SCHEME OF COURSE WORK

Course Details:

Course Title	**:Advanced Power System Protection**		
Course Code	**: 13EE2102**	**L T P C**	**:4 0 0 3**
Program:	**: M. Tech.**		
Specialization:	**: Power System Control and Automation**		
Semester	**: I**		
Prerequisites	**: Switchgear and Protection**		
Courses to which it is a prerequisite	**: --**		

Course Outcomes (COs): At the end of the course**,** the student will be able to:

1	Describe the classification of protective schemes, basic construction of static relays and different types of comparators
2	Describe and characterize different types of static over current and Distance relays.
3	Describe various types of pilot t relaying schemes.
4	Describe the protection schemes of an AC machine and Bus zone for different faults.
5	Describe, implement and test on Numerical relaying algorithms' for a Micro Processor and DSP based protective relays.

Program Outcomes (POs):

The programme outcomes are achieved through the following means:

1	The graduate will be able to acquire in depth knowledge in the area of power system control and automation.
2	The graduate will attain the ability to think critically and analyze complex engineering problems related to power system control and automation.
3	The graduate will obtain the capability of problem solving and original thinking to arrive at feasible and optimal solutions considering societal and environmental factors.
4	The graduate will be able to extract information through literature survey and apply appropriate research methodologies, techniques and tools to solve power system problems.
5	The graduate will be able to use the state-of-the-art tools for modeling, simulation and analysis of problems related to power systems.
6	The graduate will attain the capability to contribute positively to collaborative and multidisciplinary research to achieve common goals.
7	The graduate will demonstrate knowledge and understanding of power system engineering and management principles and apply the same for efficiently carrying out projects with due consideration to economical and financial factors.
8	The graduate will be able to communicate confidently, make effective presentations and write good reports to engineering community and society.
9	The graduate will recognize the need for life-long learning and have the ability to do it independently.
10	The graduate will become socially responsible and follow ethical practices to contribute to the community for sustainable development of society.
11	The graduate will be able to independently observe and examine critically the outcomes of his actions and reflect on to make corrective measures subsequently and move forward positively by learning through mistakes.

Course Outcome versus **Program Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P11
CO-1	S	S	S	S	S	S	W	M	W	W	M
CO-2	S	S	S	S	S	S	W	M	W	W	M
CO-3	S	S	S	S	S	S	W	M	W	W	M
CO-4	S	S	S	S	S	S	W	S	W	W	M
CO-5	S	S	S	S	S	S	W	S	W	W	M

S - Strongly correlated, *M - Moderately* correlated, *Blank - No correlation*

Assessment Methods:	Assignment / Quiz / Seminar / Case Study / Mid-Test / End Exam

