Module 1

Syllabus : Substation Equipment : Instrument Transformers - Role of instrument transformers in measuring and protection, difference between measuring and protection CTs, selection of technically suitable instrument transformers; **Switchgear** : Definition, Types, Location of switchgear in typical power system, single line diagram to show the measuring and protection scheme. **Switching Devices** : Isolator & Earthing switch (Requirements & definitions, types and construction, Pantograph Isolators, Ratings), Load break switches - Ratings and applications; Contactors - Basic working principle, Terms & Definitions, applications.

Module 2

Syllabus : Circuit Breaker : Arc initiation, arc quenching principles, Re-striking voltage, RRRV, Recovery voltage, Types of Circuit Breakers : For LV application- MCB, MCCB, ELCB, air circuit breakers. For HV application- SF6 circuit breakers, vacuum circuit breakers (working principle, Construction, operating mechanisms, ratings & applications), Mechanical life, Electrical life and testing of circuit breakers. Principle and applications of LV and HV DC circuit breakers.

Fuses & their applications : Introduction, classification, working principle and applications of re-wirable and HRC fuses, Expulsion and drop out fuses, Fusing factor, selection of fuse link and cut off characteristics.

Module 3

Syllabus : Shunt & Series Faults, causes and Effects of faults, Importance of protective relaying, Protective zones, primary & Back-up protection, Different types of backup protection, desirable qualities of protective relaying, PSM & TSM(Importance, Different types of Time current characteristics and application), working principle of Electromagnetic Induction disc Relays, Thermal, bimetal relays, Frequency relays, under/over voltage relays, DC relays,

Different Principles of protection : Over current & earth fault (non- directional & directional types), differential protection(current and voltage type), distance protection (Working Principle and application of Impedance relay, Causes and remedies of Over reach-under reach, Reactance and Mho relay, Power swing blocking relay).

Module 4

Syllabus : Generators : Stator side (Differential, Restricted Earth fault, protection for 100% winding, Negative phase sequence, Reverse power, turn-turn fault), Rotor side (Field suppression, field failure, Earth fault, turn to turn fault)
Transformers : Differential protection for star delta Transformer, Harmonic restraint relay, REF protection, Protection provided for incipient faults (Gas actuated relay).
Induction motors : Protection of motor against over load, short circuit, earth fault, single phasing, unbalance, locked rotor, phase reversal, under voltage, winding temperature, Protection co-ordination.

Module 5

Syllabus : Feeder protection : Time grading, current grading, combined time and current grading protection provided for Radial, Ring Main, Parallel, T- Feeder.

Bus Zone Protection : Differential protection provided for different types of bus zones.

LV, MV, HV Transmission Lines : Protection provided by over current, earth fault, Differential and Stepped distance protection.

EHV and UHV Transmission lines : Need for auto-reclosure schemes, Carrier aided distance protection (Directional comparison method), Power Line Carrier Current protection (Phase comparison method).

Module 6

Syllabus : Static Relays : Introduction, Definition, Advantages and Disadvantages, Application of op-amps, logic gates, DSP, in static/digital Relays. Relays as comparators (Amplitude and phase).

Numerical Relays : Introduction, Block diagram of numerical relay, Signal sampling, Anti - Aliasing Filter, Introduction to the concept of Phase Measurement Unit.

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