GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Fundamentals of Electrical and Electronic Instrumentation
(Course Code: 4321704)

Diploma programmer in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	Second

1. RATIONALE

The engineering diploma holders are required to use and maintain various types of electrically and electronically operated and controlled device/equipment. The fundamental principles of electrical and electronics are to be applied in most of the situations to arrive at the probable solutions which is faced in the world of work, there for the knowledge of the functions of various basic electrical and electronic devices and components required .Practical skills acquired through the laboratory experiments will help them, when they work with electrical or electronic equipment and its circuits or sub circuits. This course is designed to develop the skills to use the basics electrical and electronic devices/components and apply the knowledge to maintain the various types of electrical and electronic circuits and equipment.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
Apply principles of basic electrical and electronics in various instrumentation engineering applications.
Use principles of basic electrical and electronics to maintain various electrical and electronics instrumentation circuits and equipment.

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) Apply Basics/Fundamentals of Electrical energy (DC/AC) in real life application.
b) Apply various fundamental laws of electricity.
c) Demonstrate the function of various electrical devices.
d) Demonstrate the function of various electronic devices.
e) Implement various techniques for e-waste disposal in benefit of society & environmental consideration.

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	
3	0	2	4	30	70	25*	25	150

(*): 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	Use Digital Multimeter to measure basic electrical parameters like current, voltage and resistance.	1	02
2	Verify Ohm's law.	1	02*
3	Measure various parameters related to AC signal using Cathode Ray Oscilloscope.	1	02*
4	Draw the response of R, L, and C load with DC supply.	1	02
5	Draw the response of R, L, and C load with AC supply.	1	02
6	Calculate resistance value of series and parallel combination of resistors.	1	02*
7	Verify Kirchhoff's current law.	2	02*
8	Verify Kirchhoff's voltage law.	2	02*
9	Demonstrate function of transformer	2	02
10	Demonstrate function of DC motor	2	02
11	Demonstrate function of AC (induction) motor	2	02
12	Test Conductor, Semiconductor and Insulator.	3	02
13	Build circuit and obtain V-I characteristic of PN junction diode.	3	02
14	Build circuit and obtain V-I characteristic of Zener diode.	3	02*
15	Build circuit and obtain V-I characteristic of photo diode	3	02*
16	Build circuit and obtain V-I characteristic of photo transistor.	3	02
17	Test/identify terminals of the diode and transistor.	3	02
18	Build circuit of half wave rectifier and measure/obtain output voltage waveform using Cathode Ray Oscilloscope.	4	02*
19	Build circuit of full wave rectifier and obtain/observe output voltage waveform using Cathode Ray Oscilloscope.	4	02*
20	Build circuit and obtain V-I characteristic of common emitter transistor configuration.	4	02*
21	Build circuit and obtain V-I characteristic of common base transistor configuration.	4	02*
22	Build circuit of common emitter transistor configuration and obtain the value of current gain and input impedance.	4	02*
23	Build circuit of common base transistor configuration and obtain the value of current gain and input impedance.	4	02*
24	Build circuit of common collector transistor configuration and obtain the value of current gain and input impedance.	4	02
25	Select transistor for particular application using transistor datasheet.	4	02
26	Verify function of transistor as a switch.	4	02
27	Verify function of transistor as an amplifier.	4	02*
28	Test/verify function of photo diode as Opto-isolator.	4	02

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
29	Test/verify function of photo transistor as Opto-isolator.	4	02
30	Describe method to dispose electronic waste	5	02
	Minimum 14 Practical Exercises		**28**

Identify applicability of electromagnetic induction.

Note

i. *More* **Practical Exercises** can be designed and offered by the respective course teacher to d*evelop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list***.**
ii. *Care must be taken in assigning and assessing study report as it is a first year study report. Study report, data collection and analysis report must be assigned in a group. Teacher has to discuss about type of data (which and why) before group start their market survey.*

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.

Sr. 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 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.

Sr. No	Equipment Name with Broad Specifications	PrO. No.
1.	Digital Multimeter: 3 1/2 digit display, 9999 count digital multimeter measures: Vac, Vdc (1000V max), Adc, Aac (10 amp max), Resistance (0 – 2 Mega Ohm), diode and transistor tester.	1 to 30
2.	Cathode Ray Oscilloscope, Dual Trace 20Mhz, 1MegaΩ Input Impedance.	1,3,5,9,14 to 24,26 to 29
3.	Function Generator 0-2 MHz with Sine, square and triangular output with variable frequency and amplitude.	2, 4,18,19,27
4.	Electronic Workbench: Bread Board 840 -1000 contact points: Positive and Negative DC power rails on opposite sides of the board with , 0-30 V , 2 Amp Variable DC power supply, Function Generator 0-2MHz, CRO 0-30MHz , Digital Multimeter	1 to 29
5.	Dual variable DC power supply ,0- 30V, 2A, With Short circuit protection, separate display for voltage and current	1,2,3,5 to 8,10,12 to 24,26 to 29
6.	Discrete Component Trainer/ Analog Component Trainer: Fixed and variable D.C. Supplies, AC Supplies, Actual Components like	1 to 29

