GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Electrical Engineering/ Renewable Energy

Course / Subject Code : DI01000081

Course / Subject Name : DC Circuit

w. e. f. Academic Year:	2024-25
Semester:	1st
Category of the Course:	PCC

Prerequisite:	**Acquaintance with basic concepts of electricity and electromagnetism**
Rationale:	The "D.C. Circuits" course is fundamental for electrical engineering students, providing essential knowledge of direct current (D.C.) electrical circuits. This course covers the circuit laws, the analysis of series and parallel circuits, forming the basis for understanding more complex electrical systems. Through practical applications and problem-solving exercises, students gain hands-on experience, enhancing their analytical and technical skills. Mastery of D.C. circuits is crucial for advancing to subsequent topics in electrical engineering such as electronic, electrical machines and power systems.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Apply fundamental concepts of electricity, Ohm's law and Joule's law on electrical systems.	A
02	Develop the ability to solve electrical D. C. circuits using source transformation techniques, Kirchhoff's laws, resistor network simplifications, voltage and current divider rules, and star-delta transformations.	A
03	Develop the ability to analyze and optimize electrical networks using concepts of circuit topology, superposition, Thevenin's, Norton's, and Maximum Power Transfer theorems.	A
04	Develop a comprehensive understanding of electrostatics, capacitors and their applications, series-parallel connections, and capacitor charging/discharging dynamics.	U
05	Develop a comprehensive understanding of laws and principles of magnetic fields, magnetic circuits, and electromagnetic induction, inductance, and inductor configurations.	U

**Revised Bloom's Taxonomy (RBT)*

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Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Fundamentals of Electrical Circuits** Contents: (1) Concepts of electric charge, electric current, current density, potential, potential difference, emf-voltage (2) Define terms: Resistance, Resistivity, Conductance and Conductivity and factors affecting resistance of a material (3) Conductors, semiconductor and insulator: properties and effect of temperature on resistance of various material (4) Ohm's law: application and limitations (5) Concepts of work, power and energy (6) Joule's law of heating	08	19 %
2.	**Electrical Circuit Laws and Techniques** Contents: (1) Kirchhoff's laws (Kirchhoff's current law and Kirchhoff's voltage law) (2) Series and parallel connections of resistors and equivalent resistance (3) Source transformation techniques; series and parallel connections of battery-cells and equivalent source voltage (4) Voltage and current divider rules (5) Star-Delta transformation	08	17 %
3.	**Electrical Network Theorems**	09	17 %

	Contents: (1) Concepts of electric circuit topology (2) Superposition theorem (3) Thevenin's theorem (4) Norton's theorem (5) Maximum power transfer theorem		
4.	**Electrostatics and Capacitors** Contents: (1) Terms related to electrostatics and Coulomb's law (2) Capacitors: definition, working, factor affecting capacitance types and application (3) Series - parallel connection of capacitors and equivalent capacitance (4) Charging / discharging of capacitor: State equations of voltage and current, draw curves and define RC time constant	08	19 %
5.	**Magnetic circuit and Electromagnetic Induction** Contents: (1) Magnetic field of conductor and solenoid: right hand rule and end rule (2) Magnetic circuits: overview, terms regarding to magnetic circuit and comparison with electrical circuits (3) Faraday's laws of electromagnetic induction: types of induced emf, Fleming's right-hand rule, Fleming's left-hand rule and Lenz's law (4) Coefficient of self and mutual inductance (5) Series and parallel connections of inductors (6) Inductor: types, construction and applications	12	28 %
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
25 %	**35 %**	**40 %**	-	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. "Electrical Technology Vol-1", Theraja, B. L., S. Chand & Co. Ltd., 23 edition or latest edition,ISBN-10: 8121924405
2. "Elements of Electrical Engineering" by U. A. Patel, Atul Prakashan, 2010 edition or latest
3. "Basic Electrical Engineering", Sahdev Ritu, Khanna Publications, 2018 edition, ISBN: 9789386173492
4. "Basic Electrical Engineering", Rao, Uma. K., Pearson Education, India, 2012 or latest edition, ISBN: 9788131766026, 9788131766026
5. "Basic Electrical Engineering", Ananda Murthy, R. S Pearson Education, India,2011 or latest edition: ISBN-10: 8131754278, ISBN-13 8131754276-978**:**
6. "Basic Electrical Engineering", Mehta V. K. S., Chand & Company (PVT) LTD., 1988 or Latest edition, ISBN: 9788121908719,9788121908719
7. "Introduction to Electrical Engineering". Partha Kumar Ganguly, PHI Learning Private Limited, 2014 or latest edition Print Book ISBN: 9788120348097; eBook ISBN: 978935443371
8. "Fundamentals of Electric Circuits", Charles K. Alexander & Matthew N. O. Sadiku, Edition: 6th, McGraw-Hill Education Publication, ISBN: 978-0078028229
9. "Electrical Engineering Fundamentals", Vincent Del Toro, 2nd Edition, Pearson Education Publication, ISBN: 978-0139477021
10. "Electrical Circuit Theory and Technology", John Bird, 5th Edition, Routledge Publication, ISBN: 978-1138673700
11. "Electric Circuits", James W. Nilsson & Susan Riedel, 10th Edition, Pearson Publication, ISBN: 978-0133760037

