GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: ELECTRICAL ENGINEERING
SUBJECT NAME: DIGITAL PROTECTION
SUBJECT CODE: 3710714
M.E. 1st SEMESTER

Type of course: Program Elective-1

Prerequisite: Power System Protection and Switch-gear

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE(E)	PA (M)	PA (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction to Digital Relaying** Evolution of digital relays from electromechanical relays Performance and operational characteristics of digital protection	6	5
2	**Basic elements of digital protection** Signal conditioning: transducers, surge protection, analog filtering, analog multiplexers Conversion subsystem: the sampling theorem, signal aliasing error, sample and hold circuits, multiplexers, analog to digital conversion Digital filtering concepts The digital relay as a unit consisting of hardware and software	6	20
3	**Interconnected System Protection** Protection of an interconnected system Link net structure, Flowchart of Primary/Backup relay pairs, Examples based on existing power system network	8	15
4	**Mathematical background to protection algorithms** Interpolation formulae Numerical differentiation Least squares method Fourier analysis	8	20
5	**Digital Protection Algorithm:** Sinusoidal wave based algorithms Fourier Algorithm: Full cycle window algorithm, fractional cycle window algorithm. Least Squares based algorithms. Walsh function based algorithm.	6	15

	Differential equation based algorithms. Traveling Wave based Techniques.		
6	**Recent Trends in Protection** Recent Advances in Digital Protection of Power Systems. Digital Differential Protection of Transformers. Digital Transmission Line Protection. Problems and Solution for Protection of Series Compensated Transmission Lines.	8	25

Reference Books:

1. A.G. Phadke and J. S. Thorp, "Computer Relaying for Power Systems", Wiley/Research studies Press, 2009
2. A.T. Johns and S. K. Salman, "Digital Protection of Power Systems", IEEE Press,1999
3. Gerhard Zeigler, "Numerical Distance Protection", Siemens Publicis Corporate Publishing, 2006
   4.S.R.Bhide "Digital Power System Protection" PHI Learning Pvt.Ltd.2014
4. P M. Anderson, Series Editor, IEEE Press Power Engineering Series, "POWER SYSTEM PROTECTION"
5. S.R.Bhide "Digital Power System Protection" PHI Learning Pvt.Ltd.2014

Course Outcome:

After learning the course the students should be able to:
 1. Study of numerical relays
 2. Developing mathematical approach towards protection
 3. Study of algorithms for numerical protection

List of Experiments:

1. Study of digital relays with detailed description of each component of the schematic diagram of digital relay
2. Setting up IDMT relays for a radial feeder
3. Setting up IDMT/DOC relays for a power system using link net structure
4. Simulation of various fault signals and fault calculations.
5. Study of frequency domain analysis of a fault generated signal.
6. Study of Curve fitting and smoothing techniques.
7. Study of digital differential protection of transformers.
8. Simulation of fixed series capacitor compensated transmission line for fault at various location to explain the phenomena of current inversion and voltage inversion

List of Open Source Software/learning website:

http://nptel.ac.in/downloads/108101039/