Sr. No	Equipment Name with Broad Specifications	PrO. No.
	transistors, LDR, photo diode, resistors, capacitors, inductors, diodes, LED's, transformers, 2 mm patch cords for interconnecting components.	
7.	Single phase auto-transformer: Single phase, 0- 230 V, 10 A.	1,2,4,11,18,19

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 ethical practices.
c) Practice environmental friendly methods and processes. (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 **Basics of Electrical Energy**	1a. Describe conductor and insulator. 1b. Define basic parameters of DC fundamentals. 1c. Test Ohm's law. 1d. Identify basic electrical components. 1e. Calculate equivalent value of R, L and C in series and parallel connection. 1f. Define basic parameters of AC signal 1g. Describe behavior of pure resistor, inductor and capacitor with DC and AC supply	1.1 Introduction of conductor and insulator. 1.2 D.C. circuit parameter: Electric Charge, Electric Current, Electric Power, Electrical Energy,EMF Potential difference. 1.3 Ohm's law 1.4 Basic Electrical circuit components: Resistor,inductor,capacitor (R,L and C) Series and Parallel connection of R, L and C. 1.5 A.C. circuit parameters: Cycle, Frequency, Time period, Amplitude, RMS value, Average value, Instantaneous value, Peak Value, Impedance, Reactance 1.6 Pure resistor, inductor and capacitor with DC and AC supply.
Unit– II Fundamental laws of	2a. Apply Kirchhoff's voltage and current law for given electrical circuit. 2b. Describe phenomenon of electromagnetic induction.	2.1 Basic Electrical laws and rules: 2.1.1 Kirchhoff's voltage law. 2.1.2 Kirchhoff's current law. 2.2 Electromagnetic Induction: 2.2.1 Statically and dynamically

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Electromagnetic energy and its application	2c. Differentiate statically and dynamically induced EMF, self and mutual inductance. 2d. Explain Faraday's law of electromagnetic induction 2e. Explain Lenz's law 2f. Enlist applications of different transformers. 2g. Explain construction and working of 2 pole DC motor. 2h. Explain construction and working of induction motor.	induced EMF 2.2.2 Self and Mutual inductance 2.2.3 Faraday's law 2.2.4 Lenz's law 2.2.5 Fleming's right hand rule for Generator 2.2.6 Fleming's left hand rule for Motors. 2.3 Electrical Devices: 2.3.1 Different types of Transformer: Step-up, Step-down, Isolation, and Auto transformer 2.3.2 Construction and working of DC Motor 2.3.3 Construction and working of AC Motor
Unit-III Fundamentals of Electronics Engineering	3a.Define semiconductor 3b.Describe intrinsic and extrinsic semiconductor material. 3c. Compare Conductor, Semiconductor and Insulator. 3d. Draw the symbols of various semiconductor components. 3e. Describe biasing method of various semiconductor devices. 3f. Plot the V-I characteristic of junction diode, Zener diode and photo diode . 3g Enlist applications of opto-electronics devices. 3h. Test terminals of the various semiconductor components.	3.1 Brief introduction to semiconductor. 3.2 Semiconductor material: 3.2.1 Intrinsic type 3.2.2 Extrinsic type(P-type and N-type) 3.3 Comparison of Conductor, Semiconductor and Insulator 3.3 Basic Semiconductor devices : 3.3.1 Symbol of PN junction diode, Zener diode, LED, Photo diode, photo transistor 3.3.2 V-I Characteristics of P-N junction diode,Zener,diode,LED, photo diode ,photo transistor 3.3.3 Identify terminals of various semiconductor devices using DMM or CRO.
Unit-IV Applications of Electronics engineering in Instrumentation	4a. Explain working of a half-wave and full-wave rectifier. 4b. Describe the basic structure and operation of the transistor. 4c. Define transistor parameters 4d. Explain operating mode transistor. 4e. Test various transistor configurations. 4f. Test V-I Characteristic of transistor 4g. Test terminals of the given	4.1 Rectifier Circuits: Half Wave and Full Wave Rectifier (center tapped and bridge). 4.2 Transistor: 4.2.1Basic structure and working of NPN and PNP transistor. 4.2.2 Transistor Parameters: Input resistance, Output resistance, current gain. 4.2.3 Transistor mode of operation: Cut-off, active, saturation.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	transistor. 4h. Implement transistor as switch and amplifier. 4i Implement Photo diode and photo transistor as opto-isolator	4.3 Types of transistor configurations: 4.3.1 CE, CB, and CC transistor configuration circuit, working and V-I Characteristic. 4.3.2 Testing of transistor with DMM or CRO. 4.4.3 Transistor as a switch and amplifier. 4.4 Photo diode and photo transistor as opto-isolator
Unit-V **Handling Electronic Waste**	5a.Justify the need of understanding electronic waste 5b. Establish the relationship of Sustainability and electronic waste. 5c. Suggest methods of handling electronic waste with examples. 5d. Suggest methods to dispose electronic waste	5.1 Concept of electronic waste. 5.2 Sustainability and electronic waste. 5.3 Methods to handle electronic waste. 5.4 Disposal of electronic 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
1	Basics of Electrical Energy	08	4	6	4	14
2	Fundamental laws of Electromagnetic energy and its application	10	4	6	8	18
3	Fundamentals of Electronics Engineering	08	4	6	5	15
4	Applications of Electronics in Instrumentation	12	4	6	8	18
5	Handling Electronic Waste	04	1	2	2	05
	TOTAL	42	17	26	27	70

