



SARVAJANIK UNIVERSITY
Sarvajani College of Engineering and Technology
Bachelor of Technology



B.Tech. Semester VII

Subject Name: Power System Protection

Subject Code: BTEL10702

Type of course:	Professional Core courses
Prerequisite:	Basic knowledge of Power System – I and II
Rationale:	An electrical power system consists of generators, transformers, transmission lines, distribution lines and various types of electrical loads. In the case of an event of a fault, an automatic protective scheme comprising of protective relays and circuit breakers isolate the faulty section protecting the healthy part of the power system. Protective schemes of power system design and develop with highest priority for safety of equipment and human. Moreover, students must develop skills for operating various controls and switchgear in the power system. They are also required to carry out remedial measures for faults/abnormalities in machines/equipments in the power system using appropriate diagnostic instruments/devices. This course attempts to develop these skills in students and hence it is a core course for all electrical engineers.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
3	0	2	4	60	25	15	30	20	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests) **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr.No.	Content	Teaching Hrs.	Module Weightage
1	Introduction to Protective Relaying and electromagnetic relays Faults, Causes and Effects, Protective Zones, Primary and Backup Protection, Desirable Qualities and Terms of Protective Relaying, Basic Connection of Trip Circuit, Types of Relay Units, Relay Pick up, Reset or Drop out, Pick up/ Drop off Ratio, Construction and Working of Different Electromagnetic Relays.	3	5
2	Over Current Protection of Transmission line Introduction, Fuse, Thermal Relays, Over Current Relays,	3	5



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	Application of Definite Time & IDMT O.C. Relays for Protection of Feeder, Directional Over Current Relay, Limitations of O.C. Relays.		
3	Transformer Protection Types of Faults, Over Current Protection, Simple Differential Protection, Percentage Differential Protection, Inrush Phenomenon, Inter-turn Faults, Incipient Faults, Over-fluxing Phenomenon, High Resistance Ground Faults in Transformers, Restricted Earth fault Protection.	4	10
4	Generator protection Various faults & abnormal operation conditions, stator & rotor faults, transverse differential protection of generator, unbalanced loading, over speeding, loss of excitation, loss of prime mover, generator transformer combined differential protection. Class A, Class B and Class C Protections and conditions causing Alarms.	4	10
5	Induction motor protection Various faults & abnormal operation conditions, protection of small & large induction motor.	4	10
6	Distance Protection of Transmission line Drawbacks of O.C. Protection, Introduction to Distance Protection, Types of Distance Relay, Impedance, Reactance, MHO Relay, Performance of Distance Relay During Normal Load and Power Swing, Effect of Arc Resistance on Reach of Distance Relays, Comparison of Distance Relays, Distance Protection of Transmission line, Reasons for Inaccuracy of Distance Relay Reach, Three Step Protection, Trip contact configuration, 3-step protection of double and fed lines.	6	12
7	Carrier aided protection of transmission lines Need for carrier aided protection of transmission lines, various options for carrier, Coupling and trapping the carrier into the desired line section, single line to ground coupling, line to line coupling, unit type carrier aided directional comparison relaying, carrier aided distance scheme for acceleration of zone II, transfer trip or inter trip, permissive inter trip, acceleration of zone II, pre-acceleration of zone II, phase comparison relaying (unit scheme).	4	8
8	Numerical protection Introduction, block diagram of numerical relay, numerical over current protection, numerical transformer protection, numerical distance protection of transmission line, numerical protection of induction motor.	3	10
9	Theory of circuit Interruption Introduction, Physics of arc phenomena, Maintenance of the arc, Losses from plasma, Essential properties of arc, Arc interruption theories	2	5
10	Circuit Constant in Relation to Circuit Breaking	4	5



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	Introduction, Circuit breaker rating, Circuit constants & circuit conditions Re-striking voltage transient Characteristics of re-striking voltage, Interaction between the breaker & circuit, Current chopping, duties of switchgear		
11	Theory & Practice of Conventional Circuit Breaker and modern circuit breakers Air-break circuit breakers, Oil circuit breakers, Single and multi break Construction, Air-blast circuit breaker, Performance of circuit breakers and system requirements, Modification of circuit breaker duty by shunt resistors, Comparative merits of different types of conventional circuit breakers, Modern trends, Vacuum circuit breakers, Sulphur hexafluoride (SF6) circuit breakers D.C. circuit breaker, auto-reclosing - definitions & features.	6	15
12	Protective current transformer and potential transformer Magnetization curve of CT, Difference between measurement & protective CT, CT errors, calculation of CT accuracy, selection of CT, CT requirements for differential protection, specifications of CT, specifications of PT, PT errors, specification of CVT. protection against open circuit of secondary winding of CT.	2	5

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	30	10	10	10

Legends: R: Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create and above Levels (**Revised Bloom’s Taxonomy**)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	Fundamentals of Power System Protection	Y. G. Parithankar& S. R. Bhide	PHI		2nd
2.	Power system protection and switchgear	Oza, Nair, Mehta, Makwana			
3.	Switchgear and Protection	S. S. Rao	Khanna publication		



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4	Power System Protection and Switchgear	B. Ravindranath and M. Chander			
5	Art and Science of Protective Relaying	– Masson			
6	A Web Course on Digital protection of power system	Prof. Dr. S.A.Soman., IIT Bombay			
7	Computer relaying for power systems	A.G.Phadke, J.S.Thorp	Research studies press ltd.England John Wiley & sons Inc. New York.		
8	Protection and switchgear	By BhaveshBhalja, R.P.Maheshwari, Nileschchothani	Oxford Publication	2011	1 st edition
9	Power System Protection	– B. Ram	TMH Publication		

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	Explain various abnormal conditions that could occur in electrical system and protective relays	10%
CO-2	Demonstrate various conventional relays, their design and latest developments	25%
CO-3	Analyse various protective devices in power system for protecting equipment and personnel.	40%
CO-4	Explain of various types of instrument transformers, circuit breakers with their design and constructional details.	25%

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1	2	1		2	1	2	1			1	2		1	2	
CO-2	3	2	2	3	2	2	1	1	1	1	2	1	2	2	1
CO-3	3	2	2	3	2	2	1	1	1	1	2	1	2	2	1
CO-4	2	2	2	2	2	2	1		1	1	2	1	2	2	1



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List of Practicals

- 1 To study the effect of floating neutral on 3-phase system voltage.
- 2 Check the polarity of Current Transformer.
- 3 To study relay testing by secondary injection method and calculate error of over current relay.
- 4 To study and simulate external and internal fault of differential protection scheme for 3-phase Transformer.
- 5 To study and simulate fault in radial feeder and ring main protection scheme.
- 6 To study Induction motor protection scheme and simulate phase to phase and earth fault protection scheme of three phase induction motor.
- 7 To find out the CT errors.
- 8 To study CT and PT.
- 9 To study recent development of circuit breaker.
- 10 To study numerical differential relay and relay settings.
- 11 To study fault analysis in 3-phase system using matlab simulation.
- 12 To study Air circuit breaker.
- 13 to study under voltage relay.