

4EE01: POWER SYSTEM PROTECTION
CREDITS - 3 (LTP: 3, 0, 0)

Course Objective:

To explain the basic concepts of protective relays and their applications to power systems.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
L	T	P		Theory Marks		Practical Marks		Total Marks
			ESE	CE	ESE	CE		
3	0	0	3	60	40	0	0	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	Protective Relaying System Functions of protective relaying schemes, basic tripping circuit with system transducers, zones of protection, main and backup protection, evolution of protective relaying technology, classification of relays, characteristics of inverse time overcurrent relays, directional relays, differential relays, advantages of numerical relaying, numerical relaying hardware	08
2	Overcurrent Protection of Transmission Lines:- Basic radial feeder, time-current discrimination, rules for setting phase and ground IDMT relays, features of numerical overcurrent relays, concept of relay coordination using communication between numerical relays, detailed protective scheme of directional overcurrent protection of a high-voltage transmission line, limitations of overcurrent relays	04
3	Distance and Carrier Current Protection of Transmission Lines: Impedance relays, reactance relays, ohm relays, mho relays, quantities to be fed to distance relays, stepped distance characteristics, problems in distance measurement, switched and polyphase distance relaying schemes, limitations of distance protection of transmission lines, pilot wire protection, AC wire pilot wiring, limitations of AC wire pilot wiring, carrier current protection, carrier based distance protection	10

Unit No.	Topics	Teaching Hours
4	Generator Protection: Protective relaying schemes for differential, inter-turn fault, stator earth-fault , rotor earth-fault, negative phase sequence, field failure, overload, over-voltage, reverse power, pole-slipping, back-up impedance, under-frequency; class A, class B and class C protections and conditions causing alarms, field suppression, numerical relaying for generator protection	08
5	Transformer Protection: Faults in transformers; gas-operated relays; protective relaying schemes for overcurrent restricted earth-fault, differential, over fluxing, grounding transformers, overheating, and small transformers; numerical relaying for transformer protection	06
6	Bus-zone and Induction Motor Protection: Requirements of bus-zone protection, busbar differential protection schemes, starting characteristics of an induction motor, faults in induction motors, abnormalities of induction motors, protection of small and large induction motors, numerical induction motor protection relay.	04
7	Current and Potential Transformers: Equivalent circuit and vector diagram of a current transformer, construction of current transformers, CT saturation characteristics, difference between CT cores used for measurement and protection purpose, CT errors, Calculation of CT accuracy, factors to be considered while selecting a CT, Problems encountered in a CT, CT requirements for different protective schemes, Specifications of a CT, Equivalent circuit of a PT, construction of a PT, Capacitive Voltage Transformer (CVT), specifications of a PT, introduction to wireless CT and PT	04
Total		44

List of References:

1. B. A. Oza, N.C. Nair, R.P. Mehta and V.H. Makwana, "Power System Protection and Switchgear", McGraw Hill Education Ltd., 2010
2. Y. G. Paithankar, S.R. Bhide, "Fundamentals of Power System Protection", Prentice Hall, India, 2003
3. S. S. Rao, "Switchgear Protection And Power Systems", Khanna Publisher, New Delhi, 13th Edition, 2012
4. Stanley H. Horowitz, Arun G. Phadke, "Power System Relaying", Wiley Publication, 4th Edition, 2014

Web Resources:

1. Web course on "Power System Protection" by Prof. S. A. Soman, IIT, Bombay available on NPTEL at <http://nptel.ac.in/courses/108101039/>

2. Scilab Textbook Companion for S. S. Rao, "Switchgear Protection And Power Systems", Khanna Publisher, New Delhi, 13th Edition, 2012 available at: http://scilab.in/textbook_run/1067

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand the principles of protection and the different components involved in protection.
2. Compare advantages and disadvantages of various protective relaying technology like electromagnetic, static and numerical.
3. Compare and analyze the over-current protection, distance protection and carrier-current protection of transmission line
4. Understand the protective schemes used in practice for protection of generator and transformer and compute relay settings.
5. Understand the protective schemes used in practice for protection of bus-zone and induction motor
6. Analyze the working of current transformers and potential transformers and apply them for use in power system protection