

POWER SYSTEM PROTECTION

VII Semester: EEE																																						
Course Code	Category	Hours / Week			Credits	Maximum Marks																																
AEEB27	Core	L	T	P	C	CIA	SEE	Total																														
		3	-	-	3	30	70	100																														
Contact Classes: 45		Tutorial Classes: Nil		Practical Classes: Nil		Total Classes: 45																																
<p>I. COURSE OVERVIEW: The main objective of the course is to provide an overview of the principles and schemes for protecting power lines, transformers, buses, generators. It provides in depth knowledge of various types of relays and circuit breakers. It includes protection against over voltages in power system using lightning arrestors and insulation co-ordination.</p> <p>II. OBJECTIVES: The course should enable the students to:</p> <ol style="list-style-type: none"> I. Understand types of various circuit breakers II. Classify relays into various types such as of electromagnetic, static and numerical relays III. Evaluate the performance of protection schemes of generator and transformer IV. Analyze the performance of feeder and bus-bar protection V. Discuss the protection schemes against over voltages <p>III. COURSE OUTCOMES: After successful completion of the course, students should be able to:</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 5%;">CO 1</td> <td style="width: 75%;">Identify various abnormal conditions that could occur in power system in order to choose selective protective device for avoiding outages.</td> <td style="width: 20%;">Understand</td> </tr> <tr> <td>CO 2</td> <td>Understand Arc phenomenon and Arc extinction methods of circuit breaker under fault condition for increasing Arc resistance</td> <td>Apply</td> </tr> <tr> <td>CO 3</td> <td>Describe types of existing circuit breakers, their design and constructional details used for the protection of power system under different fault condition</td> <td>Understand</td> </tr> <tr> <td>CO 4</td> <td>Explain construction and working of various types relays for detection of fault and disconnection of a faulty section.</td> <td>Apply</td> </tr> <tr> <td>CO 5</td> <td>Classify substations based on operating voltages and their circuit elements helps in provide reliable supply for the consumers.</td> <td>Understand</td> </tr> <tr> <td>CO 6</td> <td>Summarize protection schemes of feeder and bus-bars that plays effective role in protection of transmission lines.</td> <td>Understand</td> </tr> <tr> <td>CO 7</td> <td>Outline protection schemes of transformer against open and short circuit faults for maintaining continuous supply</td> <td>Apply</td> </tr> <tr> <td>CO 8</td> <td>Design of deep learning algorithms for solving real-world problems</td> <td>Apply</td> </tr> <tr> <td>CO 9</td> <td>List the causes of over voltages in the power system network in order to study its behavior for avoiding voltage surges in the system</td> <td>Apply</td> </tr> <tr> <td>CO 10</td> <td>Classify types of lightning arrestors for the protection of power system network from high voltage surges in order to provide uninterruptable power supply.</td> <td>Apply</td> </tr> </table>									CO 1	Identify various abnormal conditions that could occur in power system in order to choose selective protective device for avoiding outages.	Understand	CO 2	Understand Arc phenomenon and Arc extinction methods of circuit breaker under fault condition for increasing Arc resistance	Apply	CO 3	Describe types of existing circuit breakers, their design and constructional details used for the protection of power system under different fault condition	Understand	CO 4	Explain construction and working of various types relays for detection of fault and disconnection of a faulty section.	Apply	CO 5	Classify substations based on operating voltages and their circuit elements helps in provide reliable supply for the consumers.	Understand	CO 6	Summarize protection schemes of feeder and bus-bars that plays effective role in protection of transmission lines.	Understand	CO 7	Outline protection schemes of transformer against open and short circuit faults for maintaining continuous supply	Apply	CO 8	Design of deep learning algorithms for solving real-world problems	Apply	CO 9	List the causes of over voltages in the power system network in order to study its behavior for avoiding voltage surges in the system	Apply	CO 10	Classify types of lightning arrestors for the protection of power system network from high voltage surges in order to provide uninterruptable power supply.	Apply
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IV. SYLLABUS:		
MODULE-I	CIRCUIT BREAKERS	Classes: 08
Circuit Breakers: Elementary principles of arc interruption, restriking and recovery voltages, restriking phenomenon, average, maximum and rate of rise of restriking voltage, current chopping and resistance switching, circuit breaker ratings and specifications, auto reclosures, description and operation of various types of circuit breakers, minimum oil circuit breakers, air blast circuit breakers, vacuum and SF6 circuit breakers, numerical problems.		
MODULE-II	ELECTROMAGNETIC, STATIC AND NUMERICAL RELAYS	Classes: 14
Electromagnetic relays: Principle of operation and construction of attracted armature, balanced beam, induction disc and induction cup relays; Relays classification: instantaneous, definite minimum time and inverse definite minimum time relays over current / under voltage relays, direction relays, differential relays and percentage differential relays, universal torque equation; Distance relays: Impedance, reactance, mho and offset mho relays, characteristics of distance relays; Static relays: Overview of static relay, block diagram, operating principle and comparison, static relays versus electromagnetic relays; Numerical relays: Introduction, block diagram of numerical relay, sampling theorem, anti aliasing filter, block diagram of phasor measurement unit and intelligent electronic device, data acquisition systems and numerical relaying algorithms, applications and numerical problems.		
MODULE-III	SUBSTATIONS AND PROTECTION OF FEEDER / BUS BAR	Classes: 07
Indoor and outdoor substations: Substation's layout, bus bar arrangements like single, sectionalized, main and transfer bus bar system with relevant diagrams; Gas insulated substation (GIS): Types, single line diagram, constructional aspects of GIS, Installation, maintenance, advantages, comparison of GIS with air insulated substations. Protection of lines: Over current, carrier current and three zone distance relay protection using impedance relays, translay relay; Protection of bus bars: Differential protection, grounded and ungrounded neutral systems, effect of ungrounded neutral on system performance, methods of neutral grounding, solid, resistance, reactance arcing grounds and grounding practices, application of numerical relays.		
MODULE-IV	GENERATOR AND TRANSFORMER PROTECTION	Classes: 08
Generator protection: Protection of generators against stator faults, rotor faults, and abnormal conditions, restricted earth fault and inter turn fault protection, numerical problems on percentage winding unprotected; Transformer protection: Percentage differential protections, numerical problem on design of current transformers ratio, Buchholz protection.		
MODULE-V	PROTECTION AGAINST OVER VOLTAGES	Classes: 08
Over voltages in power systems: Generation of over voltages in power systems, protection against lightning over voltages, valve type and zinc oxide lightning arresters, insulation coordination, basic insulation level, impulse ratio, standard impulse test wave, volt time characteristics.		
V. Text Books:		
<ol style="list-style-type: none"> 1. Badari Ram, D N Viswakarma, "Power System Protection and Switchgear", TMH Publications, 1st Edition, 2001. 2. Sunil S Rao, "Switchgear and Protection", Khanna Publishers, 1st Edition, 2013. 		

