GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: **Fundamentals of Electrical Engineering**
(Course Code: 4311101)

Diploma programmes in which this course is offered	Semester in which offered
Electronics and Communications Engineering , Power Electronics	First

1. RATIONALE

Need of knowledge about fundamental electrical concepts is vital to work in any industry related to Power Electronics and Electronics and Communications. Hence this course aims at development of knowledge and skills related with Electrical engineering basics, so that it can be applied for the understanding of further courses associated with their discipline areas.

2. COMPETENCY

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

- **Use principles of electrical engineering in solving branch specific engineering problems.**

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 fundamentals of DC circuits and batteries in relevant engineering discipline.
b) Apply fundamentals of AC circuits in relevant engineering discipline.
c) Use principles of electromagnetic induction in applications related with relevant engineering discipline.
d) Classify green energy sources with emphasis on working of solar and wind power plant.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	-	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 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 resistor, inductor and capacitor.	I	02*
2	Verify Ohm's law.	I	02
3	Verify Kirchhoff's current law.	I	02
4	Verify Kirchhoff's voltage law.	I	02
5	Find equivalent resistance for series connection.	I	02
6	Find equivalent resistance for parallel connection.	I	02
7	Find equivalent voltage for series and parallel connection of batteries.	I	02
8	Measure power consumption using wattmeter and energy meter.	I	02
9	Use digital meters like multi-meter, clip-on meter.	II	02
10	Measure voltage, current and power and power factor in single phase AC circuit.	II	02*
11	Measure voltage, current power and power factor in 3 phase AC circuit	II	02
12	Verify relationship between voltage and current for 3-phse star connection.	II	02
13	Verify relationship between voltage and current for 3-phse delta connection.	II	02
14	Identify applicability of electromagnetic induction.	III	02*
15	Identify different kinds of inductor and it's applications	III	02
16	Identify components of solar power system.	V	02*
17	Identify components of wind power system.	V	02
	Minimum 14 Practical Exercises		**28 Hrs.**

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. 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	Identify components.	10
2	Prepare experimental setup.	20
3	Operate the equipment setup or circuit.	20
4	Follow safe practices.	10

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
5	Record observations correctly.	20
6	Interpret the result and conclude.	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 usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Variable DC power supply: 0- 30 V, 2 A, SC protection, display for voltage and current	1 to 8
2	Discrete Component Trainer/ Analog Component Trainer: Fixed and variable D.C. Supplies, AC Supplies, Actual Components like transistors, SCR, LDR, photo diode, resistors, capacitors, inductors, diodes, LED's, transformers, 2 mm patch cords for interconnecting components	1 to 6
3	Single phase auto-transformer: Single phase, 0- 230 V, 10 A	10
4	3-Phase auto-transformer: 0-440 V, 50 Hz, 20 A	11,12,13
5	Digital Multimeter: 3 1/2 digit display, 9999 counts digital multimeter measures: V_{ac}, V_{dc} (1000 V max) , A_{dc}, A_{ac} (10 amp max) , Resistance (0 - 100 MΩ) , Capacitance and Temperature measurement	2 to 13
6	Clamp on meter: AC/DC current up to 40 A, 600 V	2 to 13
7	Solar Energy Demonstration Kit (Meters, Chargeable Batteries, with sample load)	16
8	Wind Energy demonstration kit or Wind turbine working Model (Small capacity)	17

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 fulfil the development of this competency.

a) Work as a leader/a team member.
b) Follow safety practices while using electrical equipment.
c) Realize importance of green energy.

