

Branch Name:	Electrical Engineering
Program Code:	ET109
Course Name:	High Voltage Engineering (Professional Elective-III)
Course Code:	2ET1090703T
Pre-requisite Course:	--

Course Objectives:

1. The students will acquire the knowledge regarding the importance of insulating materials and various breakdown mechanisms.
2. Explore the knowledge of various high voltage generation techniques.
3. Know about different high voltage testing methods and HV lab facilities.

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								Total (Marks)
					Theory (Marks)				Practical (Marks)				
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
3	3	-	-	3	24	60	16	40	-	-	-	-	100

Course Contents:

Sr. No.	Topic	Total Hours	Weightage (%)
1	Breakdown in Gases: Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge.	05	13
2	Breakdown in liquid and solid Insulating materials: Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, Intrinsic breakdown, Statistical estimation of parameters of high-voltage insulation based on breakdown voltage data, Electro-mechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.	06	13
3	Generation of High DC & AC Voltages: Half wave and full wave circuits, Voltage doubler circuits, Simple voltage doubler, Cascade voltage doubler, Voltage multiplier circuits, Cockcroft Walton voltage multiplier circuits, Ripple and regulation, Electrostatic machines, Principles, Van de Graff generator. Cascade transformers, Resonant transformers, Parallel and series resonant test systems, Generation of high frequency high voltages, Tesla coil.	08	17
4	Impulse Voltages and current Generation: Standard impulse wave shape, Analysis of commercial impulse generator circuits, Wave shape control, Multi-stage impulse generators, Marx circuit, Modified Marx impulse generator circuit, Components of multi stage impulse generator, Generation of switching surges, Generation of impulse current, Definition of impulse current waveform, Circuit for producing impulse current waves.	08	17

5	Measurements of High Voltages & Currents: Measurement of high voltages and currents- DC, AC and impulse voltages and currents, Digital Oscilloscope, Electrostatic and peak voltmeter, Sphere Gaps, Factors affecting measurement, Potential dividers (capacitive and resistive), Series impedance ammeters, Rogowski coil, Hall effect generator.	08	17
6	Lightning and Switching Over-voltages: Charge formation in clouds, Lightning Surges, Switching over-voltages, Protection against over voltages, Surge diverter, Surge modifier.	04	10
7	HV Laboratories and Testing: Various standards for HV Testing of electrical apparatus, IS, IEC standards, testing of insulators and bushings, Testing of isolators and circuit breakers, Testing of cables, Power transformers and Some high voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, Safety precautions in H. V. Lab.	06	13

Text Books:

1. High voltage engineering- M. S. Naidu, V. Kamaraju, MH Education, 6th edition, 2020.
2. High Voltage Engineering- C. L. Wadhwa, New Age International Publishers, 2nd edition, 2007.

Reference Books:

1. High Voltage and Electrical Insulation Engineering- R. Arora and W. Mosch, John Wiley & Sons, 2022.
2. High Voltage Engineering Fundamentals- D. V. Razevig (Translated by Dr. M. P. Chourasia), Khanna Publishers.
3. High voltage Laboratory Planning, High voltage test system- Nils Hylten, Cacallius, Asea Haefely.
4. Standard techniques for high voltage testing, IEEE Publication.
5. Various IS standards for HV Laboratory Techniques and Testing.
6. High Voltage Engineering Fundamentals- E. Kuffel, W. S. Zaengl, J. Kuffel, Newnes / Elsevier, 2nd Edition.

MOOCS:

1. <https://nptel.ac.in/courses/108/104/108104048/>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Acquire the knowledge regarding the fundamentals of high voltage engineering.	2 Understanding
CLO2	Categorize the insulating materials and various breakdown mechanisms.	4 Analyzing
CLO3	Explore the knowledge of various high voltage generation techniques.	3 Applying
CLO4	Learn different high voltage measurement methods.	1 Remembering
CLO5	Appraise the different high voltage testing methods and HV lab facilities.	5 Evaluating

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)			
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PS O1	PS O2	PS O3	PSO 4
CLO1	M	L	L	L	L	M	H		L	L		M			L	L
CLO2	M	L	L		M	H	H		L	L	L	M	L	M	L	
CLO3	H	M	L	L	M	M	H		M	L	M	L	M	M	L	M
CLO4	H	M	M	L	M	M	H		M	L	M	L	L		M	H
CLO5	H	L	M	M	H	H	H		M	L	H	M		M	H	

H: High, M: Medium, L: Low