

COURSE TITLE	SWITCHGEAR AND PROTECTION
COURSE CODE	01EE1703
COURSE CREDITS	4

Objective:

- 1 To develop comprehensive knowledge of protective relaying schemes used to protect various power system components and familiarize with switchgears and instrument transformer operation

Course Outcomes: After completion of this course, student will be able to:

- 1 Explain the need, main components, and underlying philosophy of electrical protective schemes.
- 2 Analyze the suitability of various protective schemes for different power system components
- 3 Choose appropriate relay, circuit breaker and instrument transformers for given applications
- 4 Explain the recent advances in the power system protection and switchgears

Pre-requisite of course:Power System-II

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	Philosophy of Protective Relaying Schemes Types of Faults, Abnormalities, Functions of Protective Relaying Schemes, Major Components of Power System, Basic Tripping Circuit, Zones of Protection, Basic Requirements of Protective Schemes, Main and Backup Protection, Protective Relay Technology: A Historical Review, Classification of Relays	4
2	Protection of Transmission Lines Protection of Lines by Over Current Relays-Methods of Discrimination, Settings of Phase and Ground relays, Directional Protection, Protection of Lines by Distance relays, performance comparison of distance relays, 3-Stepped Distance Scheme, Carrier Aided Protection of Lines-Need for carrier aided protection, Carrier coupling and trapping, Carrier aided distance schemes	13

Contents : Unit	Topics	Contact Hours
3	Apparatus Protection Transformer Protection-Types of Faults, Over Current Protection, Percentage Differential Protection, Inrush Phenomenon, Restricted Earth Fault Protection, Incipient Fault, and Protection against Over fluxing, Generator Protection-Differential Protection, Inter-turn fault Protection, Stator Earth fault, Rotor Earth fault, Negative Phase Sequence, Field Failure, Over Load, Reverse Power Protection, Induction Motor Protection-Faults and Abnormalities in Induction Motor, Protection of Small and Large Induction Motors	13
4	Circuit Breakers and Instrument Transformers Classification of switchgear and fields of application and relative merits, Theories of current interruption, Energy balance and recovery rate theories, Rating of Circuit Breakers, Construction and operation of Air Circuit Breaker(ACB), Air Blast Circuit Breaker (ABCB), Bulk oil Circuit Breaker, Minimum Oil Circuit Breakers, Sulphur Hexafluoride Circuit Breaker (SF6), Vacuum Circuit Breaker (VCB), HVDC circuit Breaker, Current Transformer: Construction, Magnetization curve, Core material, Errors, Accuracy class, Specifications, Potential Transformer: Construction, Capacitive Voltage Transformer, Specifications	8
5	Numerical Protection Introduction, Block Diagram of Numerical Relay, Sampling Theorem, Numerical Over-current, Differential and Distance Protection	4
Total Hours		42

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	List of Experiments/Tutorials To study and obtain characteristic of Non Directional IDMT (Induction Disc) relay, To study and obtain characteristic of Directional IDMT (Induction Cup) relay., To study and obtain CT Magnetizing characteristic., To perform Radial Feeder Protection., To perform Parallel Feeder Protection., Hands-on practice on Numerical Feeder Protection Relay., To study and perform Three Over-current One Earth-fault Protection., To study and perform Transformer Differential Protection., To study and perform Generator Differential Protection., To study and perform Induction Motor Protection., Simulation of Distance Protection of Transmission Lines.	14
Total Hours		14

Textbook :

- 1 Power System Protection and Switchgear, B. A. Oza, N. C. Nair, R. P. Mehta and V. H. Makwana, Tata McGraw-Hill Education, 2011

Textbook :

- 2 Fundamentals of Power System Protection, 2/e, Y. G. Paithankar and S. R. Bhide, Prentice Hall India, 2014
- 3 Protection and Switchgear, B. Bhalja, N. Chothani and R.P. Maheshwari, Oxford university pres, 2011

References:

- 1 Power system protection and switchgear, Power system protection and switchgear, B. Ravindranath and M. Chander, New Age International, 1977
- 2 Power system protection and switchgear, Power system protection and switchgear, B. Ram, Tata McGraw-Hill Education, 2011
- 3 Switchgear and protection, Switchgear and protection, S. S. Rao, Khanna Publications, 1992
- 4 The art and science of protective relaying, The art and science of protective relaying, C. Russell Mason, Wiley Chapman & Hall, 1956

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
10.00	20.00	25.00	25.00	10.00	10.00

Instructional Method:

- 1 The course delivery method will depend upon the requirement of content and the needs of students. The teacher, in addition to conventional teaching methods, may also use any tools such as demonstration, role play, Quiz, brainstorming, MOOCs, etc
- 2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and classroom
- 3 Practical examinations will be conducted at the end of the semester to evaluate the performance of students in the laboratory
- 4 Students will use supplementary resources such as online videos, NPTEL videos, e-courses, and Virtual Laboratory

Supplementary Resources:

- 1 <https://nptel.ac.in/courses/108107167>
- 2 <https://nptel.ac.in/courses/108105167>