

Department of Electrical & Electronics Engineering

COURSE MODULE OF THE COURSE TAUGHT FOR THE SESSION SEP- DEC 2024-25 (ODD SEM)

Course Syllabi with CO's				Academic Year: 2024-2025				
Faculty Member: Ms. Swapna H								
Department: Electrical & Electronics Engineering								
Course Code	Course Title	Core/Elective	Prerequisite	Contact Hours				Total Hrs/ Sessions
				L	T	P	S	
21EE71	High Voltage and Power System Protection	IPCC	Basic Electrical, Engineering Physics, Measuring Instruments	2	0	2	0	40 hours Theory + 10 Lab slots
Objectives	1. To discuss conduction and breakdown in gases, liquid dielectrics. 2. To discuss breakdown in solid dielectrics. 3. To discuss generation of high voltages and currents and their measurement. 4. To discuss overvoltage phenomenon and insulation coordination in electric power systems.							
Topics Covered as per Syllabus								
Module-1 Introduction to High Voltage Engineering: Advantages, Limitations and applications. Conduction and Breakdown in Gases: Introduction, Ionization Processes, Townsend's Current Growth Equation and it's Criterion for Breakdown, Streamer Theory of Breakdown in Gases, Paschen's Law, Breakdown in Nonuniform Fields and Corona Discharges. Conduction and Breakdown in Liquid Dielectrics: Introduction, Conduction and Breakdown in Liquid Dielectrics Breakdown in Solid Dielectrics: Introduction, Different types of breakdown studies in Solid Dielectrics								
Module-2 Generation of High Voltages and Currents: Generation of High Direct Current Voltages, High Alternating Voltages, Impulse Voltages and Impulse Currents. Measurement of High Voltages and Currents: Measurement of High Direct Current Voltages, High AC and Impulse Voltages, High Currents of Direct, Alternating and Impulse. Non-Destructive Testing of Materials and Electrical Apparatus: Introduction, Measurement of Dielectric Constant and Loss Factor, Partial Discharge Measurements.								
Module-3 Introduction to Power System Protection: Need for protective schemes, Types of Fault and it's Effects, Essential Qualities of Protection, Primary and Backup Protection. Relay Construction and Operating Principles: Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays. Overcurrent Protection: Introduction, Time–current Characteristics, Current Setting, Time Setting, Directional Relay, Protection of Parallel Feeders and Ring Mains, Earth Fault, Phase Fault Protection and Combined Earth and Phase Fault Protective Scheme, Static Overcurrent Relays, Numerical Overcurrent Relays.								
Module-4: Distance Protection: Introduction, Impedance Relay, Reactance Relay, Mho Relay, Effect of Power Surges, Line Length and Source Impedance on Performance of Distance Relays. Pilot Relaying Schemes: Introduction, Wire Pilot Protection, Carrier Current Protection. Differential Protection: Introduction, Differential Relays, Percentage Differential Relay, Balanced Voltage Differential Protection. Protection of Generators, Transformer and Bus zone Protection: Introduction, Protection of Generators. Transformer Protection, Bus zone Protection.								
Module- 5: Circuit Breakers: Introduction, Arc Voltage, Arc Interruption, Restriking Voltage and Recovery Voltage, Current Chopping. Air Circuit Breakers, SF6 Circuit Breakers, Vacuum Circuit Breakers, Rating of Circuit Breakers, Testing of Circuit Breakers. Protection against Overvoltage: Causes of Overvoltage, Lightning phenomena, Klydonograph and Magnetic Link, Protection of power stations and Substations. Insulation Coordination.								