VI. Reference Books:

1. A R van C Warrington, "Protective Relays: Their Theory and Practice", Springer Science & Business Media, Volume 2, 2nd Edition, 1977.
2. B L Soni, Gupta, Bhatnagar, Chakrabarthy, "Power System Engineering", Dhanpat Rai & Co, 3rd Edition, 2007.
3. T S Madhava Rao, "Power System Protection: static relays", McGraw-Hill Companies, 2nd Edition, 1989.
4. Paithankar, S R Bhide, "Fundamentals of Power System Protection", PHI, 1st Edition, 2003.
5. C L Wadhwa, "Electrical Power Systems", New Age international (P) Limited, 6th Edition, 2010.
6. VK Mehta, "Principles of power systems", S Chand Publications, 4th Edition, 2009.

VII. Web References:

1. https://www.eiseverywhere.com/file_uploads/aaf42a76a5588f69c7a1348d6f77fe0f_Introduction_to_System_Protection- Protection_Basics.pdf
2. <https://www.scribd.com/doc/94677925/Protection-and-Switch-Gear-by-U-a-bakshi-and-M-v-bakshi>
3. https://www.scadec.ac.in/upload/file/psg%20notes_opt.pdf
4. https://www.vssut.ac.in/lecture_notes/lecture1425873259.pdf
5. https://www.en.wikipedia.org/wiki/Power-system_protection

VIII. E-Text Books:

1. <https://www.igs.nigc.ir/STANDS/BOOK/Electrical-Eng-HB.pdf>
2. https://www.file:///C:/Users/iare20071/Downloads/Electrical_Power_Systems_Quality_Second_Edition_007138622X.pdf
3. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=49&cad=rja&uact=8&ved=0ahUKEwiB89WRo5vQAhWMuY8KHYNDCPA4KBAWCEcwCA&url=http%3A%2F%2Fbank.enzenon.com%2Fdownload%2F565727ab-789c-4920-a807-4447c0feb99b%2Fpower_system_relaying_by_stanley_h_horowitz_4th.pdf&usg=AFQjCNFH1CozChcgjUBC3AUV_XJPG1Raog&bv=m=bv.138169073,d.c2I