 Electrical Vehicle technology among the students.

g) Guide students for reading data sheets.

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 microproject 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 wires & cable board:** Prepare a board consist of different wires & cables.
b) **Staircase wiring:** Prepare a board to demonstrate staircase wiring.
c) **Extension board:** Prepare Extension board with fuse, few sockets and switches.
d) **Electronic Circuit on PCB:** Make a simple electronic circuit on PCB.
e) **Main board**: Prepare a main board with using load calculation.
f) **Energy Consumption:** Compile a report for energy ratings of different types of batteries.

13. SUGGESTED LEARNING RESOURCES

S. 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
3	Build Your Own Printed Circuit Board	Al Williams	Mc GrawHill, latest edition
4	Making Printed Circuit Boards	Jan Axelsen	Mc GrawHill, latest edition
5	Modern World Transistor Data & Its Equivalent	Lotia M.	BPB Publications, 2008, ISBN: 978-8183332477
6	Everyday Electronics Data Book	Mike Tooley	BPB Publications, 2011, ISBN: 978-8176567916
7	Hobby Electronics Project Special	BPB	BPB Publications, 2011, ISBN: 978-8183332033

S. No.	Title of Book	Author	Publication with place, year and ISBN
8	Handbook Of Batteries	David Linden & Thomas B. Reddy	McGraw-Hill, ISBN 0-07-135978-8
9	Electric Vehicle Battery Systems	Sandeep Dhameja	Newnes, ISBN 0-7506-9916-7
10	Practical Guide to Inspection, Testing and Certification of Electrical Installations	Christopher Kitcher	Newnes, ISBN: 978-0-7506-8449-1

14. SOFTWARE/LEARNING WEBSITES

a) https://shaileshdhoriyani.webs.com/apps/blog (for basic electronic components)
b) https://www.electrical4u.com/types-of-resistor (for Resistor)
c) https://www.electronics-tutorials.ws/resistor/res_1.html (for Resistor)
d) https://www.electrical4u.com/electrical-engineering-articles/batteries (for Batteries)
e) https://www.electronicshub.org/types-of-diodes/ (for Diodes)
f) https://nptel.ac.in (for online courses and video of all engineering branches)
g) www.electronicsforu.com (for basic electronic projects and technical videos)
h) https://www.vlab.co.in (Virtual Lab for all engineering branches)
i) www.omron.com (for Batteries)
j) Fritzing – PCB Designing Open Source Software.
k) KiCAD – PCB Designing Open Source Software.
l) http://dl.mitsubishielectric.com/dl/fa/document/catalog/lvcb/yn-c-0729/y07291307.pdf (for MCB)
m) https://www.electricaltechnology.org/2019/07/mcb-mccb-elcb-rcb-rcd-rccb-rcbo.html (for MCB, ELCB,RCCB)

15. PO-COMPETENCY-CO MAPPING

Semester I	Electrical & Electronic Workshop (Course Code: 4302401)						
	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	Test various electrical and electronics components and circuits.						
Course Outcomes CO 1) Select basic electrical & electronic components	3	2	2	3	1	-	3
CO 2) Fabricate staircase wiring, one room wiring and main board wiring.	3	2	2	3	1	1	3
CO 3) Adopt precautionary steps while testing, operating and maintaining electrical system.	3	2	1	3	2	-	3
CO 4) Design PCB for basic electronic circuit.	3	1	3	3	1	-	3
CO 5) Select batteries for different applications.	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

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