**University of Management and Technology**

**Course Outline**

Course code: **EE423** Course title: **Power System Protection**

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| Program | BSEE |
| Credit Hours | 3 |
| Duration | One Semester |
| Prerequisites | EE317 Power System Fundamentals |
| Resource Person | Fahad Usman KhanMuhammad Haris |
| Counseling Timing(Office # 7, Hall # 510, SEN Building ) | See office door |
| Contact | muhammad.haris@umt.edu.pkfahad.khan@umt.edu.pk |

**Chairman/Director signature………………………………….**

**Dean’s signature…………………………… Date………………………………………….**

**Introduction:**

Power System Protection is the branch of power system concerned with the principles of design and operation of equipment called Relays, which detects abnormal power system conditions, and initiates corrective action as quickly as possible in order to return the power system to its normal state.

**Learning Objective:**

Students who complete this course will have gained a theoretical and applied understanding of power system protection. The performance of instrument transformers, transducers, protective relays, and circuit breakers is first addressed. These devices are then integrated into coordinated
protective systems for generators, transformers, transmission lines, reactors, capacitor banks, system buses, etc. Although basic protection concepts are hardware-independent, the application of electromagnetic, solid state, and microprocessor-based relays will also be discussed. Trade-offs
between reliability, selectivity, speed, simplicity, and economy are emphasized.

**Learning Outcomes:**

* **Knowledge and understanding**

Having successfully completed the course, the student will be able to demonstrate knowledge and understanding of:

* The various types of protection systems.
* The types of protective relays.
* Performance and design calculations for transformers and generator protection schemes.
* Instrument transformer selection.
* Types of protective devices and their choices.
* Unit and non-unit protection systems.
* **Cognitive skills (thinking and analysis).**

Students are allowed and encourageto make seminars on various topics in power system protection schemes with comprehensive discussions.

* **Communication skills (personal and academic).**

Having successfully completed the module, student will be able to:

* Appreciate the importance of protective relays in power systems.
* Compare and contrast the operation of different types of protective schemes.
* Derive equations related to the different protection methods.
* Formulate relevant equivalent circuits of the protection schemes to analyze their actual behavior.
* Identify different types of protective relays and their applications.
* Analyze simple problems related to protection schemes.
* **Practical and subject specific skills (Transferable Skills).**

Having successfully completed the module, the student will be able to:

* Choose among the different types of protection schemes to suit a given application task.
* Explain the operation and performance of different types of protective relays.
* Apply engineering studies for different types of power system protection.
* Interpret results and correlate them with theoretical predictions
* Write a technical repots.

**Teaching Methodology:**

Lectures will be used to describe and develop the concepts stated above.

Group tasks will be given to enhance interactive learning.

Industrial visits will be arranged to further strengthen the basic concepts and to increase practical exposure.

**Grade Evaluation Criteria**

Following is the criteria for the distribution of marks to evaluate final grade in the semester.

**Marks Evaluation Marks in percentage**

Sessional (Quizzes + Assignments) 25%

Mid Term 25%

Final exam 50%

Total 100%

**Recommended Text Books:**

* Fundamentals of power System Protection by Y.G. Paithankar and S. R. Bhide

**Reference Books:**

* Protective Relaying principles and application, 3rdedn. By J. Lewis Blackburn and Thomas J. Domin
* Power System Relaying, 3rdedn. By Stanley H. Horowitz and Arun G. Phadke

**Calendar of Course contents to be covered during semester**

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| **Lectures** | **Topics** | **Textbook (TB) /****Reference Readings(RB)** |
| **02** | **INTRODUCTION**Faults and Abnormal Operating Conditions , Classification of Shunt Faults, Abnormal Operating Conditions , Evolution of Power Systems, Protection System and Its Attributes, system Transducers | Ch # 01 of TB |
| **02** | **OVER-CURRENT PROTECTION OF TRANSMISSION LINES** 0ver-current Relay, Application of Definite Time OC Relays for Protection of a Distribution Feeder, Application of Inverse Definite Minimum Time Relay on a Distribution Feeder, Directional Over-current Relay | Ch # 02 of TB |
| **03** | **DIFFERENTIAL PROTECTION**Simple Differential Protection, Zone of Protection of the Differential Relay, Percentage Differential Relay, Earth Leakage Protection | Ch # 03 of TB |
| **04** | **TRANSFORMER PROTECTION**Phasor Diagram for a Three-phase Transformer, Equivalent Circuit of Transformer, Types of Faults in Transformers, Inter-turn Faults in Transformers, Incipient Faults **in** Transformers, Transformer Protection Application Chart, An Illustrative Numerical Problem | Chap # 04 of TB |
| **05** | **BUSBAR PROTECTION**Differential Protection of Busbars, External and Internal Fault, Actual Behaviour of a Protective CT, Circuit Model of Saturated CT, External Fault with One CT Saturated: Need for High ImpedanceBusbar Protection, Minimum Internal Fault That Can Be Detected by the High*,* Impedance Busbar Differential Scheme | Chap # 05 of TB |
|  | **Mid Term Exam** |  |
| **04** | **DISTANCE PROTECTION OF TRANSMISSION LINES** Drawbacks of Over-current Protection, Introduction to Distance Protection, Simple Impedance Relay, Reactance Relay, Mho Relay, Comparison Between Distance Relays, Distance Protection of a Three-phase Line | Chap # 06 of TB |
| **03** | **INDUCTION MOTOR PROTECTION** Introduction, Various Faults and Abnormal Operating Conditions, Starting Current, Electrical Faults, Abnormal Operating Conditions from Supply Side, Abnormal Operating Conditions from Mechanical Side,  | Chap # 07 of TB |
| **04** | **STATIC COMPARATORS AS RELAYS** Comparison vs Computation, Amplitude Comparator, Phase comparator, Duality Between Amplitude and Phase Comparators, Synthesis of Various Distance Relays Using Static Comparators, Development of an Electronic Circuit for Implementing a Cosine-type Phase Comparator | Chap # 09 of TB |
| **05** | **NUMERICAL PROTECTION** Introduction, Block Diagram of Numerical Relay, Sampling Theorem, Correlation with a Reference Wave, Fourier Analysis of Analogue Signals, Least Error Squared (LES) Technique, Reasons for Inaccuracy of Distance Relay Reach, Three-stepped Distance Protection | Chap # 010 of TB |
| **End Term Exam (Comprehensive)** |