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 higher level 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 DC Circuits	1a. Explain electrical parameters related with DC supply. 1b. Distinguish basic electrical components. 1c. Explain effect of temperature on resistance. 1d. Determine voltage, current and resistance in electrical circuit using Ohm's law. 1e. Apply Kirchhoff's voltage and current law for given electrical circuit. 1f. Calculate equivalent resistance for given connection. 1g. Select relevant battery for given application.	1.1 Idea of Electric Potential, EMF, Current, Power and Energy 1.2 Introduction of Resistor, Inductor and Capacitor 1.3 Effect of temperature on resistance of conductor 1.4 Ohm's law: Applications and limitations 1.5 Kirchhoff's voltage law and Kirchhoff's current law 1.6 Types of connections: series and parallel connections of resistors 1.7 Battery: Concept of cell and battery, Rating of battery, Series and parallel connection of batteries, Applications
Unit – II AC Circuits	2a. Explain generation of alternating EMF. 2b. Define parameters related to alternating waveform. 2c. Describe behavior of pure resistor, inductor and capacitor with AC supply. 2d. Explain concept of power triangle and power factor. 2e. Explain the generation of 3-phase alternating EMF. 2f. Describe different 3 phase electrical connection.	2.1. Generation of Alternating EMF 2.2. Basic Terminology: Cycle, Time-period, Amplitude, Frequency, RMS value, Average value, Form factor, Peak factor 2.3. Pure resistor, inductor and capacitor with AC supply 2.4. Power triangle and power factor 2.5. Generation of 3-phase alternating EMF 2.6. Types of 3-phase connection: Star & Delta connection with vector diagram
Unit– III Electro-magnetic Induction and Inductors	3a. Describe phenomenon of electromagnetic induction. 3b. Apply Faraday's law, Lenz's law, Fleming's right hand rule, Fleming's left hand rule. 3c. Differentiate statically and dynamically induced EMF, self and mutual inductance. 3d. Identify the different types of inductors and explain their	3.1 Electromagnetic Induction 3.2 Faraday's law, Lenz's law, Fleming's right hand rule for Generators, Fleming's left hand rule for Motors 3.3 Statically and dynamically induced EMF 3.4 Inductance: Self and Mutual inductance 3.5 Types of Inductor 3.6 Energy stored in Magnetic field

	applications. 3e. Calculate the energy stored in magnetic field.	
Unit– IV Green Electrical Energy	4a. Justify the need of green energy. 4b. Classify sources of green energy. 4c. Explain block diagram of solar power plant. 4d.Explain block diagram of wind power plant.	4.1 Need of green energy 4.2 Classification of green energy 4.3 Solar energy: PV cell, Panel and Arrays, Block diagram of solar power system, Solar roof top 4.4 Wind energy: Types of wind turbine, Block diagram of wind power system

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	DC circuits	12	9	9	5	23
II	AC circuits	12	9	9	5	23
III	Electro-magnetic Induction and Inductors	8	4	4	2	10
IV	Green Electrical Energy	10	6	6	2	14
Total		**42**	**28**	**28**	**14**	**70**

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

Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions 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 vary slightly from above table.*

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 conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare specification of resistor/inductor/capacitor.
b) Calculate total installed electrical load of any premises.
c) Give seminar on innovation in renewable energy sources.

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.
g) Guide students for using data manuals.

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-project 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) **Demonstration kit:** Prepare demonstration kit for various electrical laws that has been part of the course.
b) **Components:** Prepare a chart for commonly used resistors, inductors and capacitors used in different domestic appliances (name of appliances with type and ratings)
c) **LED tube light :** Build and test the LED lamp circuit for its proper working.
d) **Power Factor Improvement:** Visit a nearby sub-station and observe the use of power capacitors for power factor improvement and prepare a report.
e) **Solar/Wind power generation in India:** Prepare a report on current installed capacity of RES with emphasis on solar and wind including the growth in last 10 years (From government websites)
f) **Energy Consumption and safety:** Compile a report regarding energy consumption of a house.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Basic Electronics and Linear Circuits	Bhargava N.N., Kulshreshtha D.C. and Gupta S.C.	McGraw Hill Education, New Delhi, ISBN: 9780074519653
2	A text book of Electrical Technology-Vol.1	Theraja B. L.	S. Chand Publication ISBN: 9788121924375

S. No.	Title of Book	Author	Publication with place, year and ISBN
3	Non-Conventional Energy Resources	Khan, B.H.	Tata Mc Graw Hill, IBSN: 9780070142763

14. SOFTWARE/LEARNING WEBSITES

a) www.nptel.iitm.ac.in
b) https://ndl.iitkgp.ac.in
c) www.electronicsforu.com
d) www.electrical4u.com
e) www.vlab.co.in

15. PO-COMPETENCY-CO MAPPING

Semester I	Fundamentals of Electrical Engineering (Course Code: 4311101)						
	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 .	Use principles of electrical engineering in solving branch specific engineering problems.						
Course Outcomes							
CO a) Use fundamentals of DC circuits and batteries in relevant engineering discipline.	3	2	-	1	-	1	2
CO b) Apply fundamentals of AC circuits in relevant engineering discipline.	3	2	-	1	-	1	2
CO c) Apply fundamentals of Electromagnetic induction	3		-	1	-	1	2
CO d) Distinguish working of solar and wind power plant.	3	-	-	-	3	1	2

*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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