**20EE41E4 – SWITCHGEAR AND PROTECTION**

**(EEE)**

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| **Course Category:** | Professional Elective | **Credits:** | 3 |
| **Course Type:** | Theory | **Lecture-Tutorial-Practical:** | 3-0-0 |
| **Pre-requisite:** | Power system equipment, power system Analysis, circuit analysis and field theory. | **Sessional Evaluation:****External Exam Evaluation:****Total Marks:** | 4060100 |

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| **Course Objectives:** | Students undergoing this course are expected to learn : |
| 1. About switchgear protective equipments.2. The construction and operation of different types of circuit breakers.3. Different types of relays and its operation.4. The different types of relay applications.5.The zones of protection and equipment protection in the power system.6.The protection against overvoltage and to insulation co-ordination |
| **Course Outcomes:** | After completing the course the student will be able to: |
| **CO1** | Understand the application and operation of the fuses as well as on Arcing Phenomenon. |
| **CO2** | Enumerate the operation and application of various types of circuit breakers in the real time applications of power system. |
| **CO3** | Differentiate the operation of different relays. |
| **CO4** | Choose appropriate relays for the power system protection. |
| **CO5** | Design zones of protection and equipment of protection in the power system. |
| **CO6** | Gain knowledge in the field of over voltage protection. |
| **Course Content:** | **UNIT-I****Fuses:** Definitions, characteristics, selection of fuses, types of fuses and applications.**Circuit breakers:** Arc phenomena, initiation & maintenance of arc, methods of arc interruption, restriking voltage and recovery voltages, restriking phenomenon, average and max. RRRV, expression for RRRV, resistance switching, single frequency transients, double frequency transients, current chopping, interruption of capacitive currents.**UNIT-II****Classification of circuit breakers:** Principle of operation & constructional features of oil, air blast, SF6 & vacuum CBs, ratings of CBs, testing of CBs, auto reclosures. **UNIT-III****Protective relays:** Fundamental requirement of protective relays, primary and backup protection, principle of operation of protective schemes. **Classification of relays-I:** Types of Electromagnetic relays, over current relays, directional relays and non-directional relays, earth fault relays.**UNIT-IV****Classification of relays-II:** Distance relays, negative sequence- differential and under frequency relays.**Static relays:** Basic static relays used in protective scheme, classification of static relays, over current, directional, distance, differential relays. Comparators, amplitude & phase comparators, duality.**UNIT-V****Feeder protection:** Transmission line, protection-bus bar protection.**Generator protection:** Protection for stator faults, rotor faults and protection for abnormal conditions.**Transformer protection:** Differential protection schemes-Buchholz relay. **UNIT-VI****Over voltage protection:** Causes of over voltages in the power system, Phenomena of lightning, protection against direct strokes & indirect strokes, lightning arresters, zinc oxide lightning arrester, surge absorbers.**Insulation coordination:** Volt-time curve, basic impulse insulation levels of different equipments, insulation coordination of transformers, lightning arresters, bus bars and transmission lines.  |
| **Text books****&****Reference books:** | **Text books:**1.“Power system protection and switchgear”, by Badri Ram & D. N.  Vishwakarma, Tata-McGraw-Hill, 2nd Edition2.“Electrical power systems”, by C.L. Wadhwa, 7th Edition NAI  publishers.3.“A Course in power systems”, by J.B Gupta, Publisher: S.K. Kataria & Sons; 11th Edition.**Reference books:**1. “Switchgear & protection”, by Sunil S Rao, Khanna Publishers.
2. “Power system protection & switchgear” by B.Ravindranathand N*.* Chander*,* Wiley Eastern Limited.
3. “Electrical power*”,* by Dr S L Uppal*,* Khanna Publishers.
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