GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Fundamentals of Electrical and Electronics Engineering
(Course Code: C4326401)

Diploma program in which this course is offered	Semester in which offered
Renewable Energy	2nd semester

1. RATIONALE

The Diploma program of Renewable Energy is multi-disciplinary branch. Any form of energy from renewable sources is finally converted into electrical energy. At various stages of energy transformation, the role of electrical and electronics engineering is crucial. Diploma students undertaking this course are expected to understand the fundamentals of AC-DC circuits and electronics. Students would be able to apply these concepts to analyze and study various electrical and electronics circuits as well as energy conversion devices related to renewable energy systems.

2. COMPETENCY

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

- **Maintain electrical systems by applying principles of AC-DC circuits.**
- **Identify and test the different semiconductor devices.**

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) Solve electrical circuits using basic circuit laws.
b) Interpret the working of inductor and capacitor based on principles of electromagnetism and electrostatics.
c) Understand various terminologies, waveforms and vector representation of alternating quantities.
d) Apply principles of single phase and three phase circuits to maintain electrical systems.
e) Identify the behaviour of semiconductor devices.

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(M)	ESE(E)	CA(I)	ESE(V)	
3	0	2	4	*30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

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

5. SUGGESTED PRACTICAL EXERCISES

The 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 resistor, inductor and capacitor.	I	2
2	Verify Ohm's law in the given electrical circuit.	I	2*
3	Verify Kirchhoff's current and voltage law in the given electrical circuit.	I	2
4	Measure voltage, current and resistance in the given DC circuit.	I	2*
5	Find equivalent resistance for series and parallel connection.	I	2

6	Test different types of capacitors.	I	2*
7	Test different types of inductors.	II	2*
8	Demonstrate various laws of electromagnetism.	II	2
9	Demonstrate various types of waveforms of alternating quantities using CRO and function generator.	III	2
10	Use CRO to measure peak value, instantaneous value, RMS value, time period and frequency of alternating quantity	III	2*
11	Measure voltage, current, power and power factor through RL series circuit.	IV	2
12	Measure voltage, current, power and power factor through RC series circuit.	IV	2
13	Measure voltage, current, power and power factor through RLC series circuit.	IV	2

14	Verify relation between line & phase voltage and line & phase current in three phase star connection.	IV	2
15	Verify relation between line & phase voltage and line & phase current in three phase delta connection.	IV	2
16	Test V-I characteristic of PN junction diode.	V	2
17	Testing of transistor using multi meter.	V	2*
18	Test V-I characteristic of Zener diode.	V	2
19	Derive V-I characteristic of SCR.	V	2*
20	Derive V-I characteristic of UJT.	V	2
21	Demonstrate operation of Half wave rectifier using CRO.	V	2
22	Demonstrate operation of Full wave rectifier using CRO.	V	2
	Minimum 14 Practical Exercises		28

Not

e f) *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**.***

*g) 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 and operate experimental setup	30
2	Follow safe practices	10
3	Record observations correctly	20
4	Interpret the result and conclude	20
5	Quality of Answer related to experiment (Q & A)	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This 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	PrOs No.
1	Regulated power supply: Dual DC , 0-30V/1A & 5V /1A with resolution of 10mV , 2mA	1-6
2	Resistor, Capacitors and inductors of various range	1-8

3	Single phase Variac: 10 A, 0-270 V output for input of 230 V, 50Hz AC	11-13
4	Single phase Choke coil: 230 V, 2 kVAR, 50 Hz	11,13
5	Single phase capacitor bank:230 V, 2 kVAR,50Hz	12,13
6	Single phase resistive load: 230 V, 2 kW	11-13
7	Three phase lamp loads suitable for star-delta connection	14-15
8	C.R.O.: 30 MHz Bandwidth, 2 channels, 20 ns sampling time.	9-10,21- 22
9	Half wave and full wave rectifier kit	21-22

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 (while doing a micro-project).
b) Follow ethical practices.
c) Work as a group member (while performing experiments and taking readings).
d) 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 CO s and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics

Unit I: Fundamentals of DC Circuits	1a.Explain the properties of the commonly used electrical engineering materials. 1b.Classify different types of resistors.	1.1 Conductors, semiconductors and insulators 1.2 Resistor, Inductor and Capacitor 1.3 Electric Potential, EMF, Current, Power and Energy 1.4 Ohm's law

