

NIRMA UNIVERSITY
Institute of Technology
B. Tech. in Electrical Engineering
Semester – VI

L	T	P	C
3	0	2	4

Course Code	2EE601
Course Title	Power System Protection and Switchgear

Course Outcomes (COs):

At the end of the course, students will be able to-

1. illustrate the main components and features of protection schemes
2. design the protection schemes for power systems
3. analyse the characteristics of switchgear during fault conditions
4. adopt the advances in power system protection

Syllabus:

Teaching Hours: 45

Unit-1: Philosophy of Protective Relaying System: 03

Introduction, Abnormalities, Basic tripping circuit, Requirements of protective system, Functions of protective relaying schemes, Basic relay terminology, Relay classification, Zones of protection

Unit-2: Current and Potential Transformer: 04

Current transformer: Equivalent circuit, Vector diagram, Construction, Magnetization curve, Core material, Errors, Accuracy class, Specifications and testing
 Potential transformer: Equivalent circuit, Construction, Capacitive voltage transformer, Specifications and testing, Recent trends in instrument transformers

Unit-3: Overcurrent Protection Scheme: 04

Working principle, Classification, Methods of discrimination, Directional overcurrent protection, Application of overcurrent relays for feeder protection, Coordination of overcurrent relays in interconnected systems, Earth fault relay

Unit-4: Differential Protection Scheme: 04

Principle of simple differential protection- behaviour during load, During external fault and internal fault, Actual behaviour of a simple differential relay, Through fault stability percentage differential relay, Percentage differential protection of a 3-phase transformer

Unit-5: Distance Protection Scheme: 05

Impedance relay, Reactance relay, Mho relay, Input quantities for various types of distance relays, Effect of arc resistance, Effect of power swings, Effect of line length and source impedance on the performance of distance relays, Selection of distance relays, Three stepped impedance protection, Protection of transmission line including principles of pilot wire and carrier protection

Unit-6: Equipment Protection Schemes: 05

Protective schemes for generator, Motor and busbar, Neutral grounding, Methods of grounding

Unit-7: Numerical Protection: **05**
Introduction, Numerical relay hardware, Numerical overcurrent protection, Numerical transformer differential protection, Numerical distance protection of transmission line, Advantages of Numerical Protection.

Unit-8: Advances in State of the Art in Power System Protection: **05**
Introduction to adaptive relaying, various communication protocols, Digital relaying algorithms, Non-conventional sensors for enhanced protection, protection aspects in smart grid and in DC systems, Phasor measurement unit, Concepts of Wide – Area Measurements, Concept of disturbance analysis, Special protection schemes.

Unit-9: Switchgear: **10**
Fault clearing and interruption of current, Theory of initiation of arc, Methods of quenching arc, Restriking and recovery voltage, Ratings of circuit breaker, Construction and principle of different type of circuit breakers, HVDC circuit breakers, IoT in Switchgear applications.

Self-Study:

The self- study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Laboratory Work:

This shall consist of at least 10 laboratory experiments based on the syllabus.

Suggested Readings:

1. B. A. Oza, N. C. Nair, R. P. Mehta and V. H. Makwana, Power System Protection and Switchgear, Tata McGraw Hill.
2. Y. G. Paithankar and S. R. Bhide, Fundamentals of Power System Protection, Prentice Hall India.
3. B. Ravindranath and M. Chander, Power System Protection and Switchgear, New Age International Private Limited.
4. B. Bhalja, N. Chothani and R.P. Maheshwari, Protection and Switchgear, Oxford Publication.
5. B. Ram and D. N. Vishwakarma, Power System Protection and Switchgear, Tata McGraw Hill.
6. S. S. Rao, Switchgear and Protection, Khanna Publications.
7. Walter A. Elmore, Protective Relaying Theory and Applications, CRC Press.
8. Van A. R. and Warrington C., Protective relays – Theory and Practice, Chapman and Hall.
9. Les Hewitson, Mark Brown, Ben Ramesh, Practical Power System Protection, Elsevier.
10. A. G. Phadke, and J. S. Thorp, Synchronized Phasor Measurements and Their Applications, Springer.
11. Research papers and articles from reputed journals.

L = Lecture, T = Tutorial, P = Practical, C = Credit

w.e.f. academic year 2020-21 and onwards