DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

| COURSE PLAN –PART I | | | |
|---|---|---|---|
| Name of the programme and specialization | I Year M.Tech, Power Systems, EEE | | |
| Course Title | Computer Relaying and Wide Area Measurement Systems | | |
| Course Code | EE678 | No. of Credits | 03 |
| Course Code of Pre-requisite subject(s) | Digital Signal Processing, Power system protection | | |
| Session | July 2019 | Section | -- |
| Name of Faculty | M. Jaya Bharata Reddy | Department | EEE |
| Email | jbreddy@nitt.edu | Telephone No. | 0431-2503270 |
| Pre-requisites of Course Code | Basic knowledge on the principles of digital signal processing and power system protection. | | |
| Course Coordinator(s) (if, applicable) | ------ | | |
| Course Type | ☐ Core course ☑ Elective course | | |

**Syllabus (approved in BoS)**

UNIT – I Introduction to Computer Relaying Introduction to DSP, Use of computer relay, Analog to Digital Converters, Sampling, Anti – aliasing filters. Evolution of power system relaying from electromagnetic to static to computer relaying; Relay operating principles for computer relaying; Expected benefits of computer relaying, Computer relay architecture.

UNIT – II Protection of Transmission Line using Computer Relaying Three zone protection of transmission line, algorithms for impedance calculations- Mann-Morrison algorithm - Three sample technique - Two sample technique - First and second derivative algorithms - Numerical integration methods.

UNIT –III Protection of power system equipment using Frequency domain techniques Problems associated with differential protection of transformer and bus-bar, magnetic inrush current, LSQ algorithm, Fourier analysis of transformer protection.

UNIT –IV Phasor Measurement Units Introduction to Phasor measurement units (PMUs), global positioning system (GPS), Functional requirements of PMUs and PDCs, phasor estimation of nominal frequency inputs

UNIT –V PMU Applications Wide Area Measurement Systems (WAMS), WAMS Applications in Smart Grid, WAMS Based Protection Concepts, Adaptive Relaying, State estimation

## COURSE OBJECTIVES

The goal of this course is to provide basic knowledge on computer relaying and its applications in wide area measurement systems. The internal architecture and algorithms employed in a numerical relay will be discussed. Understanding about wide area measurement systems, mathematical background for relaying algorithms and also examining line relaying algorithms for protection of power system components

| Course Outcomes | Aligned Programme Outcomes (PO) |
|---|---|
| At the end of the course students will be able to<br>1. Demonstrate knowledge of fundamental aspects of theories, principles and practice of computer relaying.<br>2. Define and understand the concepts of Wide area measurement systems<br>3. Understand and design wide area measurement systems applications in Smart grid | |

| COs / POs | | Course outcomes(COs) | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| Programme Outcomes (POs) | 1 | H | M | H |
| | 2 | H | H | H |
| | 3 | H | H | H |
| | 4 | NA | NA | NA |
| | 5 | M | M | M |
| | 6 | M | H | M |
| | 7 | M | M | M |
| | 8 | H | H | H |
| | 9 | M | M | M |
| | 10 | M | M | M |
| | 11 | M | M | M |
| | 12 | H | H | H |
| | 13 | M | M | M |
| | 14 | M | M | M |

## COURSE PLAN –PART II

### COURSE OVERVIEW

The course is designed to understand the operating principles of computer relays and wide area measurement systems. Learning about main classification of computer relay, Wide area measurement systems and their behavior, mathematical background for understanding relaying algorithms and also examining line relaying algorithms and protection of power system components.

### COURSE TEACHING AND LEARNING ACTIVITIES

| S.No. | Week | Topic | Mode of Delivery |
|---|---|---|---|
| 1 | Weeks 1 to 2 (6 contact hours, including two contact hours for problem solving) | Fundamentals of DSP, DFT, FFT | Lecture/Tutorial |
| 2 | | Numerical examples/Problem Solving | Group work (exercise) |
| 3 | Weeks 3 to 5 (9 contact hours, including two contact hours for problem solving) | Computer relaying architecture | Lecture/Tutorial |
| 4 | | Numerical examples/Problem Solving | Group work (exercise) |
| | | **Assessment 1** | Written test |
| 5 | Weeks 6 to 8 (9 contact hours, including two contact hours for problem solving) | Implementation of different types of computer relays | Lecture/Tutorial |
| 6 | | Numerical examples/Problem Solving | Group work (exercise) |

| | | | |
|---|---|---|---|
| 7 | Weeks 9 to 11 (9 contact hours, including two contact hours for problem solving) | Fundaments of PMU and WAMS | Lecture/Tutorial |
| 8 | | Numerical examples/Problem Solving | Group work (exercise) |
| | | **Assessment 2** | Written test |
| 9 | Weeks 12 to 13 (6 contact hours, including two contact hours for problem solving) | Application of PMU in Power System | Lecture/Tutorial |
| | | Numerical examples/Problem Solving | Group work (exercise) |
| 10 | Weeks 14 to 15 | **Compensation Assessment (CPA)** | Written test |
| 11 | | **End Semester Examination** | Written test |

| **Mode of Assessment** | | | | |
|---|---|---|---|---|
| **S.No.** | **Mode of Assessment** | **Week/Date** | **Duration** | **% Weightage** |
| 1 | 1st Mid Semester Examination (Written test) (1st and 2nd Units) | 5th Week | 60 Minutes | 20 |
| 2 | 2nd Mid Semester Examination (Written test) (3rd and 4th Units) | 11th Week | 60 Minutes | 20 |
| 3 | Take Home / Team Task | 3rd to 12th week | Work will be carried out along with the course | 10 |
| 4 | Compensation Assessment (CPA) | 14th week | 60 Minutes | 20 |
| 5 | End Semester Examination (Written test) | 15th week | 180 Minutes | 50 |

**ESSENTIAL READINGS : Textbooks, reference books Website addresses, journals etc**


1. A.G. Phadke, J.S. Thorp, 'Computer Relaying for Power Systems', John Wiley and Sons Ltd., Research Studies Press Limited, 2nd Edition, 2009.
2. A.G. Phadke, J.S. Thorp, 'Synchronized Phasor Measurements and Their Applications', Springer Publications, 2008.


**COURSE EXIT SURVEY**

will be obtained at the end of the course

**COURSE POLICY**

**COMPENSATION ASSESSMENT POLICY**

If any student is not able to attend I and / or II Cycle test(s) due to genuine reasons with prior permission, student is permitted to attend the compensation assessment (CPA) with 20% weightage (20 marks).

**ATTENDANCE**

- **At least 75% attendance in each course is mandatory.**
- **A maximum of 10% shall be allowed under On Duty (OD) category.**
- Students with **less than 65% of attendance** shall be prevented from writing the final assessment and **shall be awarded 'V' grade.**

**ACADEMIC HONESTY & PLAGIARISM**

- Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others during an assessment will be treated as punishable dishonesty.
- Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.
- The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to the Academic office.

  The above policy against academic dishonesty shall be applicable for all the programmes.

**ADDITIONAL INFORMATION:** ----

**FOR APPROVAL**

**Course Faculty**_____ **CC-Chairperson**_____ 27/08/19 **HOD**_____