

Branch Name:	Electrical Engineering
ProgramCode:	ET213
CourseName:	Modern Power System Protection
CourseCode:	2ET2130203T
Pre-requisiteCourse:	Fundamentals of Power System Protection

Course Objectives:

1. To understand the working, analysis and control digital relays.
2. To identify relay coordination and understand link net structure.
3. To understand new algorithm and advance technology for protection of system.

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								
					Theory (Marks)				Practical (Marks)				Total (Marks)
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
4	4	-	-	4	24	60	16	40	-	-	-	-	100

Course Contents:

Sr. No	Topic	Total Hours	Weightage (%)
1	Introduction to Digital Relays Comparison of digital relays with previous generation relays, Basic Components of Digital Relays with block diagram, Signal Conditioning Subsystems, Surge Protection Circuits, Anti-aliasing filter, Conversion Subsystem, The Sampling Theorem, Sample and Hold Circuit, Concept of analog to digital and digital to analog conversion, Idea of sliding window concept, introduction to intelligent electronic device (IED), Different relay algorithms such as algorithms for pure sinusoidal relaying signal, algorithm based on solution of system differential equations, Fourier analysis based half cycle and full cycle algorithm.	12	22%
2	Over current Relay Coordination for Radial and Parallel Feeder Protection of an interconnected system, Link net structure, Flowchart of Primary/Backup relay pairs, Flowchart of Time Multiplier Setting. Examples based on existing power system network.	08	12%
3	Wide Area Protection and Measurement Definition of wide-area protection, Architectures of wide-area protection, concept of synchronized sampling, wide area phasor measurement technology, concept of Adaptive relaying, advantageous of adaptive relaying and its application.	08	12%

4	System Response during Severe Upsets Introduction, Nature of system response to severe upsets such as system response to Islanding conditions, Under generated islands, Over generated islands, Reactive Power Balance, Power Plant Auxiliaries, Power System Restoration, Load Shedding, Factors to be considered for load shedding scheme such as maximum anticipated overload, number of load shedding steps, size of load shed at each step, frequency setting, time delay, rate of frequency decline, frequency relays, Issues with islanding and methods of islanding.	10	20%
5	Auto-reclosing and Synchronizing Introduction, history of auto-reclosing, advantageous of auto-reclosing, classification of auto-reclosing, auto-reclosing based on number of phases, auto-reclosing based on number of attempts, auto-reclosing based on speed, Sequence of events in single-shot auto-reclosing scheme, factors to be considered during reclosing such as choice of zone in case of distance relay, dead time, reclaim time, instantaneous trip lockout, intermediate lockout, breaker supervision function, Synchronism check, phasing voltage method, angular method, automatic synchronization.	10	20%
6	Concept of Different Relay Algorithms Introduction of different techniques, Least square based methods, Differential equation based techniques, Basic principles, and Digital harmonic filtering by selected limits, Fourier analysis based techniques, Introduction, The full cycle window algorithm, The half cycle window algorithm.	08	14%

Text Books:

1. A.T. Johns and S.K. Salman, Digital Protection of Power System, IEE Series, 1995.
2. Walter A. Elmore, Protective Relaying Theory and Applications, Marcel Dekker, Inc; New York.
3. S.H. Horowitz and A. G. Phadke, Power System Relaying, John Wiley & Sons, New York, 1996.
4. B. A. Oza, N.C. Nair, R.P. Mehta and Vijay Makwana, Power System Protection, McGraw Hill, 2009.

Reference Books:

1. Bhavesh Bhalja, R. P. Maheshwari and N. G. Chothani, Protection and Switchgear, Oxford University Press, 1st Edition, 2011
2. P. M. Anderson, Power System Protection, IEEE Press, New York, 1999.
3. J. L. Blackburn, "Applied Protective Relaying," Westinghouse Electric Corporation, New York, 1982.
4. Van C. Warrington A. R. "Protective Relays: Their Theory and Practice," Vol 1, Chapman & Hall Ltd, London, 1962.
5. A. G. Phadke and J. S. Thorp, "Computer Relaying for Power Systems," Research study press Ltd, John Wiley & Sons, Taunton, UK, 1988.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Analyze the tripping characteristics of various relays and its applications.	4 Analyze
CLO2	Design inductors and transformers for power electronic converters.	6 Creating
CLO3	Understand the basics of load shedding and factors affecting on it.	2 Understanding
CLO4	Know about auto reclosing and its fundamental for relays.	1 Remembering
CLO5	To operate various static relays, set their parameters and also to confirm its operations.	3 Applying
CLO6	To operate various Numeric relays, set their parameters and also to confirm its operations.	3 Applying

Mapping of CLOs with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO1			L		M			M		L		M		M	H	
CLO2	L		L		M					L		M		M	H	
CLO3				M			L				M		M			L
CLO4		L		H		M						M				L
CLO5	H				L	H		M				M	L		H	
CLO6	H				L	H		M				M	L		H	

H: High, M: Medium, L: Low