	1c.Determine voltage, current and resistance in electrical circuit using Ohm's law. 1d.Apply Kirchhoff's Voltage and Current law to determine voltage, current and power in the given resistive circuit. 1e.Determine the equivalent resistance of given series-parallel connections. 1f. Apply Mesh analysis and nodal analysis to calculate voltage, current and power in given resistive circuit. 1g. Explain the working of capacitor. 1h. Identify the factors affecting the capacitance. 1i. State applications and types of capacitors.	1.5 Kirchhoff's Voltage law and Current law 1.6 Series and parallel connections of resistors 1.7 Node, branch, loop, mesh; open circuit, closed circuit and short circuit 1.8 Mesh Analysis and Nodal Analysis 1.9 Various types of capacitors 1.10 Series and parallel combination of capacitors 1.11 Energy stored in capacitor 1.12 Numerical examples based on fundamentals of DC circuits

Unit II **Principles of Electro-magnetism**	2a Compare magnetic circuit with electrical circuit. 2b Apply laws of electro-magnetism to determine direction of flux, magnetic force, induced emf, flux density and field strength. 2c State Faraday' laws of electromagnetic induction, Fleming's right and left hand rule and Lenz's law. 2d Compute equivalent inductance in various series-parallel combinations. 2e Calculate energy stored in given inductor.	2.1 Comparison of magnetic and electric circuit 2.2 Magnetic flux, Magnetic flux Density (B), Magnetic field intensity (H), M.M.F, magnetic line of force, permeability, hysteresis loop, reluctance, B-H curve. 2.3 Electromagnetism, Electromagnetic field around a current carrying conductor. 2.4 Faraday's laws of electromagnetic induction, Fleming's right and left hand rule and Lenz's law. 2.5 Induced EMF, Self (static and dynamically induced emf) 2.6 Self and mutual inductance

		2.7 Energy stored in an inductor
Unit-III **Basics of AC Circuits**	3a. Explain the generation of AC voltage 3b. Define various terms related to alternating quantity from waveforms. 3c.Derive relation between maximum value, RMS value and average value for sinusoidal waveforms. 3d. Illustrate vector representation and mathematical operations of vectors. 3e. Solve numerical example based on ac circuits.	3.1 Generation of AC voltage 3.2 Advantages of AC system 3.3 Equation of dynamically induced emf 3.4 Cycle, frequency, time period, maximum value(amplitude), instantaneous value, RMS value, average value, form factor, peak factor, phase and phase difference 3.5 Vector representation for alternating quantities 3.6 Mathematical operations of vectors 3.8 Numerical examples based on basics of ac circuits

Unit– IV **Single Phase and Three Phase AC Systems**	4a.Compare response of 1-phase ac circuits with pure resistance, pure inductor and pure capacitor with sinusoidal ac voltage source 4b.Compare response of 1-phase ac circuits for RL,RC and RLC series circuit with sinusoidal ac voltage source 4c. Explain concept of power factor, active power, reactive power and apparent power for various loading conditions with wave forms and vector diagram. 4d. Identify advantages of three phase system over a single phase system 4e. Explain generation of three phase ac voltage 4f. Illustrate three phase star and delta connection with vector diagram.	4.1 AC through pure resistor, pure inductor and pure capacitor 4.2 Voltage and current waveform, expression of current, voltage and power for RL, RC and RLC series circuits, vector diagrams. 4.3 Power factor and power triangle. 4.4 Comparison of single phase and three phase ac systems. 4.5 Generation of three phase ac voltage 4.6 Three phase star and delta connection with vector diagrams 4.7 Numerical examples

Unit– V Basics of semiconductor devices	5a. Explain atomic structure in semi-conductor materials. 5b. Identify difference between intrinsic and extrinsic semi-conductor materials.	5.1 Bonds in semiconductor 5.2 Intrinsic and extrinsic semiconductor materials: P type, N type semiconductors. 5.3 Diode, transistors, Zener diode, FET,MOSFET, DIAC , TRIAC ,UJT and SCR

	5c. Explain working principle and construction of various semi-conductor devices. 5d. Describe the working of half and full wave bridge rectifier along with circuits and waveforms. 5e.Justify the need for different types of filters. 5f. Differentiate between C, L, LC and π filter	5.4 Applications - Diode as rectifier, half wave, full wave and bridge rectifier. 5.5 Need of Filters C, L, LC, π filters.

