GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: **D.C. Circuits**
(Course Code: C4310901)

Diploma programme in which this course is offered	Semester in which offered
Electrical Engineering	First

1. RATIONALE

Students of diploma electrical engineering need to have a thorough understanding of fundamental concepts and principles of DC Circuits to determine various electrical engineering parameters. Diploma students undertaking this course are expected to apply the fundamentals of DC circuits to analyse the different electrical and electronics engineering circuits, advance course like electrical machines and drives and also develop skills required to meet the expectations of the industry.

2. COMPETENCY

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

- **Solve basic circuit problems using circuit laws and network theorems.**

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 simple electrical circuits using basic circuit laws.
b) Solve simple electric circuits using different network solution techniques/analysis.
c) Solve simple electrical circuits using network theorems.
d) Interpret the working of capacitor based on electrostatic principle.
e) Interpret the working of inductor based on electromagnetic principle.

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	1	2	5	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.	1,4,5	2
2	Demonstrate various types of resistors	1	2
3	Calculate the temperature coefficient of the given resistor.	1	2
4	Verify Ohm's law in the given electric circuit	1	2*
5	Verify Kirchhoff's current law in the given electric circuit	1	2*
6	Verify Kirchhoff's voltage law in the given electric circuit	1	2*
7	Measure voltage, current and resistance in the given DC circuit.	1	2
8	Find equivalent resistance for series connection.	2	2
9	Find equivalent resistance for parallel connection.	2	2
10	Verify Superposition theorem and determine the current and voltage in each branch of the given circuit.	3	2*
11	Verify the Thevenin's theorem and determine the voltage and current in the given branch of the circuit.	3	2*
12	Verify the Norton's Theorem and determine the voltage and current in the given branch of the circuit.	3	2*
13	Verify Maximum Power Transfer Theorem and determine value of load resistance for maximum power transfer in the given electrical circuit.	3	2*
14	Connect given capacitors in series, parallel, series-parallel and determine the total equivalent value of capacitance.	4	2
15	Measure charging and discharging time of capacitor in the given circuit and verify the same with RC time constant.	4	2
16	Test different types of capacitors.	4	2*
17	Connect batteries in series and in parallel to the given load and check the resultant voltage and current at load terminals.	4	2
18	Test different types of inductors.	5	2*
19	Measure inductance of the given choke coil using LCR meter.	5	2
20	Demonstrate Faraday's law of electromagnetic induction.	5	2
	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	Prepare of experimental setup.	20
2	Operate the equipment setup or circuit.	20
3	Follow safe practices.	10
4	Record observations correctly.	20
5	Interpret the result and conclude.	30
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 source, Dual channel (0-30 V, 0-2 A, digital display)	3 -15, 20
2	DC Ammeter (0-2 A, Analog)	3 -15, 17, 20
3	DC Voltmeter(0-30 V or 0-50 V, Analog)	3-15, 17
4	Digital Multimeter (3-1/2 display, max reading 1999m hand held)	3-15, 17
5	Stop Watch	15
6	Thermometer (lab thermometer, degree Celsius /Fahrenheit, non-contact type)	3
7	Rheostat (0-200 Ohm, 0-2 A, linear, slider type)	2,3,7
8	Bread board (2 Power, 2 ground rails, 2 circuit areas, contact points > 200, Volt > 15 V, Current > 1 A)	4,5,6,8,9,10,11, 12,13,14
9	Resistors of various range	2
10	Capacitors of various range	16
11	Inductors of various range	18
12	Variable POT: Single turn (rotation upto 270 degrees , multi turn, Dual gang POT)	11,12,13
13	LCR meter – Diplay-3.5 Digits, Count-1999, Inductance range-1mh-10 H or suitable, Inductance accuracy-+/- 5%, Capacitor range- 1nF – 1000 micro F, Capacitance accuracy-+/- 5 %, Resistance accuracy-+/- 1 %, Auxiliary-Test leads, batteries and manual.	19
14	Batteries (1.5 V to 12 V, cylindrical, rectangular, chargeable / non-rechargeable, Size A, AA, C, D, E etc.)	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 course competency.