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:

a) Prepare charts/display boards of some electrical/electronic devices with their specification.
b) Prepare a table and interpret the technical specification of various diodes and transistors using data sheet.
c) Undertake mini/micro-projects in teams/individual basis
d) Give seminar on any relevant topic.
e) Undertake a market survey of various types of hardware components.
f) Prepare a survey report different electronic waste management adopted by the local electronics industry.
g) Undertake a visit to e-waste handling plant nearby and prepare a report.
h) Prepare showcase portfolios.

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) Guide students on how to address issues on environment and sustainability using the knowledge of this course.
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 micro project should be about **14**- **16 week** ***(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:

Using various fundamental knowledge of electrical and electronics engineering students may develop

mini/micro projects based on team/individual basis which concrete their fundamentals of electronics hardware and can work as prototypic models in various societal applications.
Electronic waste: Compile a report of handling electronic waste with figures, tables and comparative charts and strategies used and suggested.

13. SUGGESTED LEARNING RESOURCES

Sr. No	Title of Book	Author	Publication with place, year and ISBN
1	Basic Electrical and Electronics Engineering	S. K. Bhattacharya	PEARSON India, 2011. ISBN: 978-8131505564
2	A text book of Electrical Technology-Vol.1 & 2.	Theraja B. L.	S. Chand Publication ISBN: 9788121924375
3	Grob's Basic Electronics.	Mitchel E. Schultz	McGraw Hill, 2017. ISBN: 978-0070634329
4	Electronic devices: electron flow version, 9th edition.	Thomas L. Floyd	PEARSON India, 2015. ISBN: 978-9332545496
5	Electronic principles, Eighth edition.	Albert Malvino, David J. Bates	McGraw Hill, 2015. ISBN: 978-0073373881
6	Principles of electronics.	V.K.Mehta & Rohit Mehta	S. Chand, New Delhi, 2014, ISBN: 978-8121924504
7	E-Waste: Management and Procurement of Environment	Suresh Kumar, Jatindra Kumar Pradhan	Authors press 2021, ASIN : B095PR6MVS
8	Solid and Liquid Waste Management Waste to Wealth	Rajaram Vasudevan, Siddiqui Faisal Zia , Agrawal Sanjeev	PHI Learning Pvt. Ltd. New Delhi ISBN: 9788120352452

14. SOFTWARE/LEARNING WEBSITES

- www.datasheetcafe.com
- www.williamson-labs.com
- www.learnerstv.com
- www.cadsoft.io
- www.nptel.iitm.ac.in
- www.khanacademy
- www.vlab.co.in
- www.alldatasheet.com
- www.electronics-tutorials.ws
- www.instructables.com/Basic-Electronics
- www.makerspaces.com/basic-electronics
- https://www.electrical4u.com/types-of-resistor (for Resistor)
- https://www.electronicshub.org/types-of-diodes/ (for Diodes)
- https://nptel.ac.in (for online courses and video of all engineering branches)
- www.electronics4.com (for basic electronic projects and technical videos)
- https://cpcb.nic.in/e-waste/ (For E-waste Recycle guidelines)

https://www.meity.gov.in/content/gazettes (For E-waste Recycle guidelines)

15. **PO-COMPETENCY-CO MAPPING**

Semester II	Fundamentals of Electrical and Electronics in Instrumentation (Course Code: 4321704)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ develop-ment of solutions	PO 4 Engineering Tools, Experimen-tation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency	Apply principles of basic electrical and electronics in various instrumentation engineering applications.						
Course Outcomes CO 1) Apply Basics/Fundamentals of Electrical energy (DC/AC) in real life application.	3	2	-	1	-	1	2
CO 2) Apply various fundamental laws of electricity.	3	2	-	1	-	1	2
CO 3) Demonstrate the function of various electrical devices.	2	2	-	1	-	1	1
CO 4) Demonstrate the function of various electronic devices.	3	2	1	2	-	1	2
CO 5) Implement various techniques for e-waste disposal in benefit of society & environmental consideration	1	1	1	1	2	1	1

*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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