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	Fundamentals of DC circuits	10	5	5	6	16
II	Principles of Electromagnetism	06	4	3	3	10
III	Basics of AC Circuits	06	4	4	4	12
IV	Single Phase and Three Phase AC Systems	10	5	4	7	16
V	Basics of semiconductor devices	10	5	6	5	16
	Total	42	23	22	25	70

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

Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

9. 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 (or individual) 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) Present seminar on various topics from course content.
b) Prepare specification of electrical and electronic components.
c) Test different semiconductor devices using multi-meter.
d) Undertake market survey for different electrical and electronics systems.

e) Undertake micro-projects in teams.

10. 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) Show animation/ video related to course content.
e) Some of the topics/sub-topics which are relatively simpler or descriptive are to be given to the students for self-learning but to be assessed using different assessment methods.
f) Correlating the importance of the content of this course with other courses/practical applications.
g) Guide students for using data manuals.
h) Guide students on how to address issues on environment and sustainability.

11. 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 microproject 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) Prepare a basic model to demonstrate various laws of electromagnetism.
b) Build a simple electrical model to demonstrate mutually induced emf.
c) Prepare a model chart describing various types of resistor, inductors and capacitors with specifications.
d) Build model to demonstrate generation of alternating EMF.
e) Build model of various types of AC series circuit.

f) Prepare three phase lamp load for delta connection.
g) Prepare three phase lamp load for star connection.
h) Prepare chart of waveforms and vector diagram of voltage, current and power in purely resistive, inductive and capacitive circuits
i) Build circuit of half wave rectifier without filter on bread board/General purpose PCB.
j) Build circuit of half wave rectifier with filter on bread board/General purpose PCB.
k) Build circuit of Full wave rectifier without filter on bread board/General purpose PCB.
l) Build circuit of Full wave rectifier with filter on bread board/General purpose PCB.

12. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Electrical Technology Vol-1	Theraja B.L	S. Chand & Co. Ltd., 23 edition or latest edition, ISBN-10: 8121924405
2	Basic Electrical Engineering	V.K.Mehta	S. Chand & Company (PVT) LTD., 1988 or Latest edition, ISBN: 9788121908719
3	Principle of Electronics	V.K.Mehta	S.Chand New Delhi, 2012
4	Electronics Fundamental and application	Chattopadhyay D.	New Age International Publishers 2011
5	Electronics devices and circuits	J.B.Gupta	S.K.kataria& Sons, 2013
6	Electrical and Electronics Engineering	S K Bhattacharya	Pearson Education, New Delhi, 2011

13. SOFTWARE/LEARNING WEBSITES

(1) www.nptel.iitm.ac.in
(2) https://ndl.iitkgp.ac.in

(3) www.electrical4u.com
(4) www.vlab.co.in
(5) https://nptel.ac.in/courses/108/105/108105112/
(6) https://lectures.gtu.ac.in/(related to course content)
(7) https://www.electricaltechnology.org/
(8) https://circuitmaker.com/
(9) https://www.allaboutcircuits.com/

14. PO-COMPETENCY-CO MAPPING:

Semester III	Fundamental Of Electrical and Electronics Engineering (Course Code: 1326401)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solution	PO4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life- long learning
Competency	**Maintain electrical systems by applying principles of AC-DC circuits. Test the different electronic devices.**						
Course Outcomes CO-1 Solve electrical circuits using basic circuit laws.	3	2	2	2	-	1	1
CO-2 Interpret the working of inductor and capacitor based on principles of electro-magnetism and electrostatics.	3	2	-	2	2	1	1
CO-3 Understand various terminologies, waveform and vector representation of alternating quantities	3	2	-	2	-	-	1

CO-4 Apply principles of single phase and three phase systems to solve electrical circuits	3	2	1	2	-	-	1
CO-5 Identify the behavior of semiconductor devices	3	2	-	1	-	-	1

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

15. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Sagar N Vegad Lecturer-Electrical Engg.	Government Polytechnic, Jamnagar	8000096411	snv.gpj@gmail.com
2.	Mitesh K Raval Lecturer-Electrical Engg.	Government Polytechnic, Bhuj	9033968316	mitesh240@gmail.com