a) Work as a leader/a team member.
b) Follow safety practices while using electrical appliances.
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 Fundamental concepts of D.C. Circuits	1a. Explain the properties of the commonly used electrical engineering materials. 1b. Classify different types of resistors. 1c. Explain the 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 to determine voltage, current and power in the given resistive circuit. 1f. Calculate work, power and energy in given electrical circuit. 1g. Use Joule's Law of heating to compute the amount of heat produced due to current flow in a conductor. 1h. State the impact of using electrical source over the other energy sources on the environment	1.1 Electric Potential, EMF, Current, Power and Energy 1.2 Conductor, Semiconductor and insulator-properties and applications 1.3 Resistor, Inductor and Capacitor 1.4 Resistor-Properties and Practical applications, Classification based on ohmic value and material, Effect of temperature on resistance and temperature coefficient of resistance 1.5 Conductance, conductivity, current density 1.6 Ohm's law: Applications and limitations 1.7 Kirchhoff's voltage law and Kirchhoff's current law 1.8 Joule's law of heating, applications 1.9 Power and energy, unit conversion from mechanical to electrical and vice-versa

		1.10 Impact of using electrical source over the other energy sources on the environment.
Unit – II Network solution techniques	2a. Determine the equivalent resistance of given series, parallel connections. 2b. Apply source transformation techniques to simplify electrical circuits. 2c. Apply Mesh analysis and Nodal analysis to calculate voltage, current and power in given resistive circuits. 2d. Apply the principle of duality to electrical networks	2.1 Node, branch, loop, mesh; open, closed and short circuit 2.2 Series and Parallel connections of resistors and equivalent resistance 2.3 Source transformation techniques 2.4 Mesh analysis 2.5 Nodal Analysis 2.6 Duality in electrical networks.
Unit– III Network Theorems	3a. Differentiate given types of electrical circuits with examples. 3b. Apply superposition theorem to calculate current and voltage in any branch of circuit with two or more sources. 3c. Apply Thevenin's theorem to simplify a given electrical network and compute current and voltage in branch under consideration. 3d. Apply Norton's theorem to simplify a given electrical network and compute current and voltage at a branch under consideration. 3e. Apply Maximum Power Transfer theorem to calculate load resistance for maximum power transfer. 3f. Convert resistive 'T (star)' network to 'pi (delta)' network and vice versa.	3.1 Types of electric circuits - Active and Passive, Linear & Nonlinear, unilateral and bilateral circuit 3.2 Superposition theorem, equivalent circuit 3.3 Thevenin's theorem, equivalent circuit 3.4 Norton's theorem, equivalent circuit 3.5 Maximum Power Transfer theorem 3.6 'T' to 'Pi' network conversion (star-delta transformation) and 'Pi' to 'T' network conversion (delta-star transformation),
Unit– IV Capacitors and its Applications	4a. Explain the working of a capacitor 4b. Identify the factors affecting the capacitance 4c. State applications and types of capacitors 4d. Calculate the capacitance, charging and discharging time, energy stored in capacitors in electrical circuits 4e. Classify the types of batteries & connect it in series & parallel.	4.1 Capacitor- Function, types, applications, Capacitance, Capacitive reactance, Factors affecting capacitance 4.2 Behaviour of capacitors in DC circuits, Charging and discharging of Capacitor, RC time constant, Energy stored in Capacitor 4.3 Series and parallel