Teaching-Learning and Evaluation

Week	TOPIC / CONTENTS	Course Outcomes	Sample questions	TEACHING-LEARNING STRATEGY	Assessment Method & Schedule
1	UNIT-I: STATIC RELAYS: Basic construction of static relays, Classification of protective schemes, Comparison of Static relays with electromagnetic relays, Amplitude comparator, Phase comparator, Principle of Duality.	CO-1	Compare the static relays with electromagnetic relays	▫ Lecture ▫ Discussion	Mid-Test 1 (Week 9) Seminar (Week 1)
2	AMPLITUDE AND PHASE COMPARATORS (2-INPUT): Rectifier bridge circulating and opposed Voltage type- Averaging -phase splitting type - Sampling type of amplitude Comparison.	CO-1	Explain what are amplitude and phase comparators.	▫ Lecture	Mid-Test 1 (Week 9) Seminar (Week 2)
3	Block spike type-Phase splitting type- Transistor integrating type-Rectifier bridge type- Vector product type Phase comparison. UNIT-II STATIC OVER CURRENT RELAYS: Instantaneous- Definite time – Inverse time-Directional.	CO-1 & CO-2	Discuss the operating principle of a Rectifier bridge phase comparator	▫ Lecture ▫ Problem solving	Mid-Test 1 (Week 9) Seminar (Week 3)
4	IDMT- Very inverse Time-Extremely inverse time over current relays. Time current characteristics of over current relays-applications.	CO-2	Compare the time-current characteristics relays of inverse, very inverse and extremely inverse over current relays. Discuss their area of applications.	▫ Lecture ▫ Problem solving	Mid-Test 1 (Week 9) Seminar (Week 4) Assignment (Week 4)
5	DISTANCE PROTECTION: Impedance Relay: operating principle- relay Characteristic-Protective Schemes-Static Impedance Relay- Static reactance relay- static MHO relay.	CO-2	Explain Impedance relay characteristics on the R-X diagram. Explain its operating principle.	▫ Lecture	Mid-Test 1 (Week 9) Seminar (Week 5)
6	effect of arc resistance, effect of power surges, effect of line length and source impedance on performance of distance relays	CO-2	Discuss the effect of power surges on the performance of different types of distance relays.	▫ Lecture	Mid-Test 1 (Week 9) Seminar (Week 6)
7	Quadrilateral relay – Elliptical relay - selection of distance relays.	CO-2	Discuss how an elliptical characteristics is realised using static comparators.	▫ Lecture	Mid-Test 1 (Week 9) Seminar (Week 7)
8	UNIT-III PILOT RELAYING SCHEMES: Wire pilot protection: circulating current scheme-balanced voltage scheme-translay scheme-half wave comparison scheme.	CO-3	Discuss the limitations of wire pilot protection?	▫ Lecture	Mid-Test 1 (Week 9) Seminar (Week 8)
9	**Mid-Test 1**				
10	Carrier current protection: phase comparison type-carrier aided distance protection-operational comparison of transfer trip and blocking schemes-optical fiber channels.	CO-3	What is carrier current protection? With neat sketches, discuss the phase comparison scheme of carrier current protection.	▫ Lecture ▫ Discussion	Mid-Test 2 (Week 18) Seminar (Week 9)
11	UNIT-IV AC MACHINES AND BUS ZONE PROTECTION: Protection of Alternators: stator protection-rotor protection-over voltage protection-over speed protection-	CO-3 & CO-4	What type of protective device is used for the protection of an alternator against overheating of its stator and rotor?	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 10)
12	Transformer protection: earth faults in transformers-percentage differential protection-protection against magnetic inrush current-generator and transformer unit protection	CO-4	What is magnetizing inrush current? What measures are taken to distinguish between the fault current and magnetizing inrush current?	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 11)
13	Bus zone protection: differential current	CO-4	With a neat sketch, discuss the	▫ Lecture	Mid-Test 2

	protection-high impedance relay scheme-frame leakage protection.		differential scheme for buszone protection?		(Week 18) Seminar (Week 12)
14	UNIT-V MICROPROCESSOR AND DSP BASED PROTECTIVE RELAYS: MP based: Introduction-over current relays-Impedance relay-Directional relay-Reactance relay.	CO-5	Describe the realization of directional impedance relay using a microprocessor.	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 13)
15	Numerical Protection: Introduction, numerical relay, Comparison of Numerical relays with static relays Data acquisition System, Numerical relaying algorithms- Mann-Morrison technique.	CO-5	With the help of block diagram discuss the operation of the numerical relay.	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 14)
16	differential equation technique, Discrete Fourier transform technique: DSP based: Digital signal processing –digital filtering in protection relays-	CO-5	How can R and X of the line as seen by the relay be calculated by using an algorithm based on the discrete Fourier transform technique.	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 15) Assignment (Week 16)
17	digital data transmission– relay hardware – relay algorithms. Concepts of modern coordinated control system.	CO-5	Explain the concepts of modern coordinated control system.	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 16)
18	**Mid-Test 2**				
19/20	**END EXAM**				