(b) Open-source software and website:

1. www.nptel.iitm.ac.in
2. www.khanacademy.org
3. https://phet.colorado.edu/
4. https://ndl.iitkgp.ac.in

5. www.electrical4u.com
6. www.vlab.co.in
7. https://www.nde-ed.org/Physics/Magnetism/atommagnetism.xhtml
8. https://www.tinkercad.com/dashboard
9. https://www.allaboutcircuits.com/
10. https://www.electronicshub.org/
11. https://openstax.org/
12. https://ocw.mit.edu/courses/8-02t-electricity-and-magnetism-spring-2005/pages/syllabus/

Suggested Course Practical List:

Sr. No.	Practical Outcome/Title of experiment	CO 1	CO2	CO3	CO4	CO5
1	Demonstrate various types of resistors and measure resistance	√				
2	Verify Ohm's law in the given electric Circuit	√				
3	Verify Kirchhoff's current law in the given electrical circuit		√			
4	Measure voltage, current and resistance in the given DC circuit	√				
5	Verify Kirchhoff's voltage law in the given electrical circuit		√			
6	Determine equivalent resistance for series connection of resistors		√			
7	Determine equivalent resistance for parallel connection resistors		√			
8	Verify Superposition theorem and determine the current and voltage in each branch of the given circuit			√		
9	Verify Thevenin's theorem and determine the current and voltage in each branch of the given circuit			√		

10	Verify Norton's theorem and determine the current and voltage in each branch of the given circuit			√		
11	Verify Maximum Power Transfer Theorem and determine value of load resistance for maximum power transfer in the given electrical circuit			√		
12	Determine the equivalent capacitance of series and parallel connection of capacitor				√	
13	Test the different types of capacitors				√	
14	Measure charging and discharging time of capacitor in the given circuit and verify the same with RC time constant				√	
15	Test different types of inductors					√
16	Demonstrate Faraday's law of electromagnetic induction					√
17	Measure inductance of a given inductor or a choke coil using LCR meter					√

List of Laboratory/Learning Resources Required:

Sr. No.	Equipment Name with Broad Specifications
01	Variable DC source, Dual channel (0-30 V, 0-2 A, 0-5 A, digital display)
02	DC Ammeter (0-2 A, 0-5 A, Analog or Digital)
03	DC Voltmeter (0-30 V or 0-50-100 V, Analog or Digital)
04	Digital Multimeter (3-1/2 display, max reading 1999m hand held)
05	Stop Watch
06	Rheostat (0-300 Ohm, 0-2 A, linear, slider type)
07	Bread board (2 Power, 2 ground rails, 2 circuit areas, contact points > 200, Volt > 15 V, Current > 1 A)

08	Resistors of various range and types
09	Capacitors of various range and types
10	Inductors of various range and types
11	Variable POT: Single turn (rotation up to 270 degrees , multi turn, Dual gang POT)
12	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.
13	Batteries (1.5 V to 12 V, cylindrical, rectangular, chargeable / non-rechargeable, Size A, AA, C, D, E etc.)

Suggested Project List:

1. Model to demonstrate Electromagnetism: Refer the you-tube link - https://www.youtube.com/watch?v=vwIdZjjd8fo
2. Model to demonstrate mutually induced emf: Build a simple electric model to demonstrate mutually induced emf. Refer the you-tube link - https://www.youtube.com/watch?v=tcC0bS04i3s
3. Electric Bell. Refer the you-tube link - https://youtu.be/N3PKtyGBHSo?si=bMo945tDpP27g6XC
4. Build a small heater (room, water etc.)
5. Make demonstrable models of various types of resistors, capacitors, inductors, their types, application based on types and ratings etc.
6. Flashing neon bulb using RC timer circuit. (Or any application using RC timer circuit).
7. Battery Life Testing: Design a circuit to measure the discharge curve of different types of batteries (e.g., AA, AAA) under constant load.
8. Disposal of old capacitors and batteries – Compile a report on handling recycling and disposal of old capacitors and batteries
9. Voltage Divider Network: Design and build a voltage divider circuit and test its performance in providing different voltage levels from a single power source.
10. Battery Charger: Develop a simple battery charger circuit for Ni-Cd or Li-ion batteries and include features for charging status indication.

Suggested Activities for Students:

Beyond classroom and laboratory learning, the following co-curricular activities are recommended to enhance the achievement levels of various outcomes in this course. Students are encouraged to undertake these activities either individually or in groups and prepare comprehensive reports of approximately five pages for each activity. Additionally, students should gather and document physical evidences for their portfolios, which could be beneficial during placement interviews:

a) Project Model / Seminar Presentations: Demonstrate project models or deliver seminars on various topics covered in the course content.

b) Numerical Problem Solving: Work on numerical problems provided in tutorial problems.

Assignments /Tutorial problems should be distributed unit-wise, and students should seek progressive assessment from the concerned course facilitators throughout the term. At the end of the term, the entire body of work should be submitted to the respective course facilitators for evaluation.

These activities will not only reinforce the theoretical understanding but also provide practical exposure and critical thinking opportunities essential for professional growth.

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