<p align="center">Practical component of High Voltage and Power System Protection (For CIE only)</p> <ol style="list-style-type: none"> Over Current Relay: (a) Inverse Definite Minimum Time (IDMT) Non - Directional Characteristics (b) Directional Features (c) IDMT Directional. CO-3 IDMT Characteristics of Over Voltage or Under Voltage Relay (Solid State or Electromechanical type). CO-3 Operation of Negative Sequence Relay.CO-3 Operating Characteristics of Microprocessor Based (Numeric) Over –Current Relay.CO2,CO3 Operating Characteristics of Microprocessor Based (Numeric) Distance Relay. CO2,C03 Operating Characteristics of Microprocessor Based (Numeric) Over/Under Voltage Relay. CO2,O3 Motor Protection against Faults. CO4,CO5 Spark Over Characteristics of Air subjected to High Voltage AC with Spark Voltage Corrected to Standard Temperature and Pressure for Uniform [as per IS1876: 2005]and Non-uniform [as per IS2071(Part 1) : 1993] Configurations: Sphere – Sphere, Point –Plane, Point – Point and Plane – Plane. CO2 Spark Over Characteristics of Air subjected to High voltage DC. CO1, CO2 Measurement of HVAC and HVDC using Standard Spheres as per IS 1876 :2005 CO1,CO2 Measurement of Breakdown Strength of Transformer Oil as per IS 1876 :2005 CO1,CO2 	
List of Text Books	
<p>TEXT BOOKS:</p> <ol style="list-style-type: none"> High Voltage Engineering, M.S.Naidu and Kamaraju- 5th Edition, THM, 2013 Power System Protection and Switchgear Badri Ram, D.N. Vishwakarma McGraw Hill 2nd Edition 	
List of Reference Books	
<ol style="list-style-type: none"> High Voltage Engineering Fundamentals, E. Kuffel, W.S. Zaengl, J. Kuffel, Newnes, 2 nd Edition, 2000 High Voltage Engineering, Wadhwa C.L., New Age International, 3 rd Edition, 2012. Protection and Switchgear, Bhavesh et al, Oxford, 1st Edition, 2011. Power System Switchgear and Protection, N. Veerappan, S.R. Krishnamurthy, S. Chand, 1st Edition, 2009 	
List of URLs, Text Books, Notes, Multimedia Content, etc	
<ol style="list-style-type: none"> http://electrical-engineering-portal.com http://nptel.ac.in/courses/108104048/ Fundamentals of High Voltage Engineering By S.K.Singh, Dhanpat Rai& Co. 	
<p>Graduate Attributes (As per NBA)</p> <p>Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Modern Tool Usage, Ethics, Individual and Team Work, Communication, Life-long Learning</p>	
Course Outcomes	<p>At the end of the course the student will be able to:</p> <p>CO-1: Interpret the conduction and breakdown phenomenon in dielectrics and Identify the parameters governing breakdown phenomenon. (L3)</p> <p>CO-2: Analyze the circuits of high voltages, high currents in Generation and Measurements (L4)</p> <p>CO-3: Interpret performance of protective relays and its components of protection & Apply over current protection scheme(L3)</p> <p>CO-4: Analyse operating characteristics of distance relays, Pilot Relaying Schemes, differential relays for protection of generators, motors, Transformer and Bus Zone Protection. (L4)</p> <p>CO-5: Apply the principles of circuit interruption in circuit breakers and their selections and Discuss protection against Overvoltages (L3)</p>
<p>CIE: Combination of Theory and Practical</p> <p>Theory component (30 Marks):</p> <p>Three Internal Assessment of 40 mark each and considering Average of Best of 2 IAs + Sum of Two Assignment of 10 marks each. Cumulative score shall be scaled down to 50%.</p> <p>Practical component (20 Marks): 15 marks for the conduction of the experiment and preparation of laboratory record and 05 marks for the test to be conducted after the completion of all the laboratory sessions.</p> <p>The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50).</p>	

The Correlation of Course Outcomes (CO's) and Program Outcomes (PO's)

Course Code:	21EE71	TITLE: High Voltage and Power System Protection						Faculty Name:	Ms. Swapna H					
List of Course Outcomes	Program Outcomes (PO's) & Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO-1	3	2	-	-	2	2	-	-	3	2	-	2	3	-
CO-2	3	2	-	-	2	2	-	-	3	2	-	2	3	-
CO-3	3	2	2	-	2	2	2	2	3	2	-	3	3	-
CO-4	3	2	2	-	2	2	2	2	3	2	-	3	3	-
CO-5	3	2	-	-	2	2	2	2	3	2	-	3	3	-

Note: 3 = Strong Contribution 2 = Average Contribution 1 = Weak Contribution - = No Contribution