	4f. Describe in brief, the recycling as well as disposal processes of old capacitors and batteries.	combination of capacitors 4.4 Capacitance of parallel plate capacitor and Spherical capacitor 4.5 Batteries, ratings, types and their comparison, 4.6 Identification of weak battery in series and parallel combination 4.7 Recycling, disposal of old capacitors and batteries safely
Unit– V Magnetism and Electromagnetism	5a. Compare magnetic circuit with electric circuit. 5b. Apply laws of electromagnetism to determine direction of flux, magnetic force, induced emf, flux density and field strength. 5c. State Faraday's laws of electromagnetic induction, Flemings right- and left-hand rule and Lenz's law. 5d. Compute equivalent inductance in various series-parallel combinations. 5e. State applications of the given type of inductor. 5f. Calculate the energy stored in the given inductor.	5.1 Flux, Flux density (B), Magnetic field intensity (H), M.M.F, magnetic lines of force, permeability, hysteresis loop, reluctance, leakage factor, B-H Curve 5.2 Comparison of magnetic and electric circuit 5.3 Electromagnetism, Electromagnetic field around a current carrying conductor 5.4 Faraday's Laws of electromagnetic Induction, Fleming's right- and left-hand rule, Lenz's Law 5.5 Induced EMF, Self(static and dynamically induced emf) and mutually induced emf and their applications. 5.6 Self and mutual inductance, Inductive reactance, Coefficient of self and mutual inductance. 5.7 Inductance in series and parallel 5.8 Inductors- Function, types, construction and applications 5.9 Energy stored in an inductor

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	Fundamental concepts of DC Circuits	10	5	5	5	15
II	Network Solutions Techniques	7	4	5	6	15

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
III	Network Theorems	8	4	5	6	15
IV	Capacitors and its applications	7	4	2	4	10
V	Magnetism and Electromagnetism	10	6	4	5	15
Total		**42**	**23**	**21**	**26**	**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.*

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 electrical and electronic components.
b) Give seminar on resistors, Inductors and Capacitors, function, types and applications.
c) Undertake a market survey of different electrical and electronic components.

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. However, in the fifth and sixth semesters, it should be preferably be

individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, 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) Electromagnetism: Build a basic model to demonstrate Fleming's right and left hand rules.

b) Build a simple electric model to demonstrate mutually induced emf

c) Build a small heater (room, water etc.)

d) Make demonstrable models of various types of resistors, capacitors, inductors, their types, application based on types and ratings etc.

e) DC Source and application: Use toy motor and batteries to make any moving toy.

f) Flashing neon bulb using RC timer circuit. (Or any application using RC timer circuit).

g) Disposal of old capacitors and batteries – Compile a report on handling recycling and disposal of old capacitors and batteries with figures, tables and comparative charts and strategies used and suggested.

13. SUGGESTED LEARNING RESOURCES

S. 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	Sahdev RItu	Khanna Publications, 2018 edition, ISBN: 9789386173492
3	Basic Electrical Engineering	Rao, Uma. K.	Pearson Education, India, 2012 or latest edition, ISBN: 9788131766026,
4	Basic Electrical Engineering	Ananda Murthy, R. S	Pearson Education, India,2011 or latest edition: ISBN: 9788131754276
5	Basic Electrical Engineering	Mehta V. K.	S. Chand & Company (PVT) LTD., 1988 or Latest edition, ISBN: 9788121908719
6	Introduction to Electrical Engineering	Partha Kumar Ganguly	PHI Learning Private Limited, 2014 or latest edition Print Book ISBN: 9788120348097; eBook ISBN : 9789354433719

14. SOFTWARE/LEARNING WEBSITES

a. www.nptel.iitm.ac.in
b. www.khanacademy.org
c. https://phet.colorado.edu/
d. https://ndl.iitkgp.ac.in
e. www.electrical4u.com
f. www.vlab.co.in

15. PO-COMPETENCY-CO MAPPING

Semester I	DC Circuits (Course Code: C4310901)						
	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	Solve basic circuit problems using circuit laws and network theorems.						
Course Outcome CO a) Solve simple electrical circuits using basic circuit laws.	3	2	2	3	2	1	2
CO b) Solve simple electric circuits using different network solution techniques/analysis.	3	2	2	3	-	1	2
CO c) Solve simple electrical circuits using network theorems.	3	2	2	3	-	1	2
CO d) Interpret the working of capacitor based on electrostatic principle.	3	1	1	2	2	1	2
CO e) Interpret the working of inductor based on electromagnetic principle.	3	1	1	2	-	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

S. No.	Name and Designation	Institute	Contact No.	Email
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GTU Resource Persons

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