

Contents

Foreword	vii
Author's Preface	viii
List of Symbols	xi
1. Basic Principles of Protective Relays	1
Operating characteristics and equations. Types of protection. Level detectors, timing circuits and comparators. Duality of phase and amplitude comparators.	
2. Development of Static Relays	25
Early electronic relays. Semiconductor relays. Comparison of static and Electromagnetic relays. Reliability of static relays and their components.	
3. Basic Semiconductor Devices and Circuits	48
Semiconductor devices. Amplifier circuits. Compensation for temperature errors, etc. Operational amplifiers. Integrated circuits. Thyristors. Unijunction and field effect transistors. Logic. Building block circuits. Multivibrators. Voltage regulators. Symmetrical component filters. Smoothing circuits. Series and parallel resistance and reactance.	
4. Comparators	87
Amplitude comparators. Phase comparators. Direct comparison. Integrated comparison. Phase-splitting methods. Vector product devices. Effect of offset waves upon comparators.	
5. Output Devices; D.C. Supply; Transient Overvoltages	130
Tripping circuits and devices. d.c. supplies for transistors. Causes and effects of transient overvoltages. Methods of diverting or suppressing them.	
6. Power System Faults	150
Types, causes and frequency of faults on lines, cables, generators, motors, transformers and buses. Determination of relay currents and voltages during faults. Fault resistance.	
7. Current and Potential Transformers	172
Error due to magnetizing current. Effects of magnetic saturation, d.c. offset and secondary burden upon c.t. accuracy. Linear and segmental couplers. Magnetic p.t's Capacitor p.t's. Errors in p.t's. Loss of a.c. potential.	
8. Overcurrent Directional Relays	189
Operating principles of static time-current relays. Timing and resetting circuits. Adjustment of characteristics. Template and computer setting. Directional relays. Static operation indicators.	

Contents

9. Differential Relays	207
Basic principles: Longitudinal, transverse and multi-input differential comparator circuits. Applications to generators, transformers, buses and lines. Effect of c.t. errors and primary current transients. Summation c.t. versus sequence filter.	
10. Distance Relays	230
Inputs to phase and amplitude comparators. Types of distance relay; their equations and characteristics. Special types. Conic section characteristics. Quadrilateral characteristics. Distance relays with linear couplers.	
11. Steady-state Sources of Distance Relay Error	269
Effect of fault resistance with double-end feed. Effect of power transfer and power swings. Parallel lines. Transients in fault current.	
12. Multi-input Comparators	303
Conic section characteristics. Hybrid comparators. Multi-lateral characteristics. Polyphase phase comparators. Polyphase amplitude comparators. Phase sequence comparators.	
13. Heating, Harmonics and Load-Shedding	329
Overheating of electrical apparatus. Thermal protection of lines, cables, motors, alternators and transformers. Harmonic relaying. Sensitive ground fault detector. Harmonic protection of lines, transformers and industrial equipment.	
14. E. H. V. Line Protection	356
Special features. Fault incidence. Speed and reliability of relays. Back-up protection. Transient overvoltages. Auto-reclosing. E.H.V. c.t.'s.	
15. Pilot Differential Protection	372
Performance on faults, charging current and power swings. Relay characteristics. Protection of multi-ended lines. Application of wired pilot and phase-comparison carrier pilot systems.	
16. The Future	420
Miniaturization. Faster tripping. Communication channels. Use of computers in automatic protection. Other computer uses. Fault location. Power from ground wires. New fields.	
References	425
Index	431

